MAKING BETTER DECISIONS WITH PROBABILISTIC RISK ASSESSMENT

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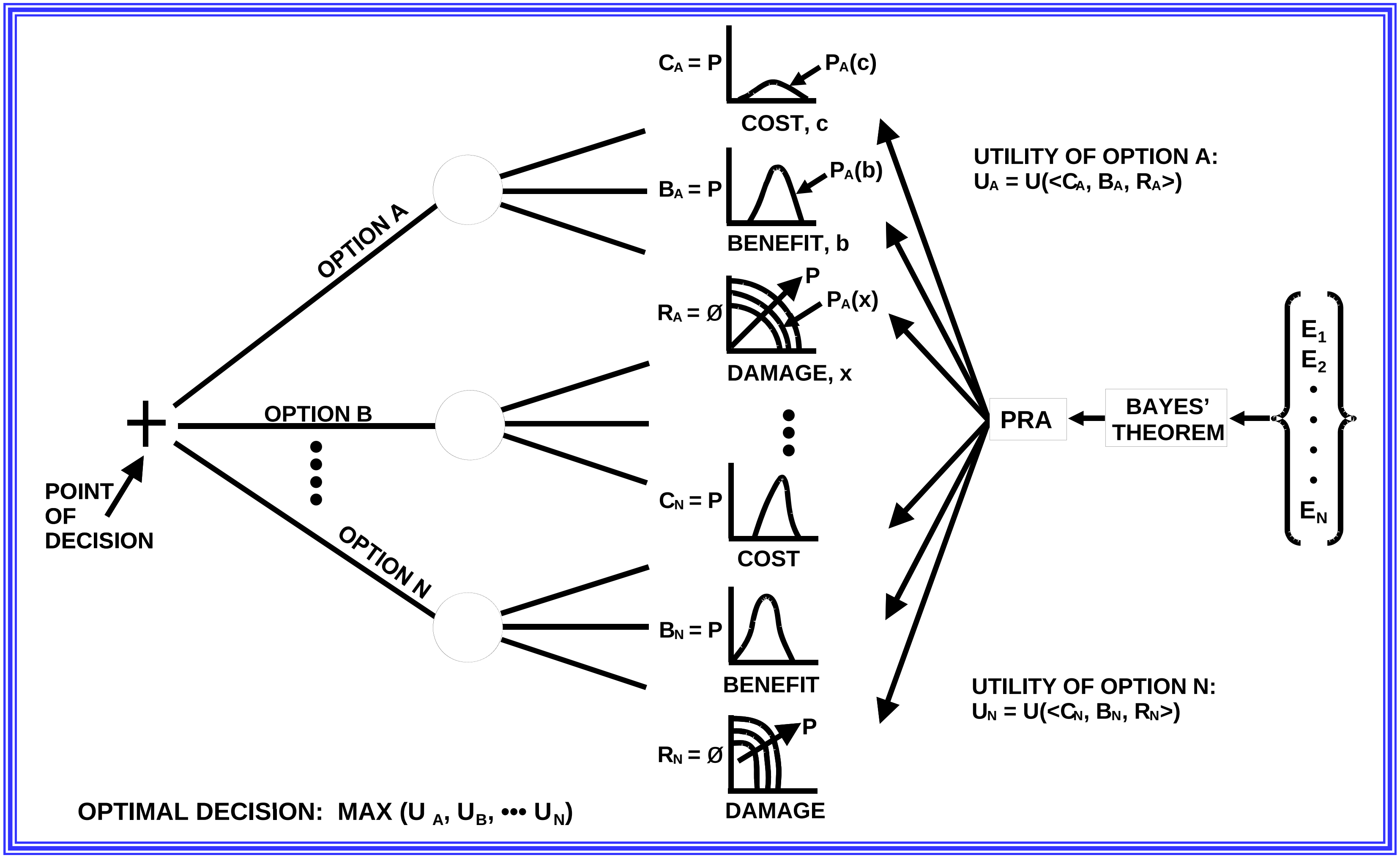
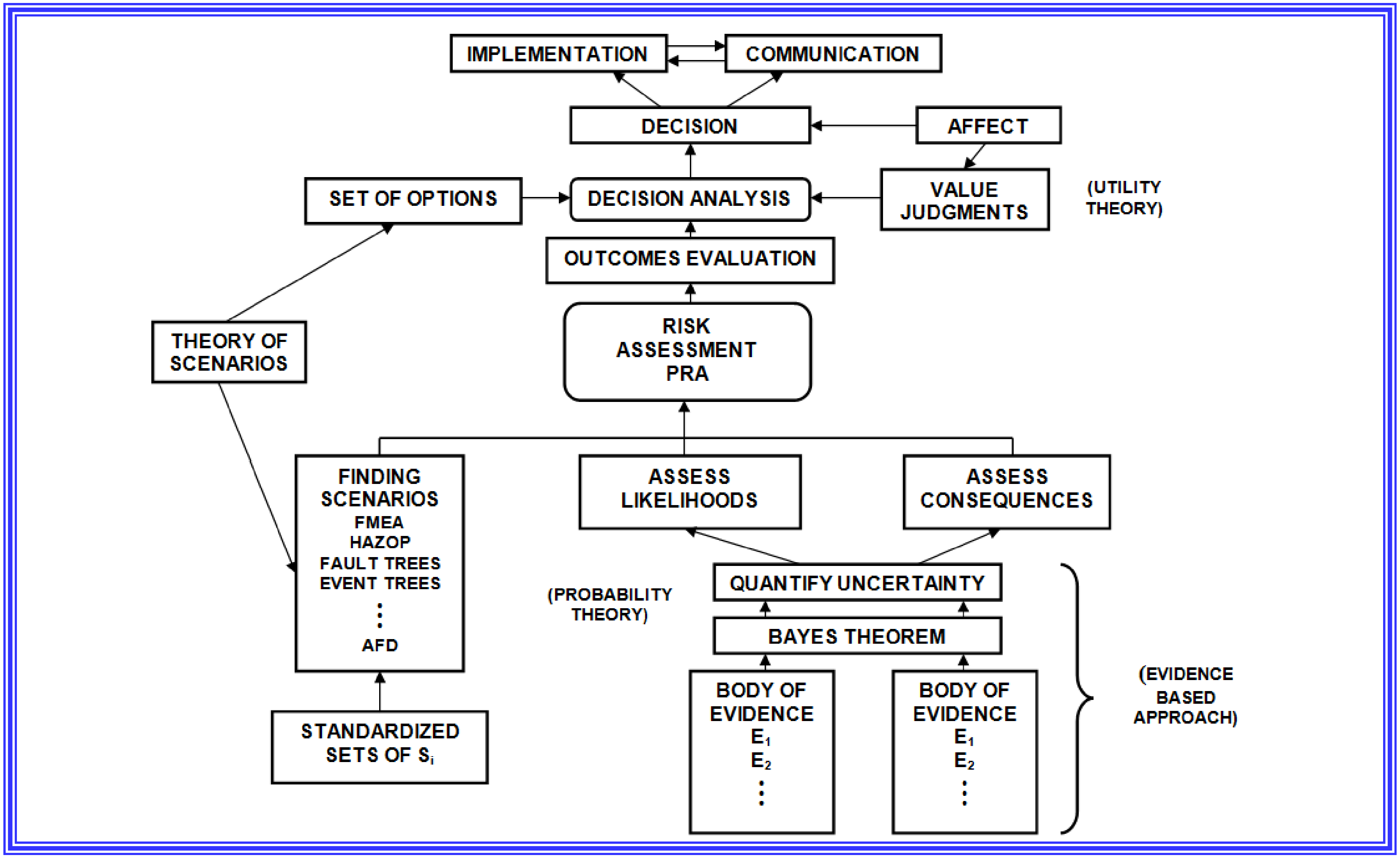
ANATOMY OF A DECISION



Road Map


IMPLEMENTATION
COMMUNICATION
DECISION
AFFECT
SET OF OPTIONS
DECISION ANALYSIS
VALUE JUDGMENTS
(UTILITY THEORY)
OUTCOMES EVALUATION
THEORY OF SCENARIOS
RISK ASSESSMENT PRA
FINDING SCENARIOS
FMEA
HAZOP
FAULT TREES
EVENT TREES
AFD
ASSESS LIKELIHOODS
ASSESS CONSEQUENCES
(PROBABILITY THEORY)
QUANTIFY UNCERTAINTY
BAYES THEOREM
STANDARDIZED SETS OF S_i
BODY OF EVIDENCE E_1 E_2
BODY OF EVIDENCE E_1 E_2
(EVIDENCE BASED APPROACH)

PRA and Decision Analysis

- **Risk is defined by the "triplet" set of questions. What can go wrong? How likely is it? What are the consequences?**
- **The role of probabilistic risk assessment in the decision process is to quantify the outcomes of all the options being considered in the decision.**
- **PRA is thus the linkage (logic) between the desired probability curves, which are the input to the decision analysis, and all the relevant evidence, especially the contributors to the risk.**

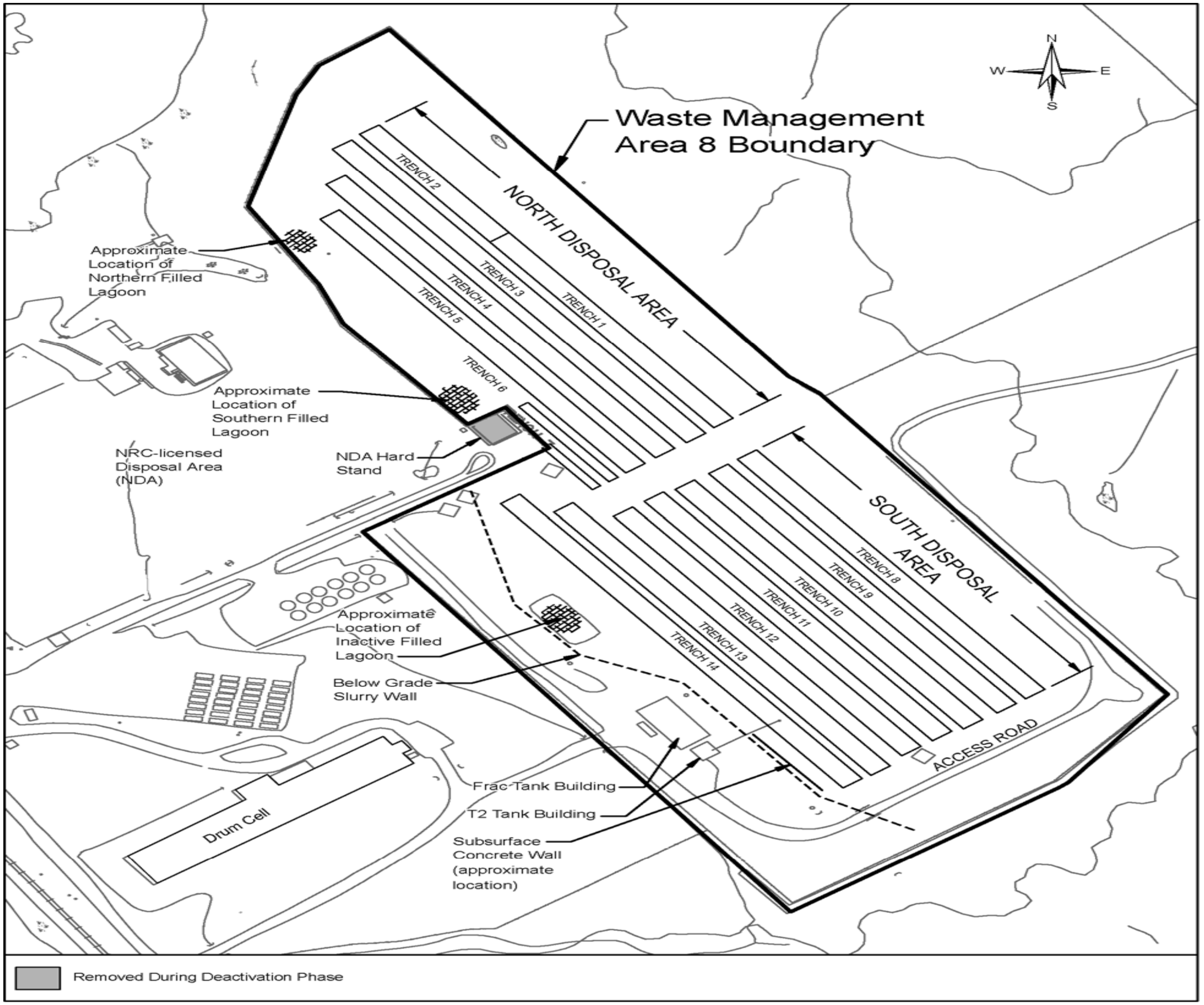
AN EXAMPLE

State Operated Disposal Area (SDA)

- **A 15 acre pre-Part 61 near-surface radioactive waste disposal facility in southwestern New York that operated from 1963-1975.**
- **Received waste from offsite locations and waste generated by the onsite nuclear fuel reprocessing operations.**
- **Inventory in the trenches included 230 radionuclides having an estimated activity of 128,000 curies, decayed to the year 2000.**

SDA Aerial View

SDA Trenches and Watershed



Decision Options

- **Exhume all waste and contamination from the SDA.**
- **Close the SDA in place.**
- **Manage the SDA in place for 10 years to allow additional data collection and analysis to address long-term issues and identify safe and cost effective management or removal options.**

Requirement of the Decision

A quantitative answer to the question, "What is the risk of operating the SDA for the next 30 years with its current physical and administrative controls."

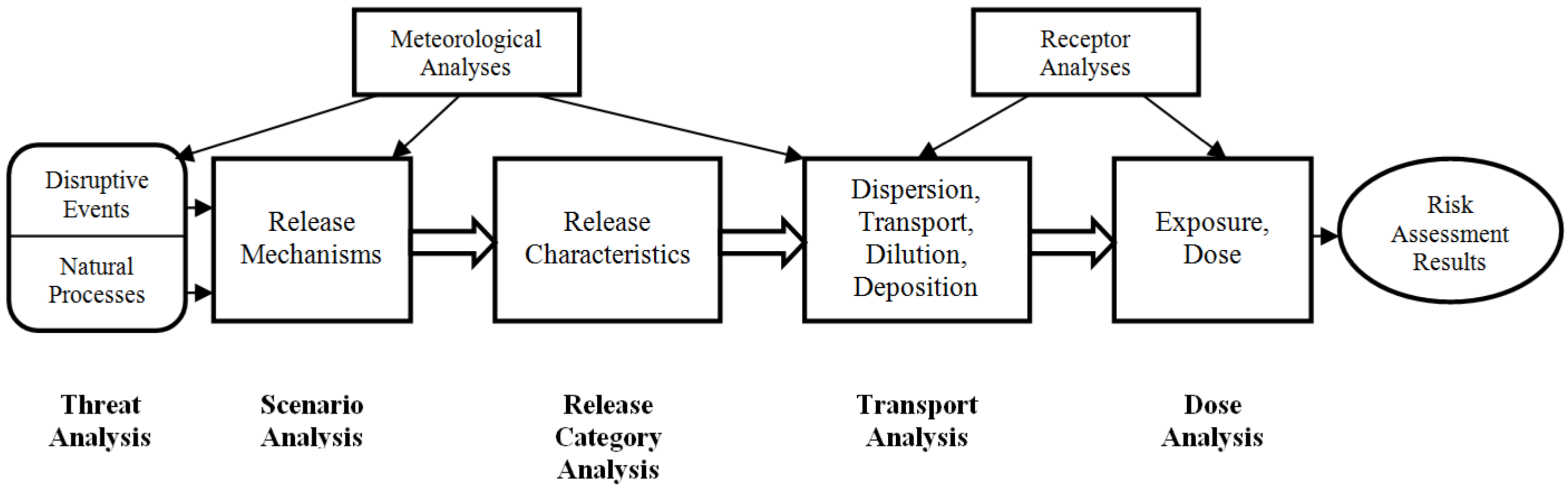
The Decision

The QRA results were instrumental in supporting the decision by the New York State Energy Research and Development Authority to manage the SDA in-place for another decade.

Methodology

- Triplet definition of risk.
- Based on a structured set of scenarios.
- Quantification of uncertainties with probability distributions.
- Credibility definition of probability.
- Data processing rooted in the fundamental rules of logic.

Structure of QRA Model



For Each Scenario, Risk Is Determined By

- **Frequency of disruptive or natural processes that cause a release of radioactive materials from the disposal area.**
- **Form, quantity, and radionuclide content of the materials released.**
- **Distribution, dilution, and deposition of the released materials.**
- **Public exposure and radiation dose.**

Radionuclide Release Mechanisms

- **Liquid releases via groundwater in the subsurface.**
- **Liquid overflows and surface water releases.**
- **Releases of solid and liquid radioactive materials via physical breaches of the trenches.**
- **Airborne releases via physical disruption of the SDA site.**

Dose Receptors

- **A permanent resident farmer on Buttermilk Creek near its confluence with Cattaraugus Creek.**
- **A transient recreational hiker/hunter who traverses areas along Buttermilk Creek and the lower reaches of Franks Creek.**

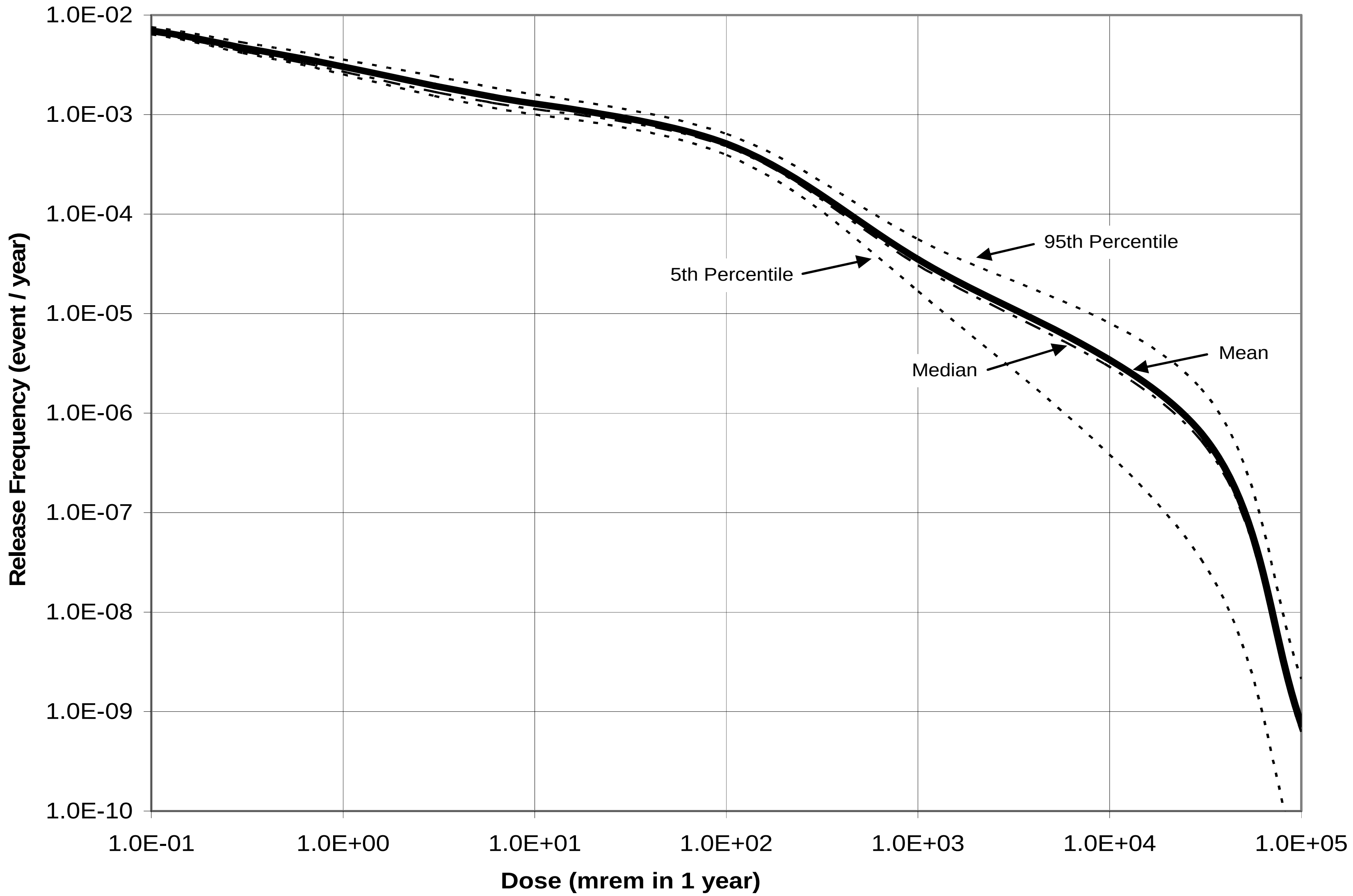
Highest Risk Scenarios

- **Lateral groundwater flows through the ULT: 37%**
- **Physical breaches of the waste trenches: 35%**
- **Lateral groundwater flows through the WLT: 10%**
- **No geomembrane and severe conditions: 6%**

Contribution by Release Mechanism

- **Groundwater flow through the subsurface: 55%**
- **Trench breaches by erosion, landslides: 36%**
- **Trench overflows and surface water runoff: 9%**
- **Airborne releases from physical impacts: <<0.1%**

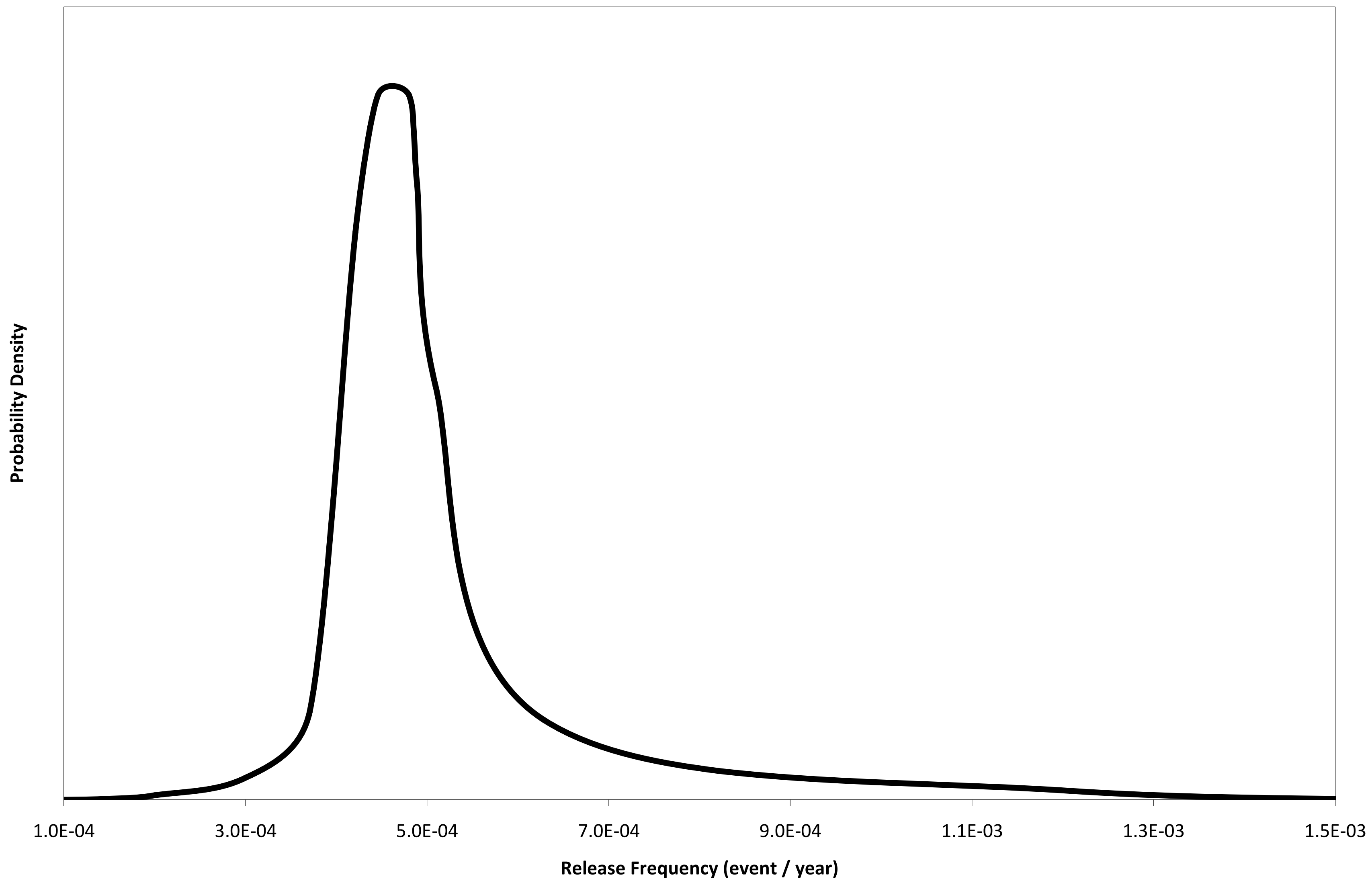
SDA Risk Curves



Vertical Slice

The analysts are 90% confident that the frequency of a dose of 100 mrem in 1 year or greater is between 3.9×10^{-4} and 6.4×10^{-4} event per year.

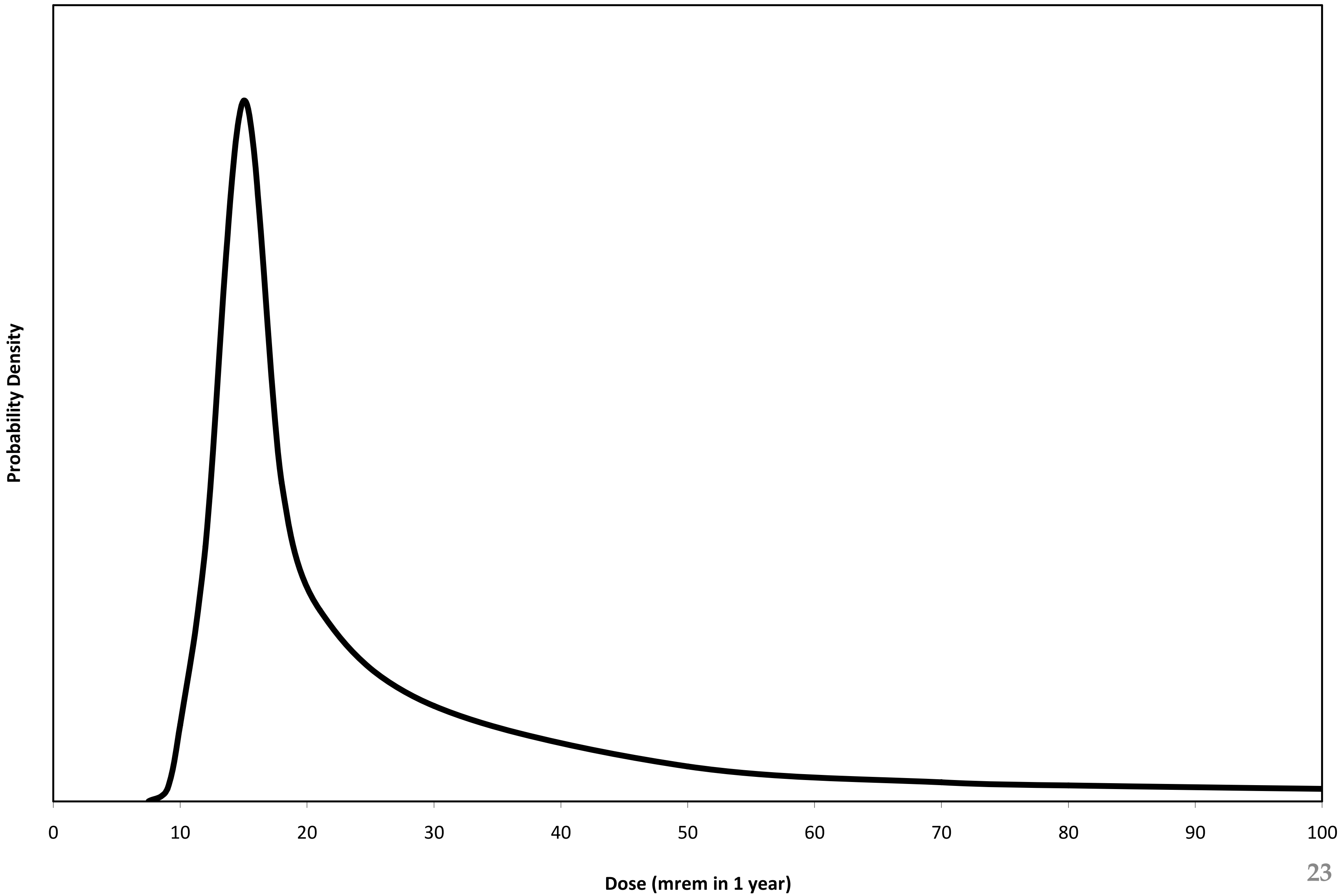
Uncertainty in Release Frequency for Exceeding a Dose of 100 Mrem in 1 Year, Probability Density Format



Horizontal Slice

The analysts are 90% confident that the frequency range of a 1 x 10^{-3} event per year or greater results in a dose between 10 and 31 mrem in 1 year.

Uncertainty in Dose for Release Frequency of 1.0E-03 Event/Year, Probability Density Format

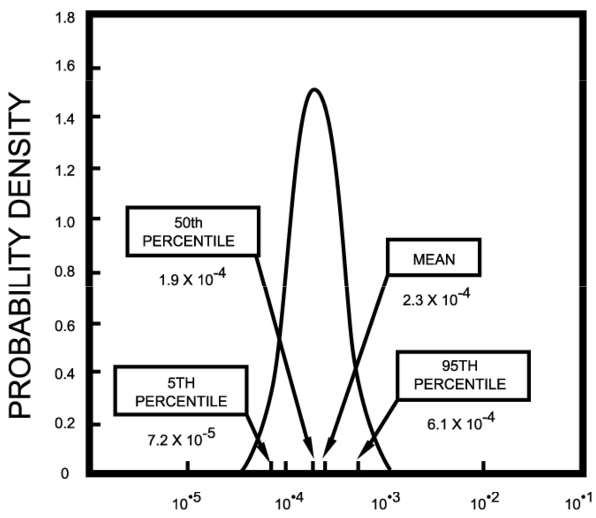


Conclusion

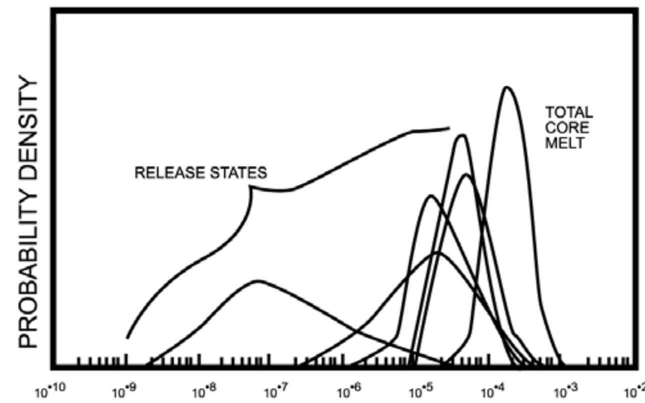
The QRA results confirm that the public health risk from operating the SDA for the next 30 years is well below widely applied radiation dose limits.

NUCLEAR PLANT EXAMPLE

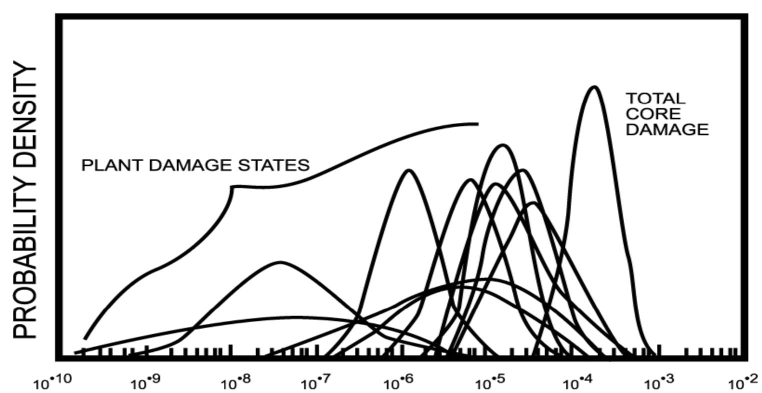
Nuclear Power Plant Risk Results



CORE DAMAGE FREQUENCY

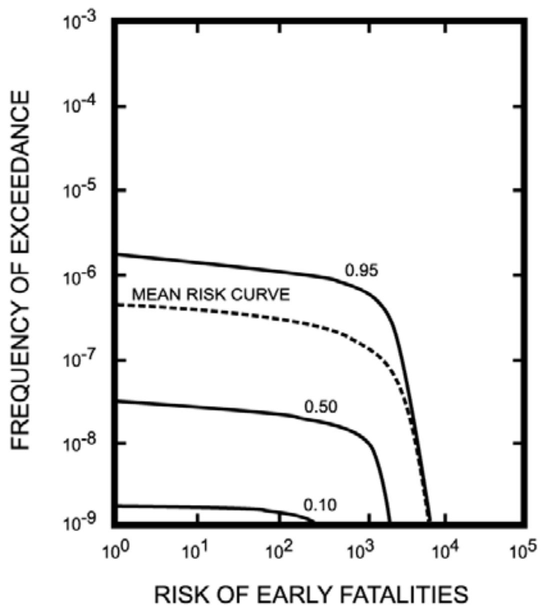


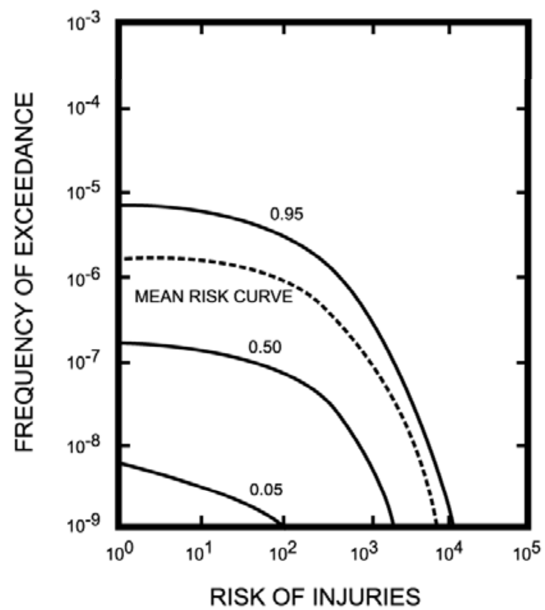
RELEASE STATE FREQUENCIES
(SOURCE TERM)

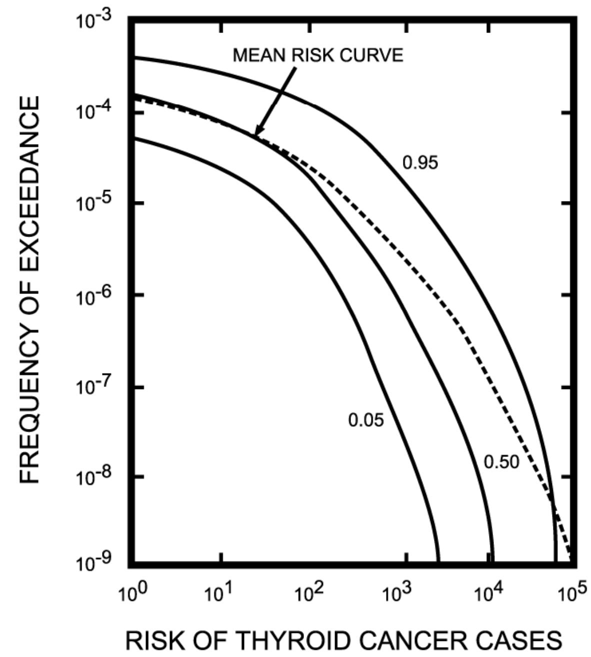


PLANT DAMAGE STATE FREQUENCIES

Nuclear Power Plant Risk Results (Continued)







Nuclear Power Plant Risk Results (Continued)