Quantitative Risk Assessment of the New York State-Licensed Radioactive Waste Disposal Area (SDA)

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Purpose of Presentation

To share with the Board a first-of-a-kind application of a quantitative risk assessment (QRA) to the performance assessment of a nuclear waste facility
Previous and Ongoing Applications

• Engineered systems: nuclear power plants, chemical and petroleum facilities, aerospace systems, transportation systems, etc.

• Natural systems: earthquakes, hurricanes, asteroids, tsunamis, climate change, etc.

• Other: animal importation, major project costs, terrorism, food safety, etc.
Why QRA?

- Exposure and quantification of threats and consequences
- Roadmap for contributors and their importance to risk
- Greatly enhanced basis for making the right decision for managing risk
Fundamentals of QRA

• Triplet definition of risk as the basic framework (scenarios, likelihoods, consequences)
• Scenarios that link initial conditions or system disturbances with possible consequences considering intervening events
• Quantification of uncertainties
Fundamentals of QRA (cont’d)

• Definition of probability based on the credibility of a hypothesis and the supporting evidence
• Information processing rooted in the fundamental rules of logic and in particular, Bayes theorem
QRA results generally take the form of an event frequency and the uncertainty in that frequency (probability of frequency concept)
A QRA does not tell you “when” an event will occur, but it will tell you with uncertainty how often it might occur, thus providing insights on the “when” question
SIX STEP PROCESS TO QRA

• Define the system and its success state(s)
• Identify and characterize the sources of danger
• Develop “what can go wrong" scenarios and their “consequences”
• Quantify scenario “likelihoods”
• Integrate scenarios into measures of total system risk
• Interpret the results for risk management
Linking of Threats and Consequences

Basic Events

Initiating Events

Threat Assessment
(Master Logic Diagram)

Point of Disturbance

System Phases

1 2 n m m+1

Vulnerability Assessment
(Scenarios)

Intelligence Information Expertise

System Analysis

Damage States

A B C Z

1 2 3 4 n
Quantitative Risk Assessment of a Nuclear Waste Repository

INITIAL CONDITIONS

1. NONDISRUPTIVE CASE
   a) CLIMATE CHANGES
   b) WATER FLOW RATES AND DURATION

2. DISRUPTIVE EVENTS
   a) EARTHQUAKES
   b) VOLCANIC ERUPTIONS
   c) EXTREME FLOODING/EROSION
   d) METEORITES
   e) HUMAN INTRUSIONS
   f) OTHER

INfiltration
(Water Flow to Engineered Barrier System)

Engineered Barrier Breach
(Degradation and Failure of Engineered Barriers)

Transport Media
(Radionuclide Transport Through Different Media)

Pathways and Dosimetry
(Radionuclide Transport Through the Biosphere)

Exposure
(Radionuclide Release States)

Dose to Humans
(Dose Assessment)

Dose Values

Release States

Exposure Release States

Radionuclide Release States

Transport Media

Engineered Barrier Breach

Transport Media

Pathways and Dosimetry

Exposure

Dose to Humans

Dose Values

Release States

Initial Conditions

Water Composition

Infiltration

Release States

Engineered Barrier Breach

Degradation and Failure of Engineered Barriers

Transport Media

Radionuclide Transport Through Different Media

Pathways and Dosimetry

Radionuclide Transport Through the Biosphere

Exposure

Dose to Humans

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Release States