

1 **Q. (Reference Application, 4.1 Sandy Brook Hydro Plant Generator**
 2 **Refurbishment, page 10) It is stated “based on the age of the generator, the**
 3 **probability of equipment failure increases each year that the generator**
 4 **remains in service without refurbishment.” Is this not the case with any piece**
 5 **of equipment? What is the probability of failure in 2023, 2024 and 2025 if the**
 6 **generator refurbishment is deferred? How does this compare to the probability**
 7 **of failure in past years; i.e., in 2021 or 2010?**

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 9 **A.** Yes, the probability of equipment failure increases with age and operational experience
 10 every year a piece of equipment, including generators, is in service without
 11 refurbishment.

12
 13 In 2001, the Sandy Brook Hydro Plant’s stator and rotor were deemed to be in
 14 satisfactory condition. The probability of failure has increased since that time due to the
 15 age of the unit and its operating experience, particularly given the frequent on/off
 16 cycling of the generator and the thermal and mechanical stresses placed on the stator
 17 coils.¹

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 19 *Section 4.0 Risk Assessment* of report *4.1 Sandy Brook Hydro Plant Generator*
 20 *Refurbishment* provides information from a statistical analysis of the lifetime of stator
 21 windings published by the Institute of Electrical and Electronics Engineers.² The analysis
 22 is based on industry experience. It shows that the average age of resin-based windings
 23 is approximately 27 years, the leading causes of failure are aging and contamination of
 24 the windings, and the probability of generator failure increases with age.

25
 26 Table 1 approximates the failure probabilities based on the age of the Sandy Brook
 27 Hydro Plant generator for the requested scenarios using the statistical analysis described
 28 above.

Table 1 Failure Probability Based on Age of Sandy Brook Generating Plant Resin Stator Windings Over Equipment Lifetime		
Year	Age (years)	Failure Probability ³
2010	47	96%
2021 - 2025	58 - 62	>99%

¹ For more information, see *Section 3.0 Condition Assessment* of report *4.1 Sandy Brook Hydro Plant Generator Refurbishment*.

² See C. Sumeder, *Statistical Lifetime of Hydro Generators and Failure Analysis, IEEE Transactions on Dielectrics and Electrical Insulation*, Vol. 15, No. 3, June 2008.

³ Failure probability is based on the age of the unit, not the specified year. For example, after 47 years, only 4% of the windings studied by C. Sumeder, 2008, would have neither failed nor have been replaced. Similarly, after 62 years, less than 1% of windings studied would have neither failed nor have been replaced.

- 1 Based on the plant's age, condition and operating experience, Newfoundland Power
- 2 has assessed the probability of failure to be likely if the *Sandy Brook Hydro Plant*
- 3 *Generator Refurbishment* project were to be deferred.⁴

⁴ See the *2023 Capital Budget Application, Schedule B*, page 121.