Nuclear Legacy Liability Program (NLLP) Prioritization

Risk-based prioritization of the environmental remediation and facility decommissioning projects at the Chalk River Laboratory in Ontario, Canada

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Project Objectives

- Develop an objective, risk-based, defensible, and repeatable process and basis for the prioritization and ranking of the projects in the Nuclear Legacy Liability Program (NLLP)

- Prioritize the environmental remediation and facility decommissioning projects in the NLLP at the Chalk River Laboratory (CRL)
Portfolio Prioritization and Sequencing

Previous Experience

Savannah River Site (SRS)

- 1,013 facility decommissioning projects
- 253 environmental remediation projects
- Existing operations
- Liability: $4-5B (USD), 22 years
Portfolio Prioritization and Sequencing
Previous Experience

- Y-12 Security Complex & Oak Ridge National Laboratory
  - 440 facility decommissioning projects
  - 320 environmental restoration projects
  - 16 Capital, modernization, construction, and reconfiguration projects
  - Liability: $4-8B (USD), 40 years
Sequencing Unit Prioritization Estimating Risk Model (SUPERmodel) - Prioritization Process

- **Projects**
  - Facility Decommissioning
  - WMAs - Affective Lands
  - Additional Projects

- **Risk Factors & Associated Risk Parameters Evaluated**
  - **Health, Safety, Security & Environment (HSSE)**
    - Radiological Contamination
    - Non-Radiological Contamination Condition
    - Proximity to Surface Water
    - Proximity to Public
  - **Programmatic**
    - Technical Feasibility
    - Experience and Knowledge
    - Complexity
    - Uncertainty
    - Conformance
  - **Economic**
    - ROM Cost Estimate (Facility and Environmental)
    - Annual Maintenance (or Long-Term Monitoring) Costs

- **Develop and Apply Scoring Schemes**

- **Prioritized Project List: Highest to Lowest Risk**

- **Adjustments based on changing priorities, and conditions**
Gathered/obtained minimum core project data required for prioritization

- Project # & Name
- Project Type
- Square footage
- Area
- Year built/created
- Status
- Endstate
- Radiological/non-radiological
- Liquids/solids
- Waste volumes

Used data to assist in initial (i.e. default) risk value determinations

Project data used in parametric rough order-of-magnitude (ROM) cost estimating models for both environmental remediation and facility decommissioning projects
Projects organized into Planning Envelopes (PEs), consistent with the Comprehensive Preliminary Decommissioning Plan

Total of 369 projects

- 275 Facility Decommissioning projects
  - PE1: Nuclear Facilities (59)
  - PE2: Radiochemical Laboratories (36)
  - PE3: Low Hazard Contaminated Structures (68)
  - PE4: Non-contaminated Structures (107)
  - PE5: Distributed Services (5)
- 94 Environmental Remediation Projects
  - PE6: Affected Lands (15)
  - PE7: Waste Management Areas (WMAs) (79)
Twelve (12) risk parameters were identified and used:

- Radiological contamination
- Non-radiological contamination
- Proximity to public
- Proximity to surface water
- Condition
- Technical feasibility
- Experience and knowledge
- Complexity
- Uncertainty
- Conformance
- Rough Order-of-Magnitude (ROM) cost estimate
- Annual maintenance costs
  - % of overall ROM cost when actuals not available

Defined with specific criteria and documented through the development of matrices for each risk parameter.
<table>
<thead>
<tr>
<th>Risk Parameter Matrix: Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uncertainty</strong></td>
</tr>
<tr>
<td><strong>Risk Level</strong></td>
</tr>
<tr>
<td><strong>Building/Structure</strong></td>
</tr>
<tr>
<td>Extensive Information Gaps</td>
</tr>
<tr>
<td>Moderate Information Gaps</td>
</tr>
<tr>
<td>Partial/Limited Information Gaps</td>
</tr>
<tr>
<td>Minimal Information Gaps</td>
</tr>
<tr>
<td>No Information Gaps</td>
</tr>
</tbody>
</table>
Risk Parameter Weightings

- Risk parameter weightings developed with input from stakeholders in alignment workshops
  - Allowed for stakeholder influence in prioritization by risk
  - Accounts for differing views and perspectives of risk
- Prevented arbitrary prioritization of specific projects
- Forced to balance risks at appropriate level
  - Major factors vs. influencers
- Maintained a technically objective evaluation without introducing social bias or additional judgement
  - Supports multi-criteria analysis and risk-based decision-making
  - Social factors are considered during sequencing
## Risk Parameter Weightings

Determined with input from major stakeholder groups

<table>
<thead>
<tr>
<th>Health, Safety, Security, &amp; Environment (HSSE)</th>
<th>Final Weightings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiological Contamination</td>
<td>31%</td>
</tr>
<tr>
<td>Non-Radiological Contamination</td>
<td>23%</td>
</tr>
<tr>
<td>Condition</td>
<td>19%</td>
</tr>
<tr>
<td>Proximity to Surface Water</td>
<td>18%</td>
</tr>
<tr>
<td>Proximity to Public</td>
<td>9%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Programmatic</th>
<th>Final Weightings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty</td>
<td>23%</td>
</tr>
<tr>
<td>Conformance</td>
<td>21%</td>
</tr>
<tr>
<td>Technical Feasibility</td>
<td>19%</td>
</tr>
<tr>
<td>Complexity</td>
<td>19%</td>
</tr>
<tr>
<td>Experience &amp; Knowledge</td>
<td>18%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Economic</th>
<th>Final Weightings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Maintenance / Long-Term Monitoring Costs</td>
<td>70%</td>
</tr>
<tr>
<td>ROM Estimated Cost</td>
<td>30%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
Project data was not always readily available

Default risk parameter values were developed for each risk parameter matrix

- Required in order to assign a risk value to each project when little to no information exists or is readily available

The following data was used to establish defaults risk values:

- PE
- Contamination Zone – existing areas of increasing radiological impact
- Year built/created
- Location
Risk Parameters: Facility Decommissioning ROM Cost Estimate

- Determined base facility Deactivation and Decommissioning (D&D) unit cost
  - Escalated previous decommissioning rates to current year rates

- Facility ROM Cost Estimate = Size × Decommissioning Unit Rate × Radiological Contamination × Non-Radiological Contamination × Complexity × Uncertainty × End State × Construction Type * Site Correction Factor
  - Based on INL Parametric ROM Cost estimating model
Environmental ROM cost estimates were estimated by an independent third party and used

- SUPERmodel-generated environmental ROM cost estimates were overridden

SUPERmodel still calculates ROM cost estimates for environmental remediation projects using selected unit rates for likely remediation methods

- Environmental ROM Cost = V × U
  - V = volume of contaminated media or installed remediation material (m³), depending on remediation technology being applied
  - U = remediation method unit cost ($/m³)
  - Units rates were selected and escalated to 2012 dollars from published unit rates from the Federal Remediation Technology Roundtable (FRTR) and/or U.S. Environmental Protection Agency (EPA)
Risk Factors & Scoring Schemes

Risk factors

- HSSE = \([ (R-\text{Cont}(w) + NR-\text{Cont}(w)) \times (ProxP(w) + ProxW(w) + Cond(w)) ] \)
- Programmatic = \((TF(w) + E&K(w) + Comp(w) + Unc(w) + Conf(w))\)
- Economic = \((ROM(w) + MaintCost(w))\)
  - \((w) = \text{weighting}\)

Scoring schemes & weighting

<table>
<thead>
<tr>
<th>Scoring Scheme</th>
<th>HSSE</th>
<th>Programmatic</th>
<th>Economic</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS1: All Things Being Equal (Baseline)</td>
<td>33%</td>
<td>33%</td>
<td>34%</td>
</tr>
<tr>
<td>SS2: Safety First</td>
<td>60%</td>
<td>30%</td>
<td>10%</td>
</tr>
<tr>
<td>SS3: Program Objectives</td>
<td>10%</td>
<td>60%</td>
<td>30%</td>
</tr>
<tr>
<td>SS4: Economic</td>
<td>10%</td>
<td>30%</td>
<td>60%</td>
</tr>
</tbody>
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Basis for Prioritization

- Prioritization results reflect a highest to lowest relative risk ranking for all projects in the NLLP portfolio.
- Utilizes a composite risk score to assign a ranking.
- Evaluated and compared results of four (4) different scoring schemes.
- Two (2) groups:
  - All NLLP projects (70-year plan)
  - All projects currently in the NLLP including those expected to be handed over in the next 10 years
    - Excludes those beyond 10 years.
Baseline Case:

- Nuclear facility projects and waste management areas (WMAs) generally trending toward the top of the priority/ranking list
- Due to higher programmatic risks and opportunities to reduce maintenance costs
- Specific WMA/Affected lands projects are found in the Top 50 with high HSSE risks
- Non-contaminated structures/projects trend toward the bottom of the list (i.e. lower priority)

Higher Programmatic or HSSE weighting = more nuclear projects rise and affected lands/WMAs lower
Outcomes & Conclusions

- Developed a technically objective and repeatable prioritization process and basis
- Engaged stakeholders throughout process to obtain input and buy-in of the risk evaluation criteria and process
- Risk-based prioritized project list
- Developed independent ROM cost estimates for facility decommissioning and a select number of environmental remediation projects
  - Can be compared to actual costs or used for benchmarking
- As a by-product, updated and consolidated project data is now in one central database
Proposed Next Steps

- Conduct sequencing and schedule optimization
  - High priorities don’t necessarily reflect the order in which projects will be performed/executed
  - Addresses cost, schedule, operations, budget, and other stakeholder constraints
  - Provides ability to conduct ‘unconstrained’ model runs

- Use as a consistent prioritization process to support more detailed annual planning
SUPERmodel Process: Next Steps - Sequencing

**PRIORITIZATION**
- Prioritized Project List: Highest to Lowest Risk
- Additional Considerations:
  - Annual Budgets
  - Durations
  - Time Frames
  - End Dates
  - Date Available
  - Milestones/Commitments
  - Associated/Predecessors
  - Inflation
  - Project Phases
  - Enabling Facilities

**SEQUENCING**

**Outputs**
- Optimized Schedule & Export
  - Set or adjust baseline
- Forecasts
  - Footprint Reduction
  - Waste Generation
  - Maintenance Cost Reduction
  - Risk Reduction
  - Resources and Equipment
- Funding / Budget Profiles
  - Annual Budgeting and Requests

**Management / Stakeholder Decision Making**

**Project Planning**
- Development of site-wide, integrated, program-level, strategic, and/or execution plans

**Reviews**
- In response to changing conditions or stakeholder concerns

**Execution & Performance**

Adjustments based on changing priorities, and conditions

Legend:
- Data Retrieval/Input
- SUPERmodel Runs
- Analysis/Decisions
- Outputs
Sequencing: Maximizing the Benefits of Prioritization

- Conducts ‘what if’ scenarios to evaluate impacts of changes in priorities, budgets, timeframes, risks, etc.
- Provide forecasts (e.g. Maintenance reductions, budget, waste generation, footprint reduction, resources, etc.)
- Utilizes prioritization to provide an optimal sequence (i.e. project schedule) based on constraints
Sequencing: Maximizing the Benefits of Prioritization

- Instant visibility of gaps in projects or funding
- Supports strategic and integrated planning and budgeting
- Forecasts budgeting, waste forecasting, resources, equipment
- Produces and optimized schedule for any portfolio to reduce maintenance/monitoring costs and maximize benefits
- Win-Win-Win for all stakeholders
...the risk model (SUPERmodel) was designed... to make D&D decisions and already considers the impact of off-site receptors when assigning a risk score. If Environmental Management used the Model [SUPERmodel] and focused on risk for prioritizing its D&D activities, this issue would have already been addressed.

This would have led to reduction of the annual C&M costs by $2.2M instead of $306K and reduced the D&D costs incurred by $20M and conducted the additional D&D of over 20 facilities.

—US. Inspector General Audit
Thank you