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American Nuclear Society
Importance of Systems Engineering to Support Risk-Informed Performance-Based Methods

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Outline

What is systems engineering?
Key concepts
Value of systems engineering to support RIPB methods
Tailoring and best practices
Effective program management
Additional resources
What is systems engineering?

A set of proven tools and techniques for managing the complexity of large projects/products in order to control cost, schedule, and quality.
System engineering standards

ISO/IEC/IEEE 15288:2015 Systems and software engineering -- **System** life cycle processes
ISO/IEC/IEEE 12207:2017 Systems and software engineering -- **Software** life cycle processes
ISO/IEC/IEEE 24748 Systems and software engineering
-- Life cycle management
  – 2018 -- Part 1: Guidelines for life cycle management
  – 2016 -- Part 4: **Systems** engineering planning
  – 2017 -- Part 5: **Software** development planning
  – 2016 -- Part 6: System integration engineering

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System lifecycle and V-model
## Systems engineering processes

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<th>Technical Management and Control</th>
<th>5. Product Realization</th>
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<td>Stakeholder Expectations Elicitation and Validation</td>
<td>Technical Planning</td>
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<td>Technical Solution Definition</td>
<td>Integration of the Systems Engineering Effort</td>
<td>Product Integration</td>
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<td>Integration of Specialty Engineering (Systems Analysis)</td>
<td>Configuration Management</td>
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Typical requirements set

- Mission Statement
- Customer Requirements
- System Technical Requirements
- Detailed Technical Requirements
- Derived Requirements

Analysis stages:
- Mission Analysis
- Requirements Analysis
- Functional Analysis
- Subsequent Iterations

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Goal vs requirement

Goal:
- Maximize
- Minimize
- Optimize

Requirement:
- At least
- At most
- Range
- Exactly

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Product structure modeling

Conceptual model for safety requirements specification and management in nuclear power plants, VTT TECHNOLOGY 238, Copyright VVT 2015

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Value of systems engineering to support RIPB methods

Without a robust SE infrastructure, organizations will face challenges successfully implementing RIPB methods into the following key processes

• Requirements engineering and management
• Decision making
• Configuration management
• Technical assessment
Tailoring and best practices

SE programs should be tailored to the organizational needs and lifecycle phase of the system or product
One size does not fit all when tailoring SE programs
Outside experts need to work closely with internal change leaders
The nuclear industry can learn a lot from other industries regarding SE best practices (e.g., aerospace)
Effective program management

After initial establishment of SE programs, they need to be actively maintained and adjusted.

Initial programs typically focus on supporting one or two products or projects, but then grow to support the entire enterprise.

SE resources should be planned and tracked as a percentage of total project resources to evaluate effectiveness.
Additional SE resources

ISO/IEEE
INCOSE
NASA
DOD
DOE
IpX
American Nuclear Society
ans.org