

Expedited System Impact Assessment Report

Assessment Summary

Bruce Power Inc.



Bruce B Standby Generator G5 to G8 AVR Replacements

CAA ID Number: 2006-EX295

1.0 General Description

Bruce Power is planning to replace the AVRs on their standby generators SG5 to SG8 at Bruce B GS. The existing Unitrol 2211 AVRs will be replaced with the Basler Digital Excitation Control Systems – Model DECS-200. The permanent magnetic generators and Brushless exciters will remain as is. The tentative in-service schedule for the AVR upgrades are as follows:

- SG7 – to be in-service on March 2009
- SG8 – to be in-service on April 2010
- SG5 – to be in-service on April 2011
- SG6 – to be in-service on April 2012

Bruce Power was unable to provide an existing excitation model to the IESO for bench mark testing. It has, however, provided documentation to the IESO that indicates the excitation system with the new AVR will perform as well as the excitation system with the existing AVR.

2.0 Models and Parameters

2.1 AVR and Exciter Model and Parameters for SG5 to SG8

The brushless exciter with the new AVR is represented by the IEEE type AC8B. A block diagram of the PSS/E representation, ESAC8B, is shown in **Figure 1** below.

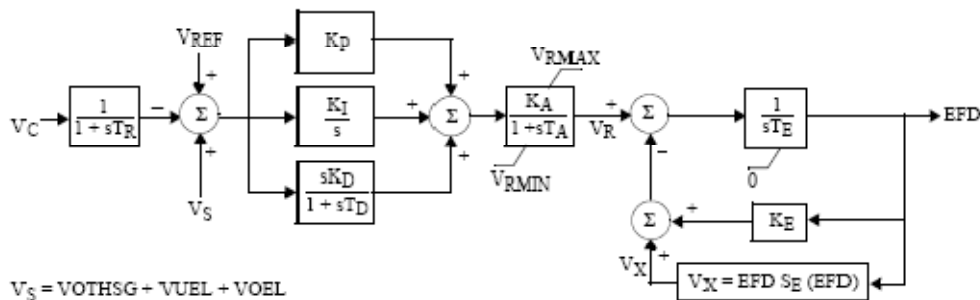


Figure 1: Block Diagram of IEEE AC8B

The following table summarizes the exciter parameters accounting for the new AVR.

Bruce Standby Generator SG5 to SG8 Exciter Model: ESAC8B									
T_R	K_P	K_I	K_D	T_D	K_A	T_A	V_{RMAX}	V_{RMIN}	T_E
0.01	155	138	28	0.04	0.55	0.005	12.7	0	0.42
K_E	E_1	$S_E(E_1)$	E_2	$S_E(E_2)$					
1.0	7.89	0.077	8.74	0.214					

2.1 Generator Model

The following are the Bruce B SG generator parameters for SG5 to SG8 provided by the applicant. The 13.8 kV generator is rated at 15.2 MVA, with a maximum continuous rating of 12.2 MW. There are no changes in generator parameters as a result of the AVR upgrades.

Bruce Standby Generator SG5 to SG8 Generator Model: GENSAL								
T'_{do}	T''_{do}	T'_{qo}	T''_{qo}	H	D	X_d	X_q	X'_d
6.0	0.006	0	0.045	0.89	0	1.60	0.86	0.25
X''_d	XI	S(1.0)	S(1.2)					
0.18	0.15	0.05	0.298					

3.0 Assessment

3.1 Excitation System Performance

Excitation performance requirements are listed as per Reference 12 in Appendix 4.2 of the Market Rules. An open circuit test and response ratio test were simulated to assess the performance of the modified excitation system under the (i) standard and (ii) lesser Market Rule requirements respectively.

In the case of AVR replacements, the IESO requires that the new AVR must meet or exceed the performance of the existing AVR. Excitation performance requirements as per Reference 12 in Appendix 4.2 will only need to be adhered to if the exciter is fully replaced.

3.1.1 Open Circuit Test

The IESO requires that the exciter have the capability of attaining $2xE_{fd_{rated}}$ on the open circuit test. Simulations show that $E_{fd_{rated}}$ is approximately 2.53 pu. Therefore, the exciter should have a capability of attaining $2 \times 2.53 = 5.06$ pu.

Figure 2 shows the exciter's response to a 5% step change in reference voltage for an open circuit test. As shown, a field voltage ceiling of 2.77 pu is reached; therefore, the exciter does not meet the standard Market Rule requirements.

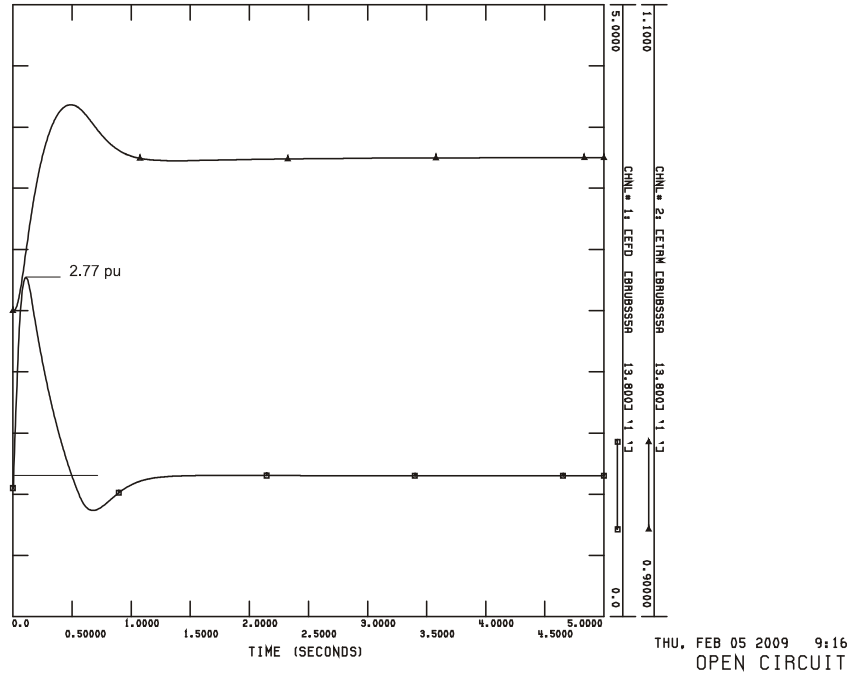
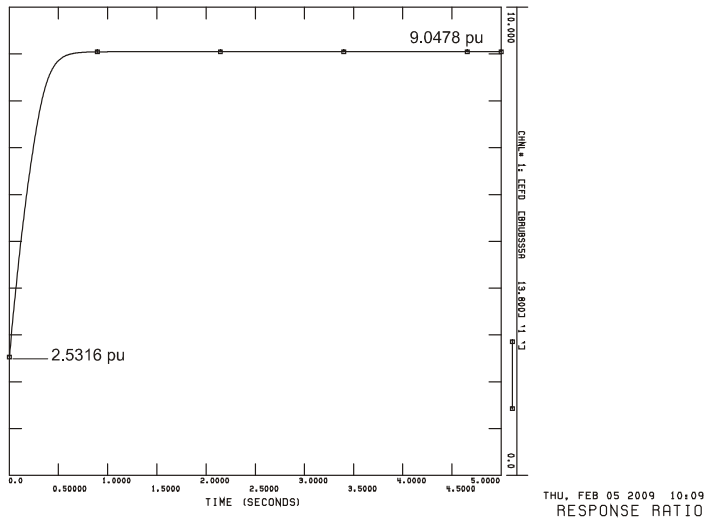


Figure 2: Open Circuit Response

3.1.2 Response Ratio Test

In the response ratio test, the generator is initialized to its rated output of 12.2 MW. At time equals to zero, the voltage regulator reference is changed by a large value and the behaviour of at the field voltage is observed. **Figure 3** shows the response. The positive ceiling voltage is 358 % of the rated field voltage. This meets the Market Rule requirement of a positive ceiling voltage of 150% of the rated field voltage.



Ceiling Voltage	
$E_{fd_{ceiling}}$	9.05 pu
$E_{fd_{rated}}$	2.53 pu
$E_{fd_{ceiling}}/E_{fd_{rated}}$	3.58

Figure 3: Response Ratio – Ceiling Voltage

As shown from the calculations below, the nominal response is 6.44. The exciter meets the Market Rule requirement of a nominal response of at least 0.5.

In the technical data that Bruce has sent for the existing excitation system, the exciter response ratio is listed as 1.0. Therefore, it is expected that the new AVR will result in an improved nominal response.

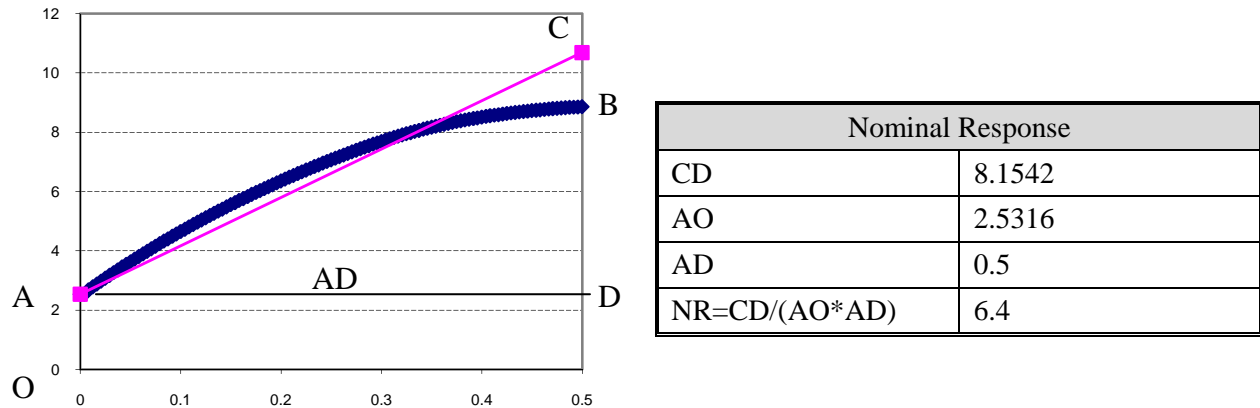


Figure 4: Response Ratio – Nominal Response

Therefore, the modified exciter meets the lesser Market Rule requirements as demonstrated by the response ratio test.

3.2 AVR Technical Details

Bruce Power has indicated that the exciters with the new AVR type will have similar response time, voltage control accuracy and field forcing capability as the exciters with the original AVR type. No new operating modes are being implemented with the new AVR.

4.0 Conclusions and Requirements

- (1) Based on details provided by the applicant, it is expected that with the new AVR, the Bruce SG6-SG8 exciters will have a performance that meets or exceeds the existing exciters.
- (2) The modified excitation system meets the IESO's lesser performance requirements.
- (3) The modified excitation system is expected to have an improved response ratio.
- (4) The applicant must ensure that the performance of the Bruce B SG5 to SG8 exciters with the new AVR is similar or exceeds the predicted performance observed in the simulation results obtained using the models provided by the applicant.
- (5) In addition to (4), Bruce must provide evidence through commissioning tests that the excitation system with the new AVR meets or exceeds the performance of the excitation system with the existing AVR.
- (6) The applicant must notify the IESO as soon as it becomes aware of any changes to the model parameters or assumptions made in the connection assessment. The IESO will determine whether these changes require a reassessment.

5.0 Notification of Approval

From the information provided, our review concludes that the proposed changes will not result in a material adverse effect on the reliability of the IESO-controlled grid. It is recommended that a Notification of Conditional Approval be issued for Bruce B Standby Generator G5 to G8 AVR replacements subject to the IESO receiving written acknowledgement that the requirements listed in this report will be implemented.