SAND2016-5123PE

# Used Fuel Disposition Campaign

## Statistical Outputs of Probabilistic Performance Assessment

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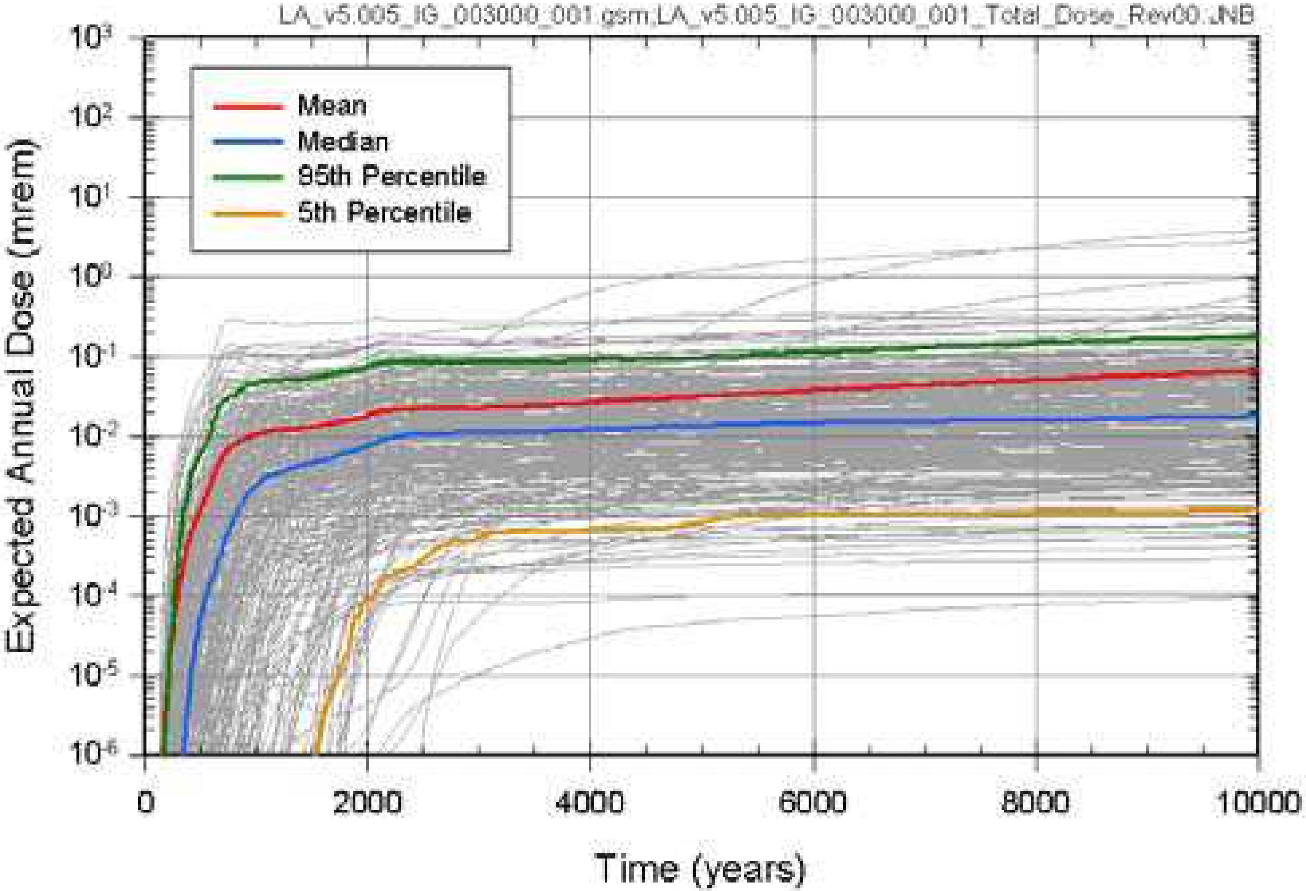
# Performance Assessment Modeling and Predictions

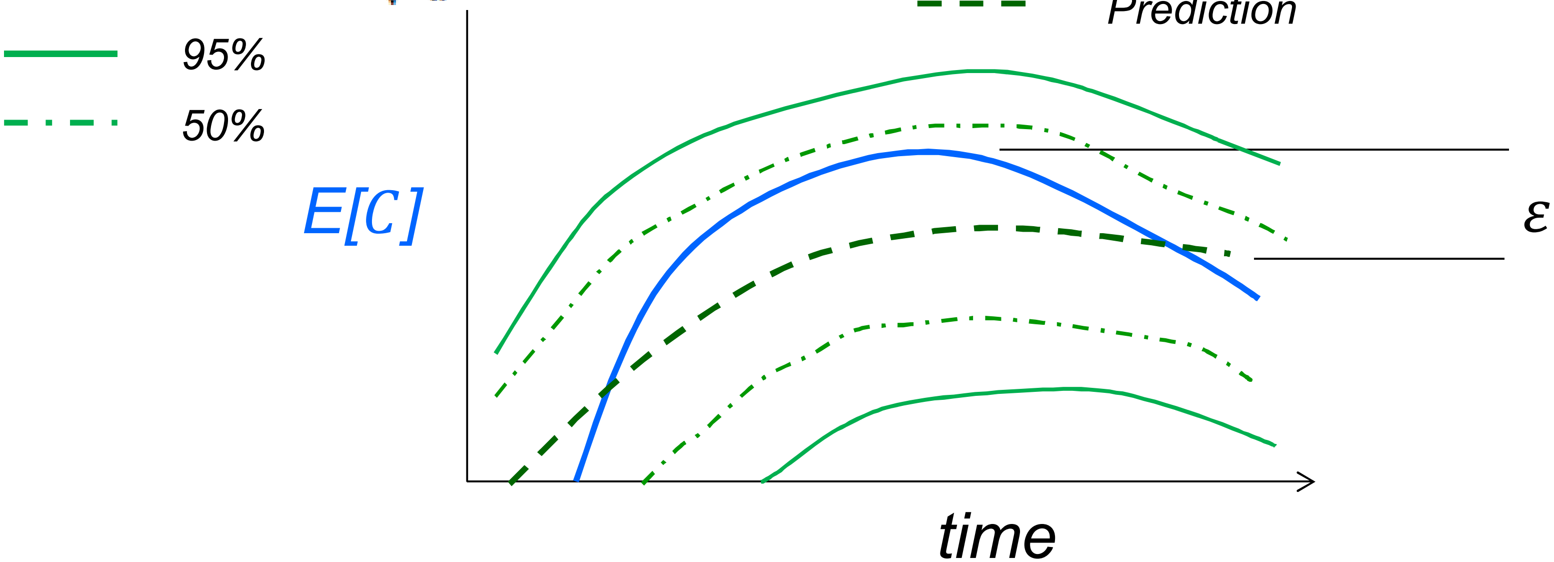
- **PA is the required regulatory approach for assessing DGR compliance with quantitative radiological safety criteria**
- **Overall error and uncertainty arise from the following major modeling activities:**
  - Selection of the mathematical models providing an abstraction of the physical processes and events of interest;
  - Identification of appropriate parameters and data defining the models;
  - Use of physical observations and measurements, including data from the literature, laboratory, and field to validate and calibrate the models;
  - Development of a computational model through discretization of the mathematical model and its implementation on a computer;
  - Identification of specific goals of PA simulations and the performance quantities of interest; and
  - Quantification of uncertainties in the predictions, including sensitivity analysis.

# Regulation requests "mean" and "median" values of dose to a reasonably maximally exposed individual



# Expected Value of Performance Quantity of Interest: Precision and Reliability

$$|e_{MC}(S)| \leq e^*_{MC} = z_{1-\frac{\alpha}{2}} \frac{|S|}{\sqrt{N_R}},$$




$$\varepsilon = Statistical\ Error + Spatial\ Discretization\ Error$$
$$+ Temporal\ Discretization\ Error$$

*with* $+/-$ *Confidence levels*

# Numerical Errors

***Tolerance = maximum allowable ε***

***Statistical Error*** $e_{MC} \sim \frac{S}{\sqrt{N_R}}$

***Spatial Error*** $e_h \sim C_h h^{\ k}$

***Temporal Error*** $e_t \sim C_t \Delta t^{\ l}$

***1: Mackinnon and Kuhlman, 2016. A Control Variate Method for Probabilistic Performance Assessment: Improved Estimates for Mean Performance Quantities of Interest***

***2: Currently analyzing $e_{MC}$ and $e_h$ for elliptic model problem, including W***

***3: Parabolic Model Problem $e_{MC}$, $e_h$, $e_t$, W***

***Computational Work*** $W \sim O(N_R \times N_e \times N_t)$

**Goal is to meet the tolerance with** $\frac{dW}{d\varepsilon} = 0$

# Control Variate Technique

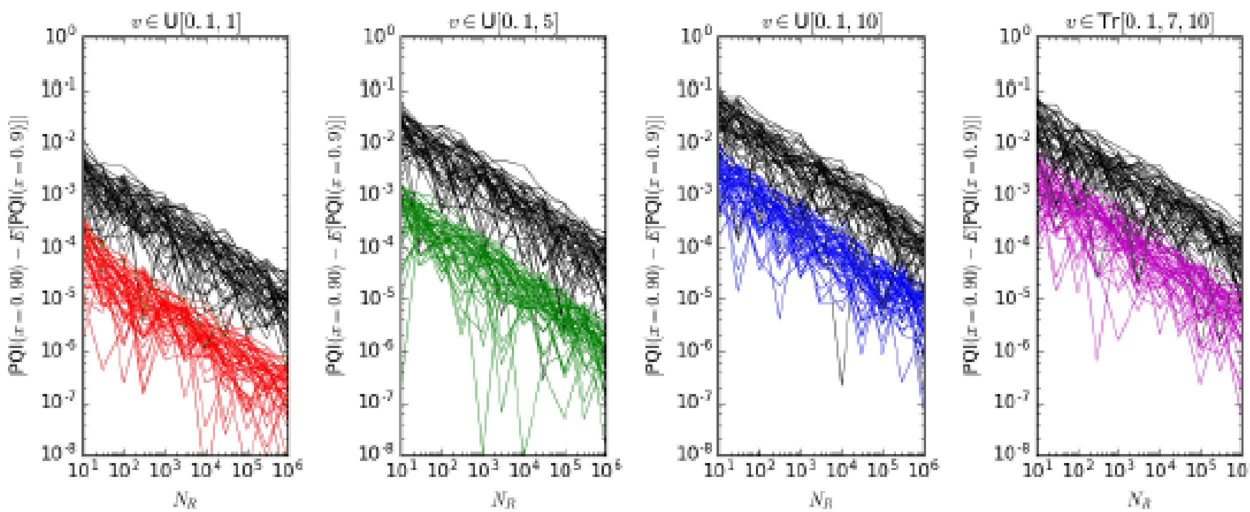



Figure 2. PQI(x=0.9) for Four Distributions in Table 1 across Sample Sizes $N_R$ for 50 different random seeds.