Risk Analysis & Management

Presentation to
Gosatomnadzor of Russia

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Introduction

- In the nuclear business, the terms “risk analysis” and “risk assessment” are usually associated with nuclear safety issues.
- This presentation will describe:
  - Why it is important to understand risks (schedule, cost, and performance)
  - How modern analysis tools can be used to assess risks and consequences
  - An example application of risk analysis

Importance of Various Risks

- **Schedule Risk:**
  - **Possible event: Delay in "critical path" schedule item**
  - **Possible consequences: Idled resources, delay of production, continuation of accrued costs beyond budgeted amounts**
- **Cost Risk:**
  - **Possible event: Cost overrun in critical part of project**
  - **Possible consequences: Funding shortfall, need to stretch schedule or redesign process, adverse political implications**
- **Performance Risk:**
  - **Possible event: Performance or reliability shortfall**
  - **Possible consequences: reduced production, higher unit product costs, schedule interruption**
- **All three of these risk factors can be intimately related!**

Risk Analysis is a Tool for Quantifying, Understanding, and Managing Risk

- Results of a risk analysis can identify what "inputs" to a project are likely to have the greatest impact on its ultimate success.
- Good planning, i.e. planning based on risk management, can allow one to prevent or ameliorate projected adverse consequences of unpredictable events that often plague nuclear projects.

An Example Application of Risk Analysis

- **DOE requested ORNL to perform a risk assessment with the following guidelines:**
  - The project analyzed involved a major facility for the U.S. Plutonium Disposition Program to be constructed at the Savannah River Site (SRS) and licensed by the U.S. Nuclear Regulatory Commission (NRC)
  - Obtain reliable data that can serve as a basis for generating the quantitative risk assessment to address programmatic risks
  - Provide an allowance for factors that might influence these risks
  - Develop a probabilistic risk analysis model which will correlate cost and schedule analyses
  - Provide a qualitative and quantitative assessment

Risk Assessment Parameters

1. NRC (regulatory) revised requirements
   - A major revision to existing guidance
   - Substantially more "Requests for Additional Information" (RAIs) than anticipated
   - Substantially more meetings than anticipated
2. Major NRC changes
   - Polycarbonate changed to glass in gloveboxes
   - Changes to criticality control
   - Changes to confinement, classification of components, fire protection for HEPA filters, etc.
   - Changes that substantially affect building characteristics.

Risk Assessment Parameters (continued)

2. Major NRC changes: (continued)
   - Changes to operating parameters that affect design and the plant operating philosophy
   - Change to seismic load definition
   - Treatment of soft zones (soil characteristic)
   - Provision for soil liquefaction
3. IAEA revised requirements (previous assumption based on EURATOM requirements)

Risk Assessment Parameters (continued)

4. Delays in Construction Authorization Request (CAR) and Environmental Report (ER) approvals
   - Moderate delays [4-6 months]
   - Major delays [up to 1 year – could also include protracted hearings by the Atomic Safety and Licensing Board (ASLB)]
   - NRC denies early construction activity until conclusion of hearings and issuance of the final Safety Evaluation Report (SER)
5. Requirement for additional production equipment

Risk Assessment Parameters (continued)

6. Client-initiated changes to the facility scope of work
   - Use of sand filters in place of HEPA filters
   - Increase in number of ventilation air changes
   - Changing from CO_2 to clean agent for fire protection
   - Changing the fire hazards analysis methodology
   - Changing the seismic return frequency from the current design basis

Risk Assessment Parameters (continued)

7. Unforeseen construction work delay or interruption by others:
   - Severe weather for extended periods of time
   - Extended strikes or work stoppages
   - Actions by others that affect the facility – staffing, materials or procurement
   - Oversight by Defense Nuclear Facilities Safety Board (DNFSB), Westinghouse Savannah River Company (WSRC), or any other "third party" organization

Risk Assessment Parameters (continued)

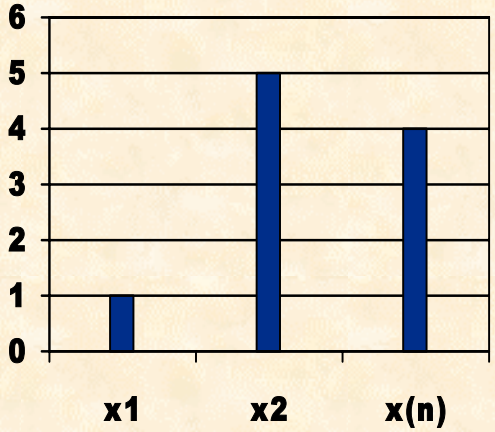
8. Exchange rate fluctuation (US$/EURO)
   - Moderate (5%)
   - Major (10%)
9. Any underground obstructions or site contamination [tritium, trichloroethylene (TCE), previously remediated areas]
10. WSRC (site production organization) cost impacts
    - Infrastructure cost
    - Security level changes
    - Changes affecting operations
    - Imposed safety, security, or quality practices
    - Infrastructure not in place when needed

Procedure

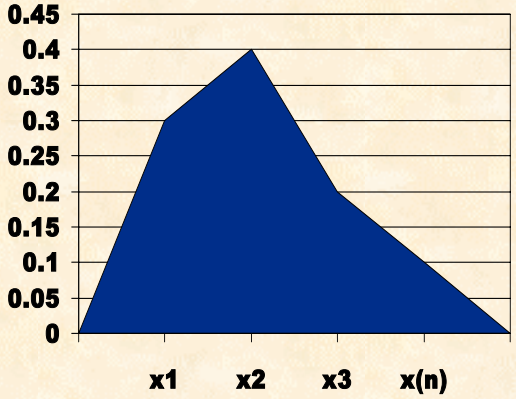
- Elicited data from experts in each field, establishing range width for each input variable
- Developed a risk assessment model using Palisade *@Risk* software in combination with *Microsoft Project* and *Microsoft Excel*
- Determined probability distribution functions and uncertainty bands for input variables
- Correlated input variables (statistical dependence between inputs)
- Performed the simulation and analyzed the results

Distribution Functions

- Discrete ({X1, X2, …, Xn},{p1, p2, …, pn})
  - Has a number of outcomes totaling "n"
  - Each outcome has a value "X" and a weight "p" which specifies the outcome's probability of occurrence

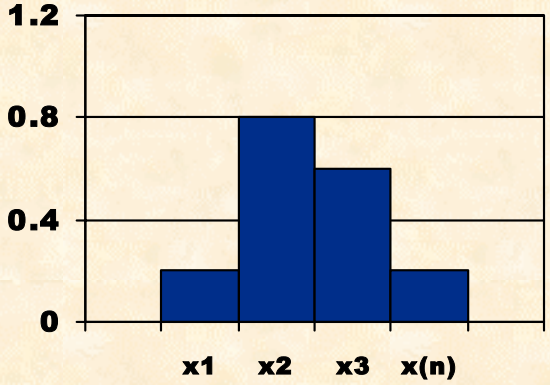


- General (minimum, maximum, {X1, X2, …, Xn},{p1, p2, …, pn})
  - Each outcome has a value "X" and a probability "p" which specifies the relative height of the probability curve at value "X"

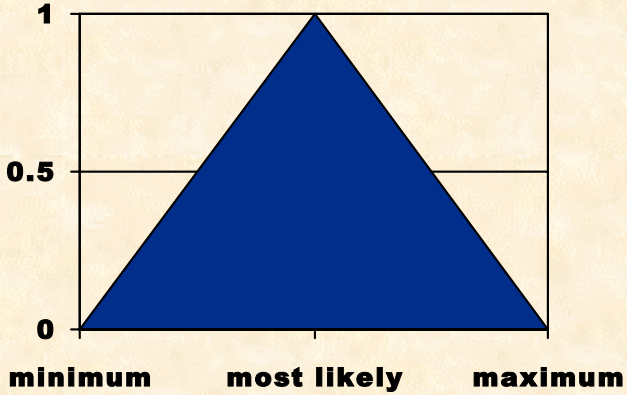


Distribution Functions (continued)

- Histogram (minimum, maximum, {p1, p2, …, pn})
  - Range is divided into “n” classes
  - Range is defined by the specified minimum and maximum values



- Triangular (minimum, most likely, maximum)
  - Minimum and maximum are fixed points with zero probability of occurrence
  - Most likely point falls between minimum and maximum and has the largest probability of occurrence



Analysis Results (most likely causes of cost increases & schedule delays)

Cost Increases

- NRC Denies Early Construction Activity
- Major NRC changes that substantially affect building characteristics
- Delays in CAR & ER approvals
- WSRC cost impacts
- Impacts due to other regulatory requirements

Schedule Delays

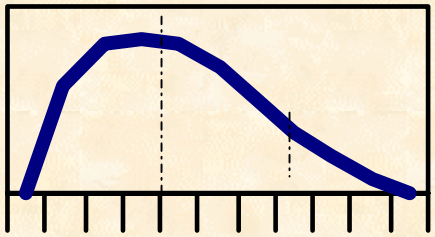
- WSRC cost impacts
- Client-initiated changes to facility scope of work
- Increase in number of ventilation air changes
- Delays in CAR & ER approvals
- Major NRC changes that substantially affect building characteristics

Simulation Results: 12½ Percent Increase in Project Cost Correlated with 26 Percent Increase in Project Duration

Cost increase

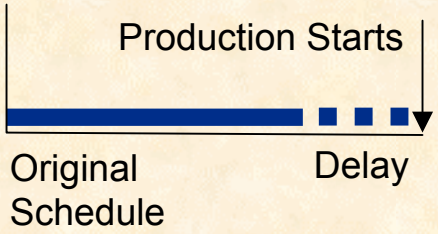
(12 ½ % over base cost
at 90% confidence level)

with correlated



Schedule delay

(26% over base schedule
duration at 90% confidence level)



Summary

- Risk elements (schedule, cost, and performance) can impact the success of any project.
- Risk can be defined as a function of the uncertainty associated with each of these three elements.
- Input uncertainty must be quantifiable in order for output uncertainty to be modeled and analyzed.
- The mathematical algorithms developed and project model should translate input uncertainty into output uncertainty.
- Risk management is a means of identifying, analyzing, and responding to issues with varying degrees of risk during the life of the project.