

## **System Impact Assessment Report**

Calm Lake GS and Sturgeon Falls GS Excitation System and Governor System Control Replacement

### **Acknowledgement**

The IESO wishes to acknowledge the assistance of Abitibi Bowater in completing this assessment.

### **Disclaimers**

#### **IESO**

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

Approval of the proposed connection is based on information provided to the IESO by the connection applicant and the transmitter(s) at the time the assessment was carried out. The IESO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by the transmitter(s) at the request of the IESO. Furthermore, the connection approval is subject to further consideration due to changes to this information, or to additional information that may become available after the approval has been granted. Approval of the proposed connection means that there are no significant reliability issues or concerns that would prevent connection of the proposed facility to the IESO-controlled grid. However, connection approval does not ensure that a project will meet all connection requirements. In addition, further issues or concerns may be identified by the transmitter(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 IESO in accordance with Chapter 4, section 6 of the Market Rules. The IESO assumes no responsibility to any third party for any use, which it makes of this report. Any liability which the IESO may have to the connection applicant in respect of this report is governed by Chapter 1, section 13 of the Market Rules. In the event that the IESO provides a draft of this report to the connection applicant, you must be aware that the IESO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IESO will use its best efforts to advise you of any such changes, it is the responsibility of the connection applicant to ensure that it is using the most recent version of this report.

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## PROJECT DESCRIPTION

Abitibi Bowater have replaced the excitation and governor control systems at Calm Lake GS and Sturgeon Falls GS and have indicated that the new equipment will be available for service during the last week of July, 2008.

Calm Lake GS is comprised of 2 x 5 MW generating units and Sturgeon Falls GS is comprised of 2 x 4 MW generating units. Both stations are connected to a radial 115 kV feeder at Moose Lake TS.

## SIA CONCLUSIONS

This assessment examined the performance of the proposed new control systems at Calm Lake GS and Sturgeon Falls GS and its effect on the reliability of the IESO-controlled grid. The studies concluded that:

- the new excitation system model meets the Market Rules requirements
- there are no market rule requirements for governor systems on generating units having a capacity less than 10 MVA . In the absence of a suitable governor model, the studies have been completed without consideration to governor action.
- the generating unit equipped with the new excitation system displays stable performance and well damped oscillations, without governor action.

## SUMMARY OF REQUIREMENTS

The applicant is required to ensure that the performance of the exciter system at Calm Lake GS and Sturgeon Falls GS is similar or exceeds the predicted performance observed in the simulation results obtained using the models provided by the applicant.

As soon as the commissioning tests are completed and actual data is available, the connection applicant is required to provide an updated block diagram model and data of the excitation systems. If the models and data differ materially from those used in the studies, the IESO may be performing additional studies to verify the behavior of the excitation system and establish the need for any new controls and adjustments, as part of the Facility Registration Process.

Up to date hydro alternator and governor models should also be submitted after commissioning.

## NOTIFICATION OF APPROVAL

It is recommended that a *Notification of Approval for Connection* be issued for this project subjected to implementation of the requirements given above.

If the new equipment either does not meet the specified performance standards when installed, or is subsequently determined not to meet those performance standards, the IESO connection approval may be withdrawn until the specified performance standards, or their equivalent can be demonstrated.

## 1.0 MARKET RULES REQUIREMENTS

The requirements for exciters on generation unit rated at below 10 MVA are listed in Reference 12 and 13 of Appendix 4.2 in Market Rules as follows:

- An excitation system nominal response of at least 0.5 and
- A positive ceiling voltage of at least 150% of the rated field voltage
- Terminal voltage must be maintained with +/- 0.5% of any set point within +/-5% of rated voltage

The requirements for governors on generation units rated greater than 10 MVA are listed in Reference 16 of Appendix 4.2 in Market Rules as follows:

- Speed droop between 3% and 7%
- Intentional deadband = +/- 36mHz

It should be noted that the governor requirements are not applicable for the Calm Lake and Sturgeon Falls GS machines since they are all rated below 10 MVA but since the data was submitted by Abitibi Bowater they were assessed regardless and were found to be unsuitable for our modelling purposes. The excitation requirements detailed above do apply to these machines.

## 2.0 DATA VERIFICATION

The connection applicant has provided complete dynamic models for the new excitation systems and the stabilizers.

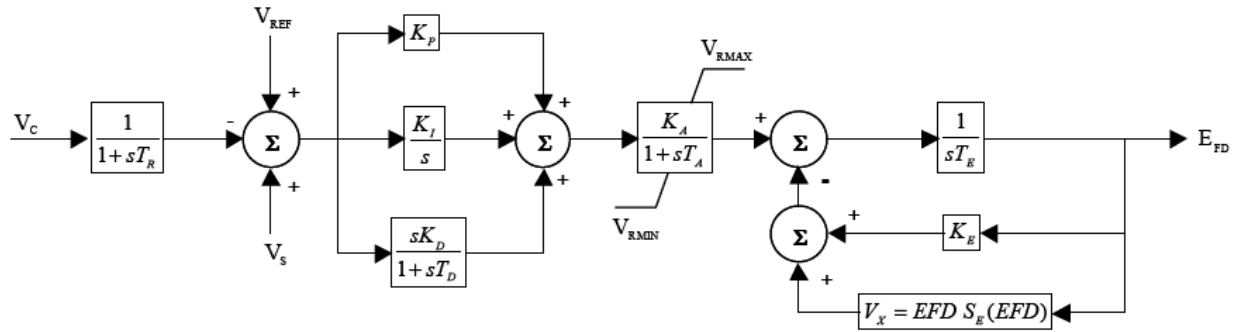
### 2.1 EXCITER SYSTEM MODEL

The proposed new exciter is Basler DECS-200 is PSS/E type ESAC8B.

The block diagram of the excitation system provided by the connection applicant is shown in Figure 1. The parameters of the exciter are shown in Table 1 and are identical for Calm Lake and Sturgeon Falls.

Abitibi Bowater have stated that no power system stabilizer is fitted.

After the installation of the new exciter, the proponent is required to perform commissioning tests to validate the control models and data. The test results must be supplied to the IESO within three months of in-service date. If the actual data differ materially from the data that was used in the assessment, then the analysis will need to be repeated.



**Figure 1. Block Diagram of Excitation System**

**Table 1. Parameters of the Basler DECS-200 Exciter**

Description	Constant	Parameter	Value
Voltage transducer time constant	J	Tr	0.0
Voltage regulator proportional gain	J+1	Kp	170
Voltage regulator integral gain	J+2	Ki	130
Voltage regulator derivative gain	J+3	Kd	60
Voltage regulator derivative time constant	J+4	Td	0.03
Power source gain	J+5	Ka	0.2
Voltage regulator time constant	J+6	Ta	0.0
Maximum controller output	J+7	Vrmax	10
Minimum controller output	J+8	Vrmin	0.0
Exciter field proportional constant	J+9	Ke	1.0
Exciter field time constant	J+10	Te	1.0
Rectifier regulation factor	J+11	Kc	0.1
Exciter regulation factor	J+12	Kd	0.5
Exciter flux at knee of curve	J+13	E1	3.0
Saturation factor at knee	J+14	Se1	1
Maximum exciter	J+15	E2	1.8
Saturation factor at maximum flux	J+16	Se2	0.2

## 2.2 GOVERNOR MODEL

Abitibi Bowater provided a block diagram and associated data of the WESGOV Pti model type shown below in Figure 2. The data is identical for Calm Lake and Sturgeon Falls. Commissioning values may change.

The model provided caused problems and was discovered to be suitable only for use with gas turbines and not hydro machines. Some attempts were made by IESO to find an acceptable substitute model but due to the greatly varying nature of hydro schemes this was not successful. The exciter studies were able to be completed without a governor model since there is no market rule requirement for governors on units having a capacity less than 10 MVA.

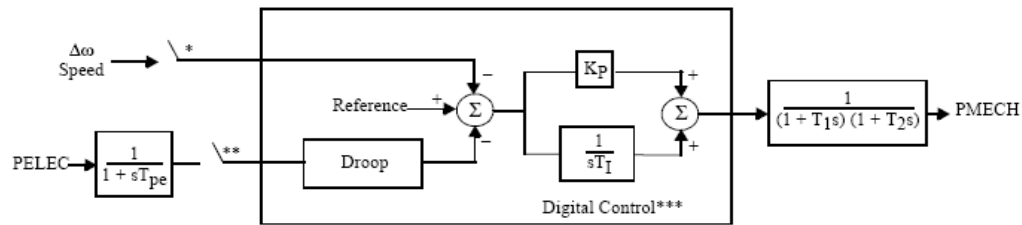
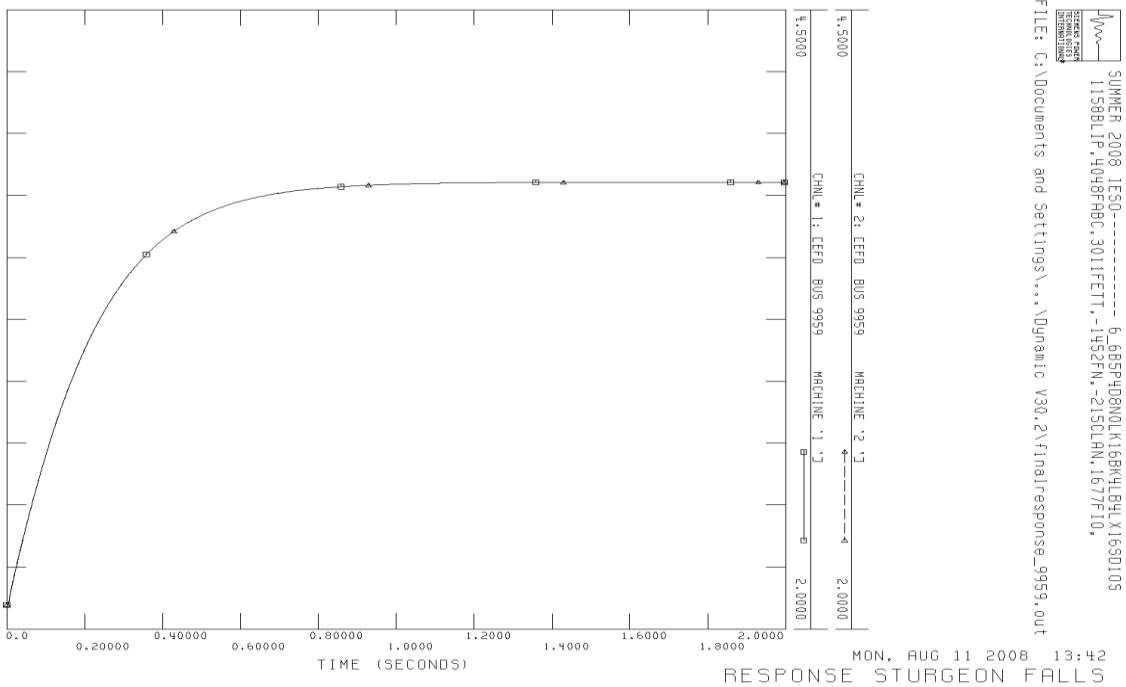
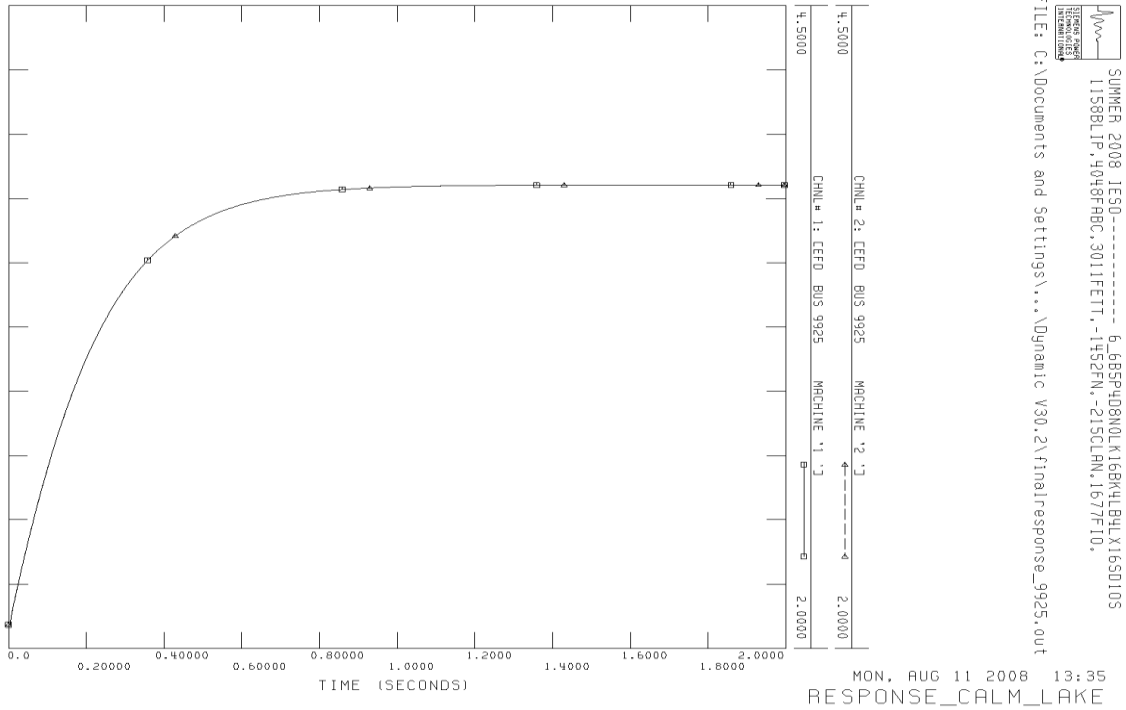


Figure 2 – WESGOV Pti Governor Block Diagram

Description	Constant	Value
$\Delta t$ sample for controls, $\Delta TC$ (sec)	J	0.04
$\Delta t$ sample for PE, $\Delta TC$ (sec)	J+1	0.04
Droop	J+2	0.05
$K_p$	J+3	1.0
$T_1$ (sec)	J+4	1.0
$T_1$ (sec)	J+5	0.1
$T_2$ (sec)	J+6	1.0
$A_{LIM}$ (pu)	J+7	0.01
$T_{pe}$ (Sec)	J+8	0.01

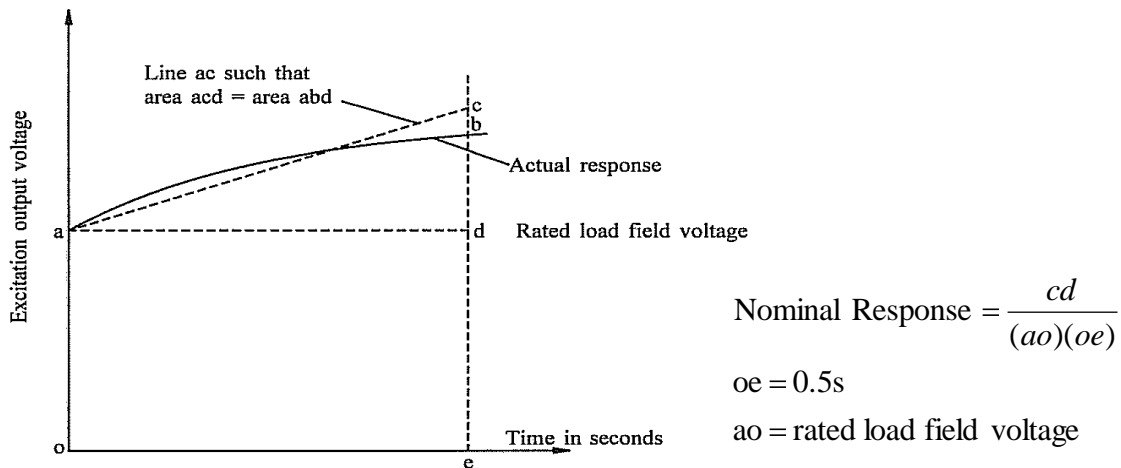
### 2.3 EXCITATION AND GOVERNOR SYSTEMS PERFORMANCE TESTING

Dynamic simulations were performed to verify that the transient response of the new excitation system and governor controls meet the Market Rules requirements.



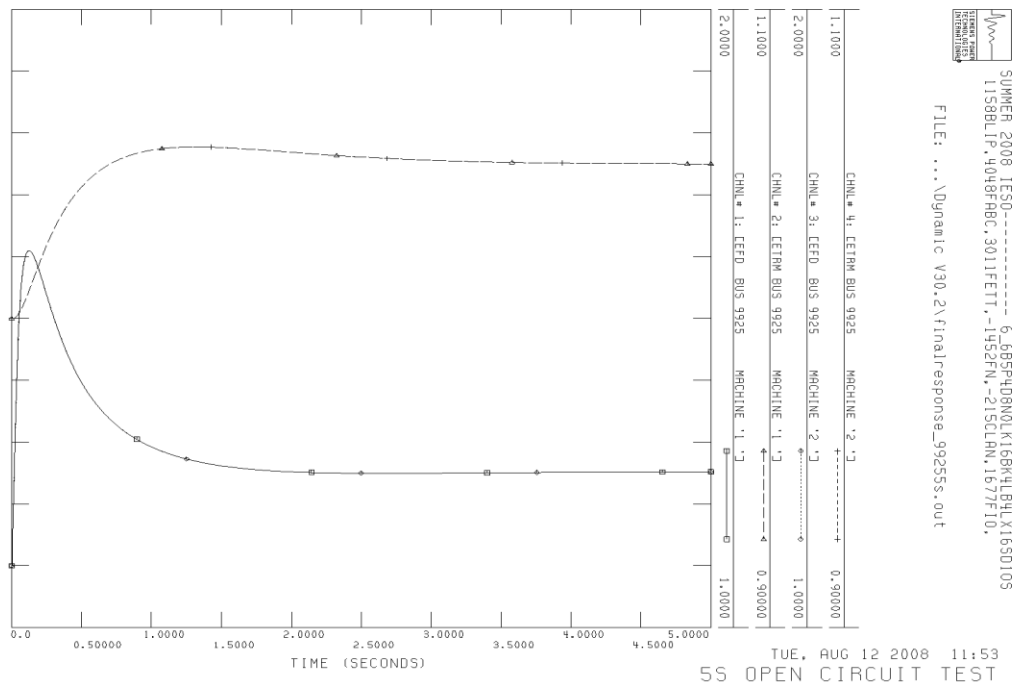
**Figure 3. Nominal Response Test for the Exciters – Actual Response Curve (ab) Calm Lake and Sturgeon Falls**

The exciter was forced from an initial condition of rated load field voltage (oa = approx 2.1p.u.) to it's maximum for 2 seconds to determine curve "ab". The nominal response is approximately 1.5 based the method of calculation given below. Market rules require a nominal response of at least 0.5 and a ceiling voltage at least 150% of rated field voltage and these conditions have been met with a ceiling voltage of approximately 180% of rated field voltage.



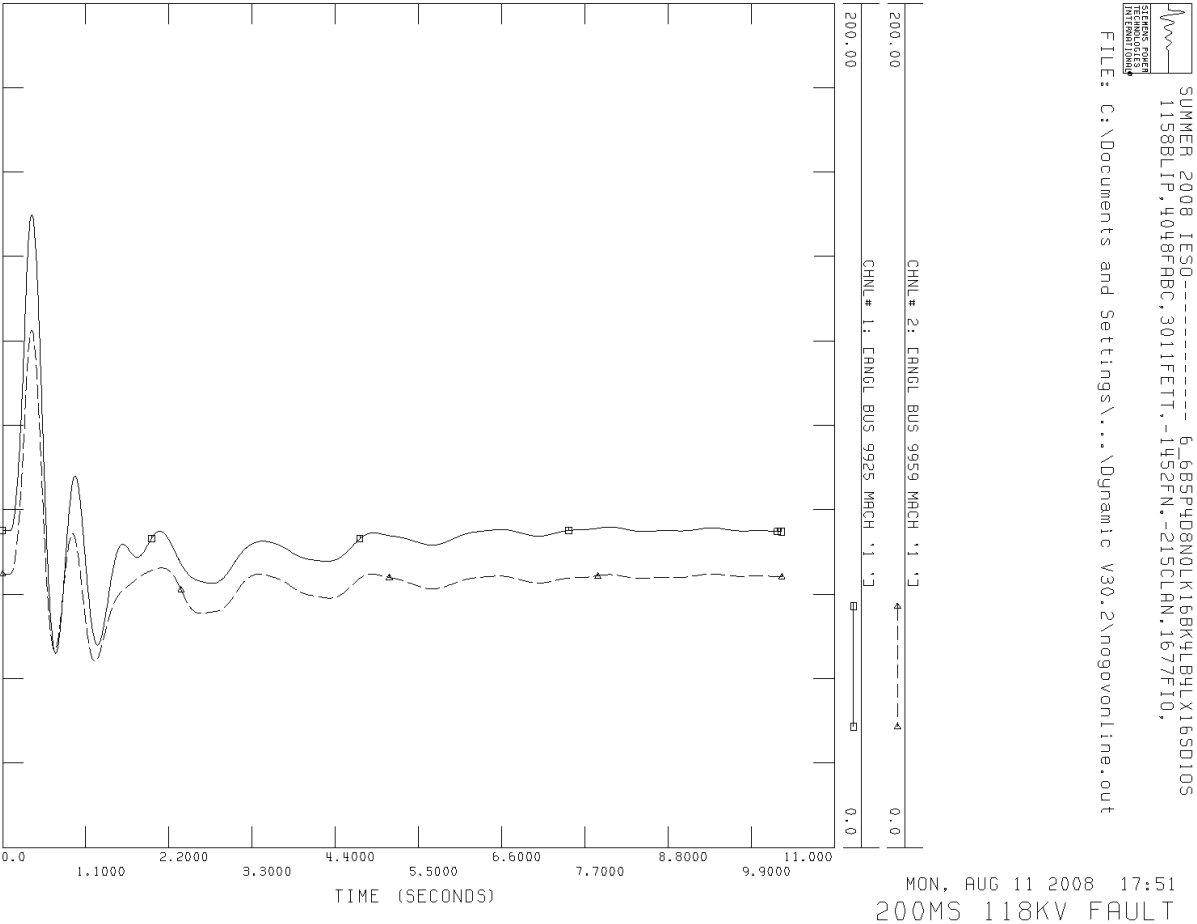
**Figure 4 – Response Test Calculation Method**

Figure 5 below demonstrates that for a 5% increase in the set point from 1 p.u. the exciter response time is approximately 100ms and the new terminal voltage is within 0.5% of the required 1.05 p.u. This satisfies Market Rule 4.2, Ref 13.



**Figure 5 – Open Circuit Test**

It can be seen in Figure 6 that for a 200 ms, 118kV fault at Moose Lake, the excitation system damps system oscillations well. This study was undertaken without a governor model at Calm Lake and Sturgeon falls



**Figure 6. 115kV Fault at Moose Lake**

### 3.0 CONCLUSIONS AND REQUIREMENTS

This assessment examined the performance of the proposed new excitation and governor control systems at Calm Lake GS and Sturgeon Falls GS and its effect on the reliability of the IESO-controlled grid. The studies concluded that:

- the new excitation system model meets the Market Rules requirements and
- the generating units equipped with the new excitation control systems display stable performance and well damped oscillations.
- The governor model provided was not suitable for analysis but since the units are below 10 MVA we were able to complete the studies without it.

Therefore the replacement of the excitation and governor control systems will not have any adverse impact on the reliability of the IESO-controlled grid.

The applicant is required to ensure that the performance of the governor and excitation systems installed at Calm Lake GS and Sturgeon Falls GS is similar or exceeds the predicted performance observed in the simulation results obtained using the above models.

As soon as the commissioning tests are completed and actual data is available, the connection applicant is required to provide an updated block diagram model and data of the excitation systems. If the models and data differ materially from those used in the studies, the IESO may be performing additional studies to verify the behaviour of the excitation system and establish the need for any new controls and adjustments, as part of the Facility Registration Process.

Up to date hydro alternator and governor models should also be submitted after commissioning.

#### **4.0 NOTIFICATION OF APPROVAL**

The study results show that the new exciter is not expected to adversely impact the IESO-controlled grid. It is therefore recommended that a Notification of Approval for this proposal be issued to the applicant.