

IESO Expedited System Impact Assessment

EXCITER REPLACEMENT AT EAR FALLS GS

2013-EX687

FINAL REPORT

Executive Summary

Conditional Approval for Connection

Ontario Power Generation Inc. (the “connection applicant”) is proposing to replace the existing exciters on Ear Falls G1, G2, G3 and G4 with new static exciters. These units will also be equipped with power system stabilizers.

This assessment concluded that the proposed changes are expected to have no material adverse impact on the reliability of the IESO-controlled grid. Therefore, the IESO recommends that a *Notification of Conditional Approval for Connection* be issued for the exciter replacements at Ear Falls GS, subject to implementation of the requirements outlined in this report.

The connection applicant shall satisfy all applicable requirements and standards specified in the Market Rules and the Transmission System Code. The following requirements highlight some of the general requirements that are applicable to the proposed project.

Requirements

1. The excitation system shall have (a) positive and negative ceilings not less than 200% and 140% of rated field voltage at rated terminal voltage and rated field current; (b) a positive ceiling not less than 170% of rated field voltage at rated terminal voltage and 160% of rated field current; (c) a voltage response time to either ceiling not more than 50 ms for a 5% step change from rated voltage under open circuit conditions; and (d) a linear response between ceilings. Rated field current is defined at rated voltage, rated active power and required maximum continuous reactive power
2. The Power System Stabilizer (PSS) shall have (a) a change of power and speed input configuration; (b) positive and negative output limits not less than $\pm 5\%$ of rated AVR voltage; (c) phase compensation adjustable to limit angle error to within 30° between 0.2 Hz and 2.0 Hz under conditions specified by the IESO, and (d) gain adjustable up to an amount that either increases damping ratio above 0.1 or elicits exciter modes of oscillation at maximum active output unless otherwise specified by the IESO.
3. The connection applicant must complete the IESO Facility Registration/Market Entry process for the project in a timely manner before the IESO final approval for connection is granted.

The connection applicant is required to ensure that the performance of the excitation system and power system stabilizers installed at Ear Falls GS matches or exceeds the predicted performance in this assessment. As soon as the commissioning tests are completed and the actual data is available, the connection applicant is required to provide updated parameters and models for Ear Falls GS. If the actual data differs materially from

the data that is used in the report, then further analysis of the project will need to be done by the IESO.

1 Project Description

The applicant is proposing to (i) replace the exciters and (ii) install power system stabilizers on each of the four units at Ear Falls GS. The connection applicant did not provide simulation models as part of its System Impact Assessment application, but has indicated that the exciters and PSS will meet the Market Rules and as such has asked the IESO to assume models similar to the default models as provided in the [IESO Market Manual 2, Performance Validation](#), which minimally meet the Market Rules.

The upgrade will take place in stages with the first replacement to take place in April 2014 and the last replacement to take place in December 2015.

2 Assessments

It is expected that after the upgrade, the performance of the Ear Falls units will be better as they currently do not have power system stabilizer nor meet the current Market Rule requirements in terms of exciter performance. A description of the Market Rule requirements for exciter performance and simulation procedure is described in **Appendix A**.

The following table is a summary of the performance of the existing Ear Falls G1, G2, G3 and G4 against the Market Rule requirements for exciter performance. Simulation plots can be found in the **Appendix B**.

Table 1: Summary of Existing Ear Falls G1-G4 Exciter Performance

	Positive Ceiling ≥200% of $E_{fd_{rated}}$	Positive Ceiling response time ≤50 ms	Negative Ceiling Capability ≥140% of $E_{fd_{rated}}$	Negative Ceiling response time ≤50 ms	Field Voltage ≥ 1.70% of $E_{fd_{rated}}$ at $1.60\% I_{field}$
G1	Yes	No	No	No	Yes
G2	No	No	No	No	Yes
G3	Yes	No	No	No	Yes
G4	No	No	No	No	No

Appendix A

The following is a description of the Market Rule requirements for exciter performance and simulation procedure.

(1) Positive/Negative Ceiling: Appendix 4.2 of the Market Rules requires the excitation system for a generation facility directly connected to the IESO-controlled grid to have positive and negative ceilings not less than 200% of rated field voltage and 140%, respectively, at rated terminal voltage and rated field current.

To test this, a response ratio test is performed in which the generator is initialized to its rated active power at 0.9 lagging power factor and rated terminal voltage. For the positive ceiling, the voltage set point is raised to drive the field voltage to its positive ceiling as quickly as possible. To determine the negative ceiling, the voltage set point is raised to drive the field voltage to its negative ceiling as quickly as possible.

(2) Field Voltage at 160% Rated Field Current: Appendix 4.2 of the Market Rules requires the excitation system for a generation facility directly connected to the IESO-controlled grid to a positive ceiling not less than 170% of rated field voltage at rated terminal voltage and 160% of rated field current.

To test this, the field voltage from the positive ceiling test is observed to ensure that the value corresponding to 160% of rated field current is greater than 170% of the rated field voltage.

(3) Positive and Negative Ceiling Response Time: Appendix 4.2 of the Market Rules requires the excitation system for a generation facility directly connected to the IESO-controlled grid to have a voltage response time to either ceiling not more than 50 ms for a 5% step change from rated voltage under open-circuit conditions and a linear response between ceilings.

To test this, an open circuit test is performed with the generator initialized to its rated terminal voltage under open circuit conditions and the voltage set point is increased or decreased by 5%. The response time is the time for the excitation voltage to attain 95% of the difference between ceiling voltage and rated field voltage. For the positive ceiling, this is the time to reach $1.95 E_{fd}$ and for the negative ceiling, this is the time to reach $-1.28 E_{fd}$. As the test is performed under open circuit conditions, in which the initial field voltage is not equal to the rated field voltage, the Market Rule response time requirement must be translated as follows:

$$RT_{OC_POS} = 50 * (1.95 E_{fdrated} - E_{fdoc}) / (1.95 E_{fdrated} - E_{fdrated})$$

$$RT_{OC_NEG} = 50 * (1.28 E_{fdrated} + E_{fdoc}) / (1.28 E_{fdrated} + E_{fdrated})$$

If the response time is within RT_{OC_pos} and RT_{OC_neg} , the positive ceiling response time and negative ceiling response time are met respectively.

Appendix B

Table 2: Existing Ear Falls G1-G4 Unit Ratings

Description	G1	G2	G3	G4
Nameplate Rating (MVA)	5	4.5	6	6
Rated Voltage (kV)	6.6	6.6	6.6	6.6
Rated Active Power (MW)	3.2	3.1	5.4	5.4
Rated field voltage ($E_{fd, rated}$)	1.89 pu	1.82 pu	2.08 pu	2.85 pu
Rated field current ($I_{f, rated}$)	1.89 pu	1.82 pu	2.08 pu	2.85 pu

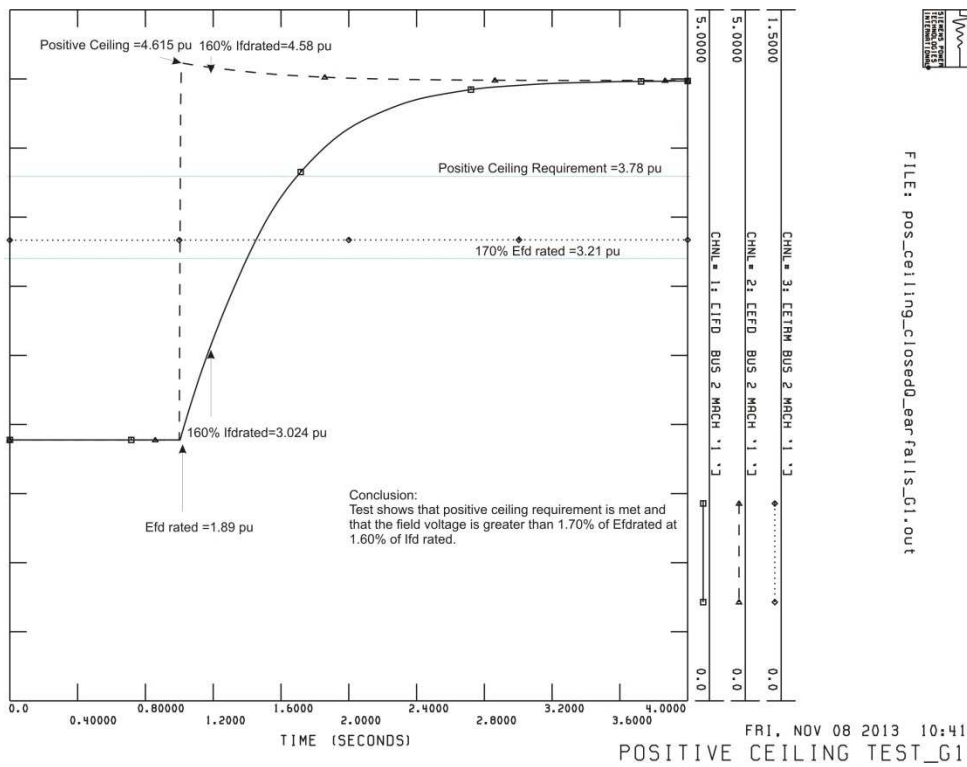


Figure 1: Positive Ceiling Test for Ear Falls G1

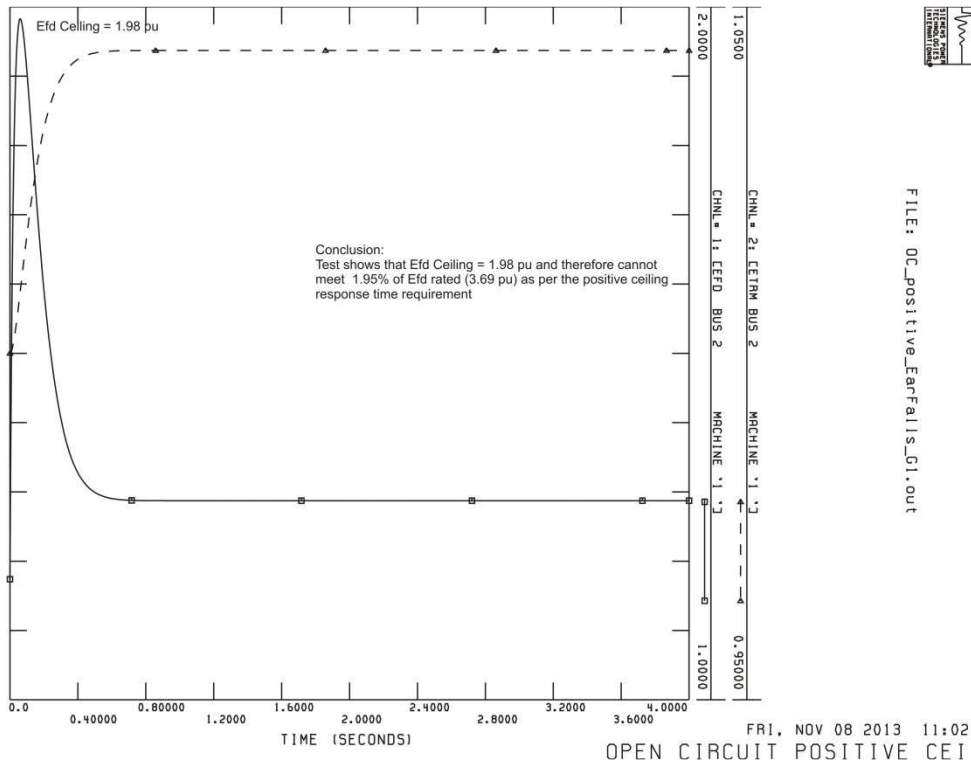


Figure 2: Positive Ceiling Response Time Test for Ear Falls G1

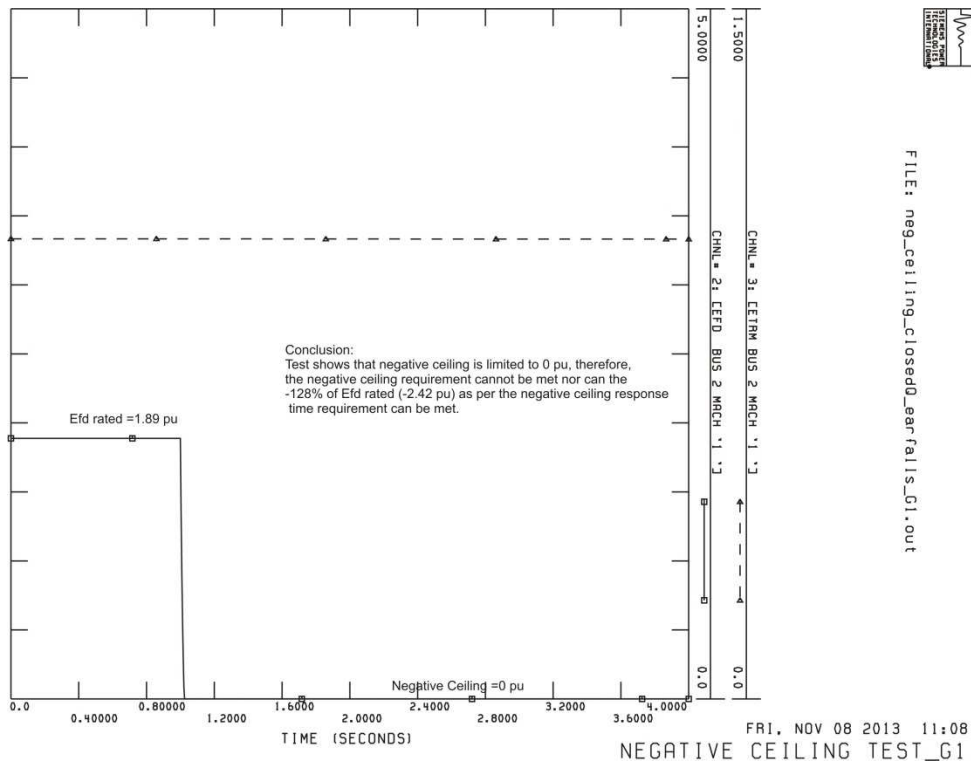


Figure 3: Negative Ceiling Test for Ear Falls G1

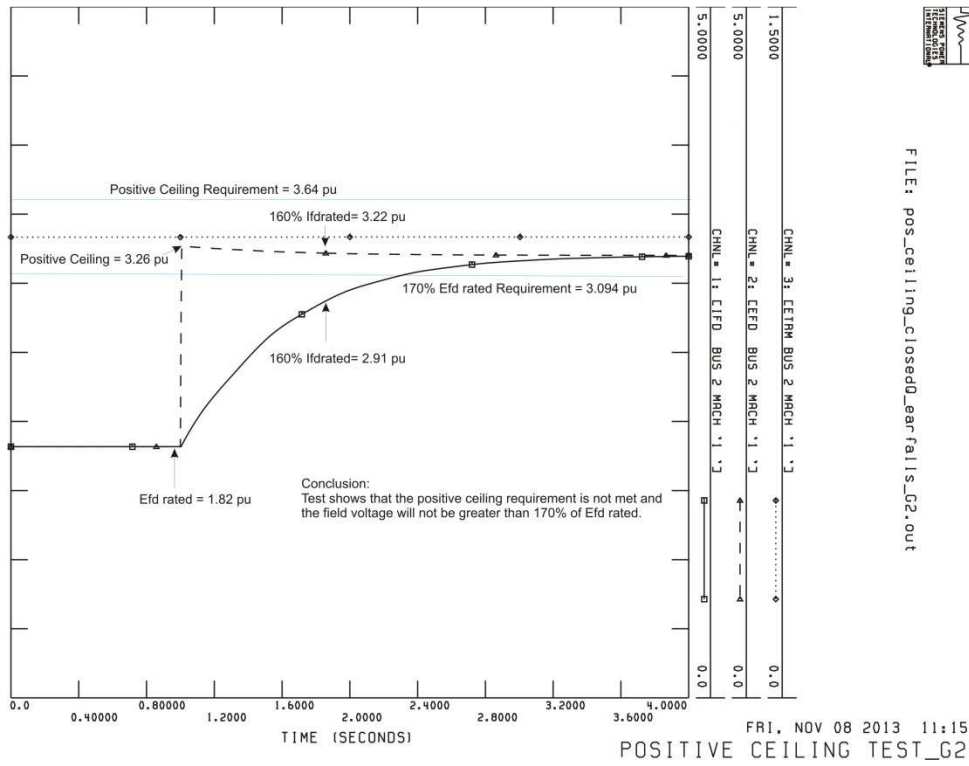


Figure 4: Positive Ceiling Test for Ear Falls G2

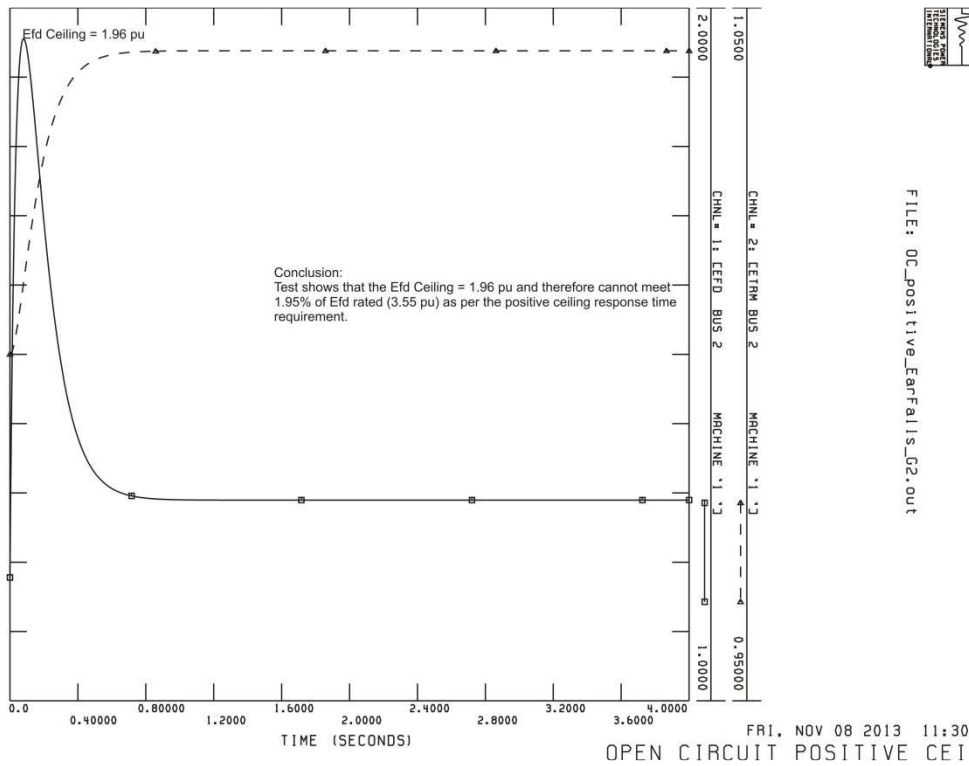


Figure 5: Positive Ceiling Response Time Test for Ear Falls G2

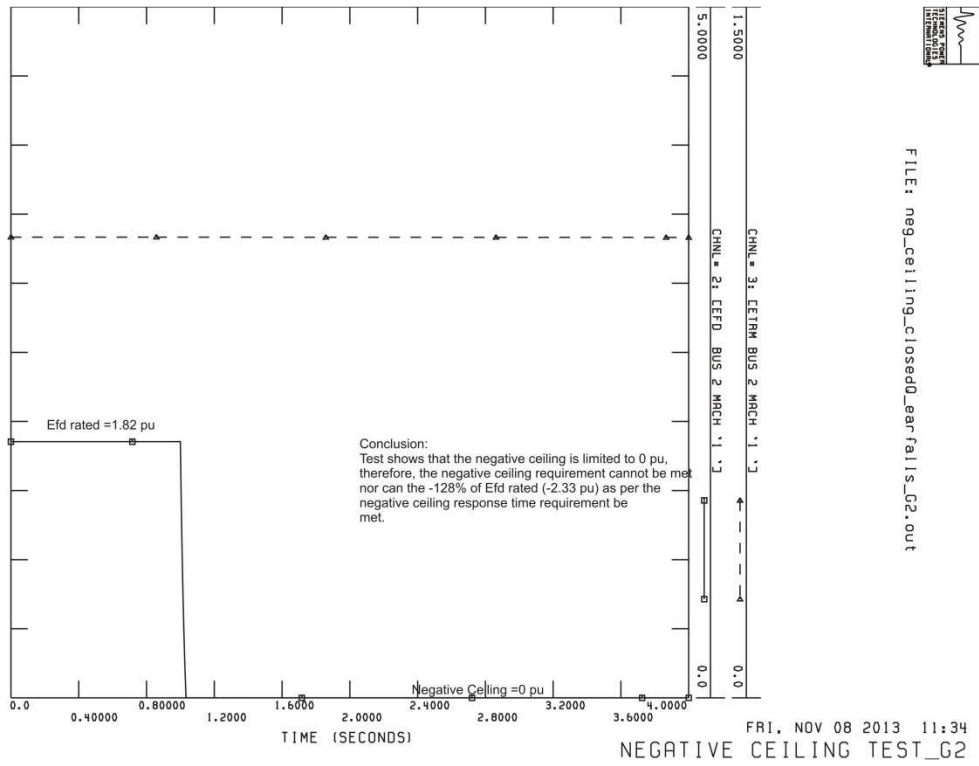


Figure 6: Negative Ceiling Test for Ear Falls G2

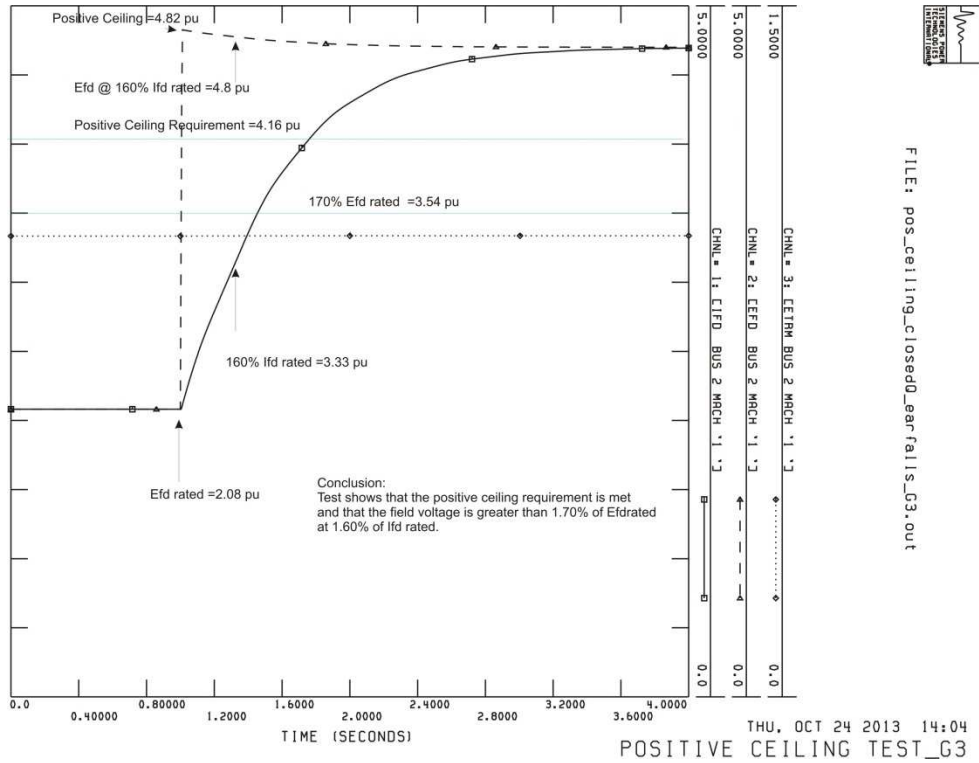


Figure 7: Positive Ceiling Test for Ear Falls G3

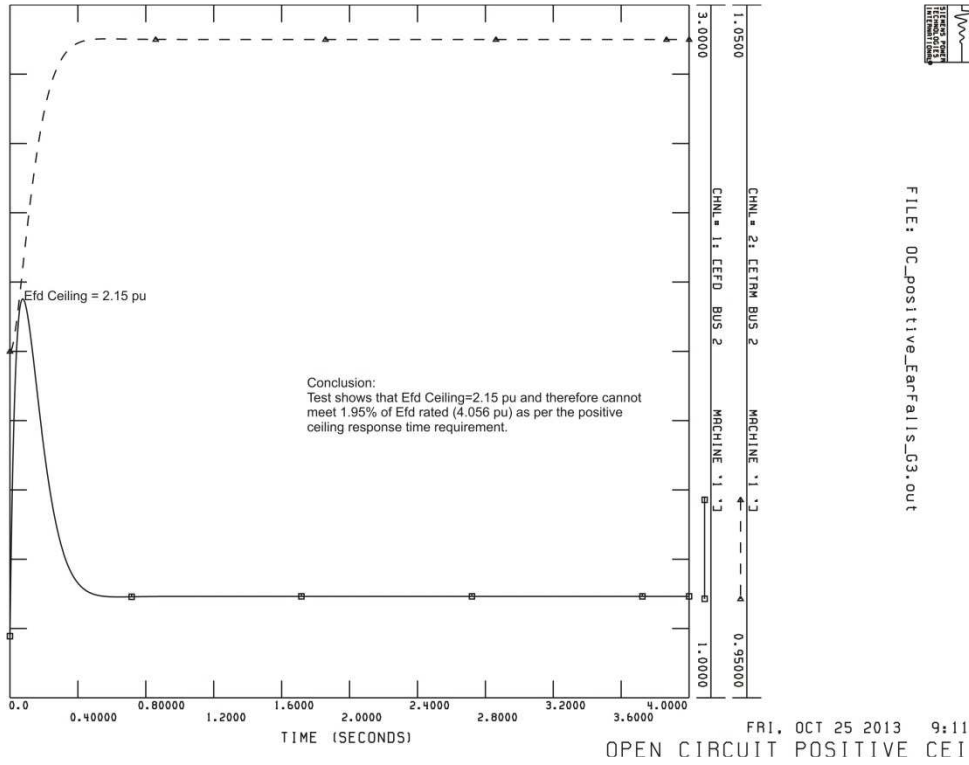


Figure 8: Positive Ceiling Response Time Test for Ear Falls G3

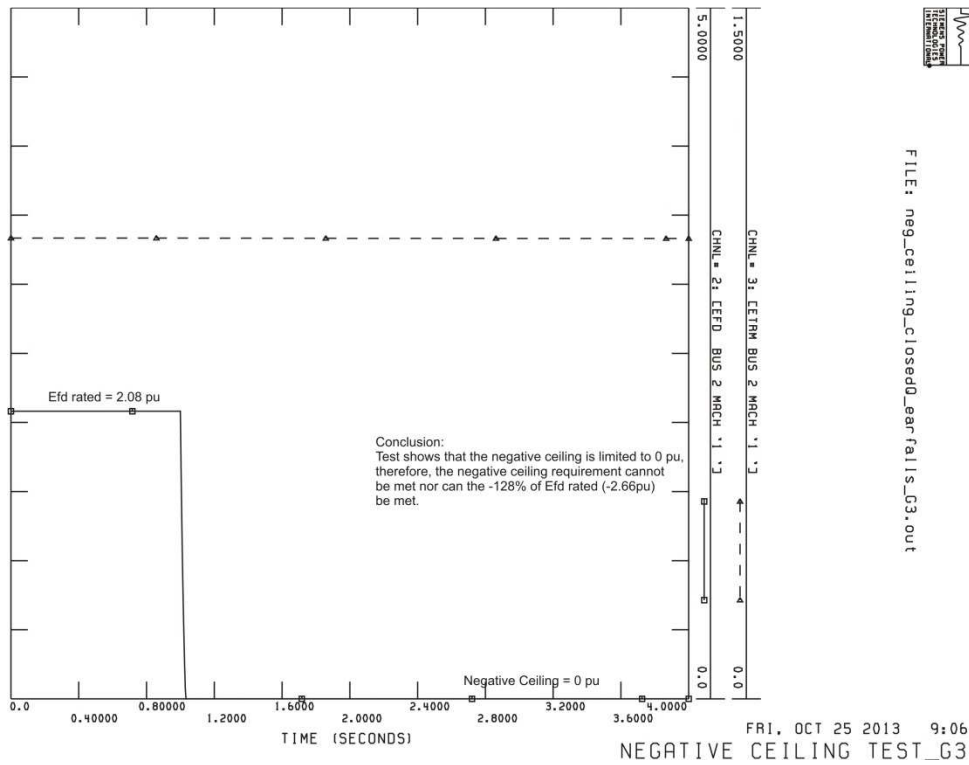


Figure 9: Negative Ceiling Test for Ear Falls G3

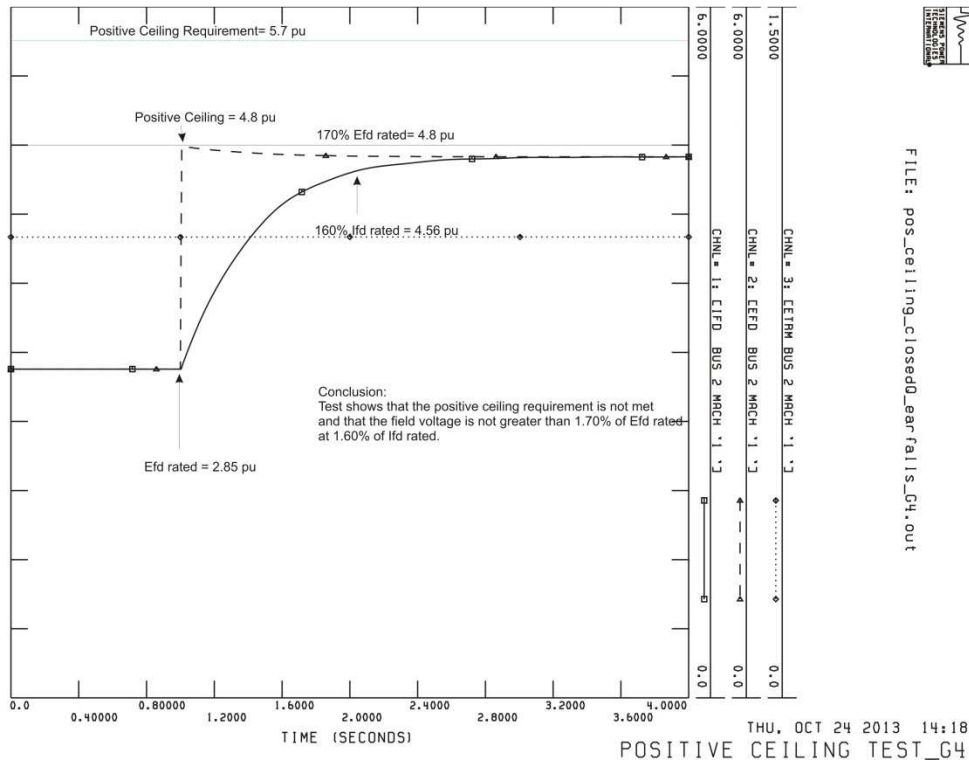


Figure 10: Positive Ceiling Test for Ear Falls G4

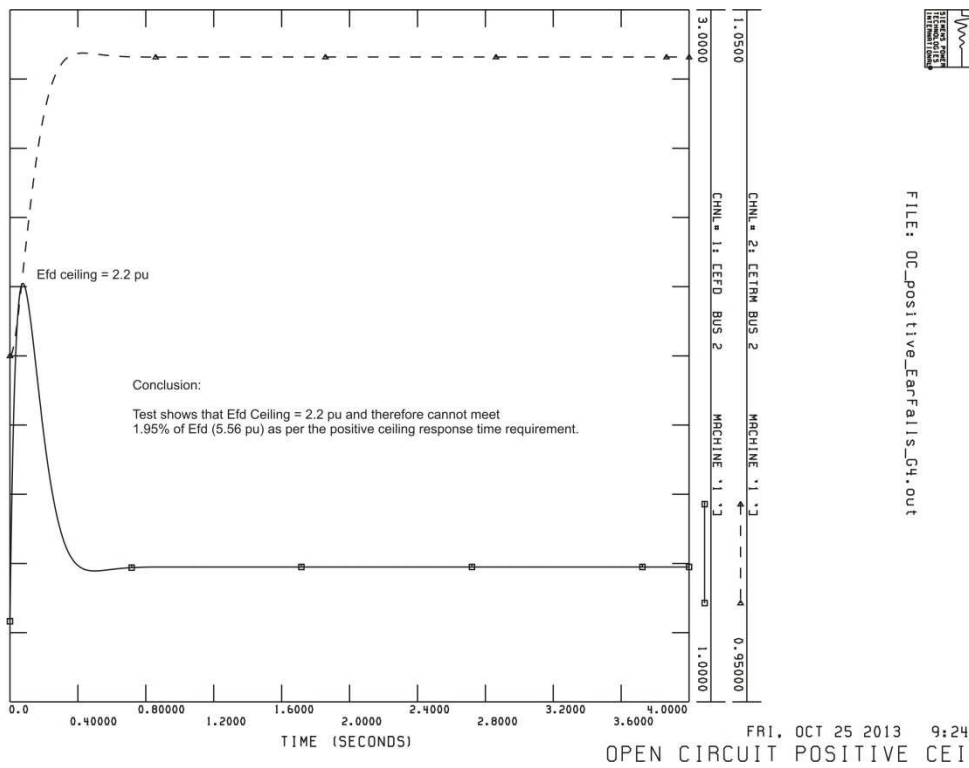


Figure 11: Positive Ceiling Response Time for Ear Falls G4

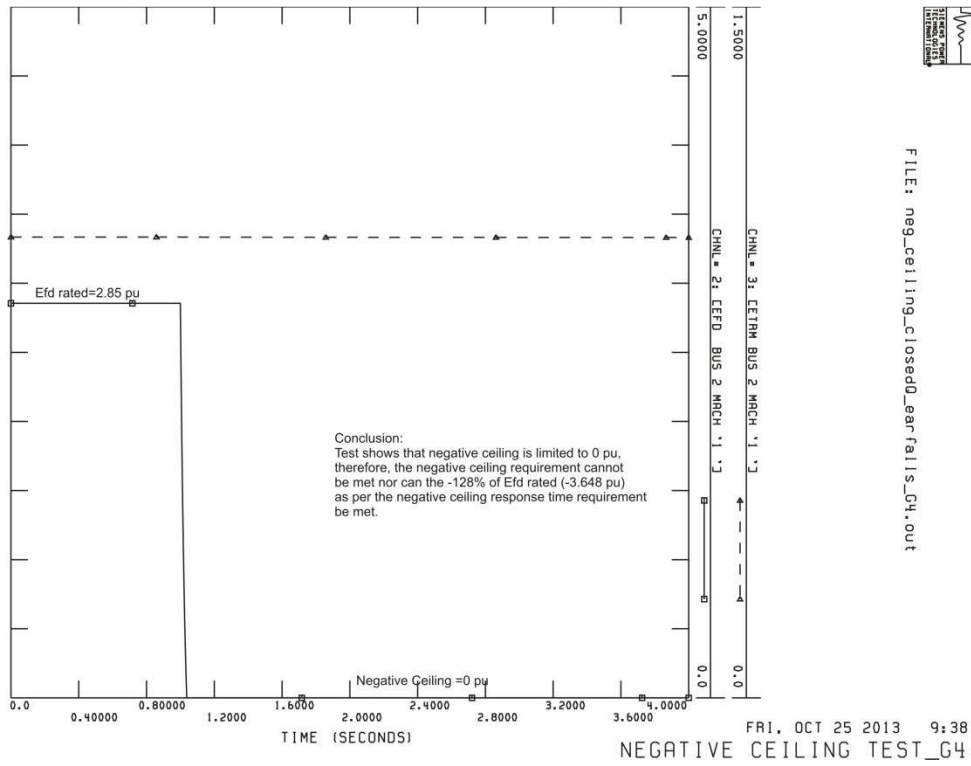


Figure 12: Negative Ceiling Test for Ear Falls G4
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