The problem: A certain ground motion has an *x* percent probability of being exceeded in *Y* years. What is the probability, *w*, that that same ground motion is exceeded in *Z* years?

The solution: In the algorithm used to create the maps, one specifies a probability of exceedance for a given number of years. The computer finds the ground motion that has an annual rate that satisfies the following equation:

$$1 - r(a) = F(a) = e^{-T\varphi(a)}$$

where *r(a)* is the exceedance probability of the ground motion *a*, *F(a)* is sthe corresponding probability of non-exceedance, *e* is the base of the natural logarithm scale, *T* is the number of years for which we want to know the corresponding probability, and $\varphi(a)$ is the annual rate of exceedance of ground motion *a*. This equation is nothing more than the Poisson probability that given an expected number *n* of events, e^{-n} is the probability of getting none.

Given a ground motion, *a*, the annual rate at a site $\varphi(a)$ is constant. Taking logs and solving for $\varphi(a)$, we can make the equation,

$$\frac{\ln F(a)}{T} = -\varphi(a)$$

and equate for the two cases, number of years =*Y* and *Z*

$$\frac{\ln(1-x)}{Y} = \frac{\ln(1-w)}{Z}$$

Solving for 1 – *w*,

$$\ln(1-w) = \frac{Z}{Y}\ln(1-x)$$

$$(1-w) = e^{\frac{Z}{Y}\ln(1-x)} = (1-x)^{\frac{Z}{Y}}$$

So, for instance, for *r* = 0.10, *Y* = 50, and *Z* = 500; *F* = 0.9 and

$$(1-w) = (0.90)^{10} = 0.35,\ \textit{hence}\ w = 0.65$$

In a similar way, for *r*=0.05, *w* = 0.40, and for *r* = 0.02, *w* = 0.18

If a ground motion has this probability of being exceeded in 50 years,	**the same ground motion has the following probability of being exceeded in 500 years.**	**Prob of exceedance in 500 ––––––––––––––––––––– Prob of exceedance in 50**
0.02	0.18	9.0
0.05	0.40	8.0
0.10	0.65	6.5