

1 **Q: What is the probability that one of the three units at Holyrood will be forced**  
 2 **out of service at any given time assuming a 10% forced outage rate for each of**  
 3 **the three units? Please provide the calculation.**

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6 **A.** Forced outage rate is the number of hours per year that a unit is forced offline,  
 7 versus the total hours online plus hours forced offline. Therefore, the probability of  
 8 a single Holyrood unit being forced offline when running equals forced outage rate  
 9 – here 10%.

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11 The use of a forced outage rate tends to oversimplify the challenge. For example,  
 12 during the 2014 emergency, the great majority of the 233 MW of lost generation  
 13 did not result from units being forced offline, but rather from units being partially  
 14 de-rated. Such partial losses do not count in the forced outage rate calculation.  
 15 Risks therefore are over and above the 10% risk of losing a whole unit. Utilities use  
 16 a De-rating Adjusted Forced Outage Rate, or DAFOR, to deal with this challenge.  
 17 The DAFOR looks at the MWh lost versus the MWh that would have been  
 18 available and running in that period.

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20 Assume a 13% DAFOR and a 10% forced outage rate. The probability is 10% that  
 21 the unit will be fully lost due to a forced outage. But there is an additional 3%  
 22 probability that, in any given hour, an operating unit will be forced to reduce load  
 23 by some amount below its full output.

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25 The calculations are shown below.

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$$\text{Forced Outage Rate} = \frac{\text{Hours in a forced outage condition}}{\text{Synchronized hours} + \text{Forced outage hours}}$$

$$\text{De-rating Adjusted FOR} = \frac{\text{FO Hrs} + \text{Equiv. Forced De-rated Hrs}}{\text{FO Hrs} + \text{Equiv. Forced De-rated Hrs} + \text{Synchronized Hrs}}$$