Application of Classical Reliability Management Tools to Support Remedial Program Optimization

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Introduction

Reliability is defined as the ability of an item to perform a required function under stated conditions for a stated period of time.

- Historical perspective.
- Principal of eventual failure.
- Importance – Maintaining safety, performance, and cost of dynamic systems.
- Requirement of both process and technique.
- The RM Universe.

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Reliability Management Principles

- Dividing a remediation program into simpler pieces improves reliability.
- Iterative remedial program development increases reliability.
- Increased reliability involves higher initial but lower life cycle costs.
- Tradeoffs between project/system complexity, performance, and cost.
- Reliability increases with understanding/quantification of controlling factors.
- Reliability predictions of low confidence often have significant value in decision-making.
- Multi-disciplined team often more effective in addressing RM issues.
- Savings from increased reliability continue to accrue with time.

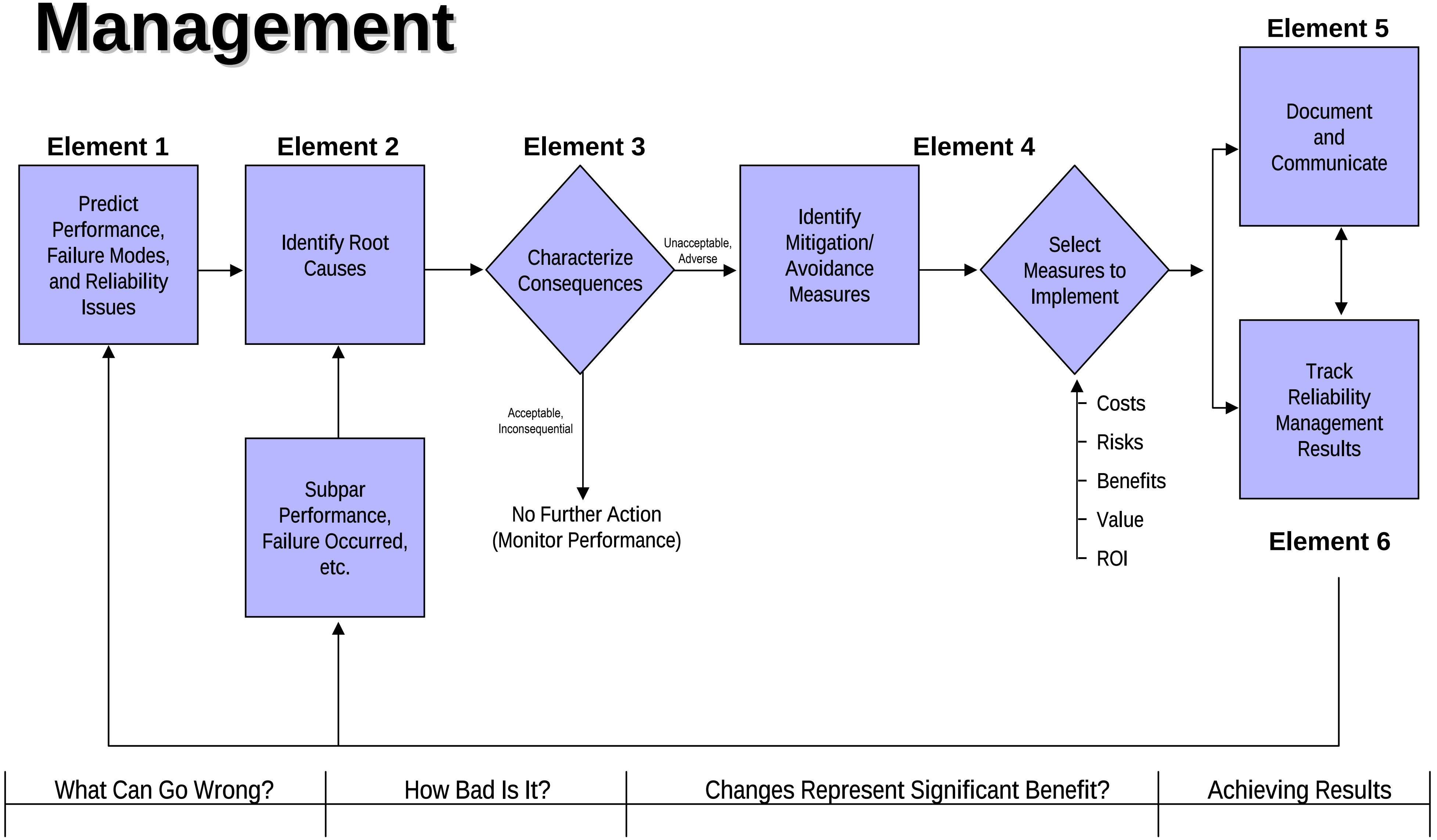
Reliability Management Tool Applicability to Each Remediation Project Stage

Superfund Program Stage	Conceptual Site Model	Event Probability Frequency Analysis	External Hazard Analysis	Failure Mode and Effect Analysis	Predictive Testing	Predictive Testing	Reliability Block Diagram	Risk Management Planning	Root Cause Failure Analysis
Remediation Investigation/ Feasibility Study	●		S	S	P		P		
Record of Decision	●		S	S	P		P		
Remedial Design	●	S	S	S	P	P	P	P	P
Remedial Action Construction	●	S		S		P	P	P	P
Operation and Maintenance	●	S				P		P	P
Five-Year Review	●	S				P		P	P
Post-Action Monitoring	●	S				P		P	P

S = Reliability tools of secondary importance

P = Reliability tools of primary importance

The Six Elements of Reliability Management



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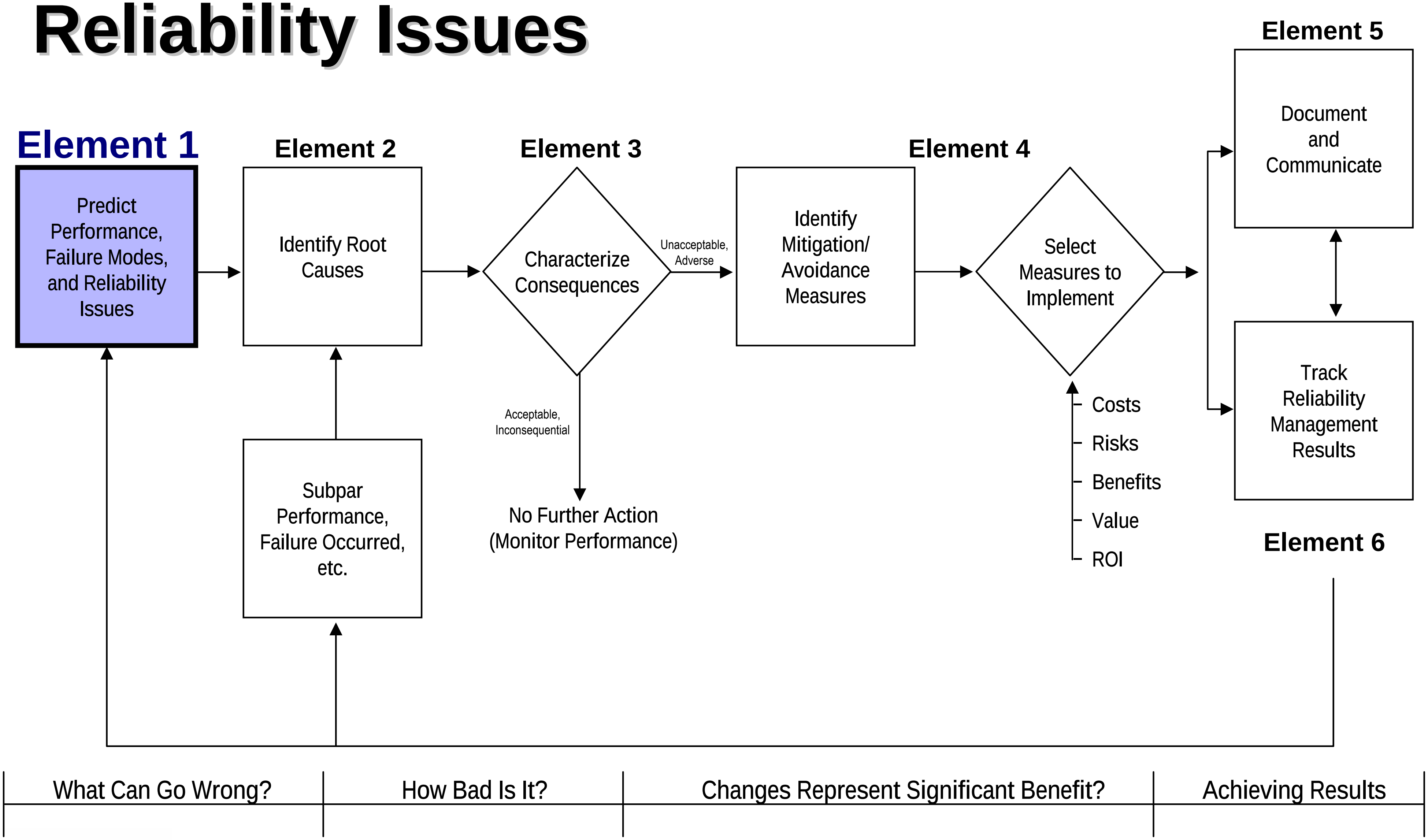
Predict Performance, Failure Modes, and Reliability Issues



Methods used to predict the likelihood of failure depend on incident frequencies from historical records and experience, which are only now beginning to be developed for remediation projects and technologies.

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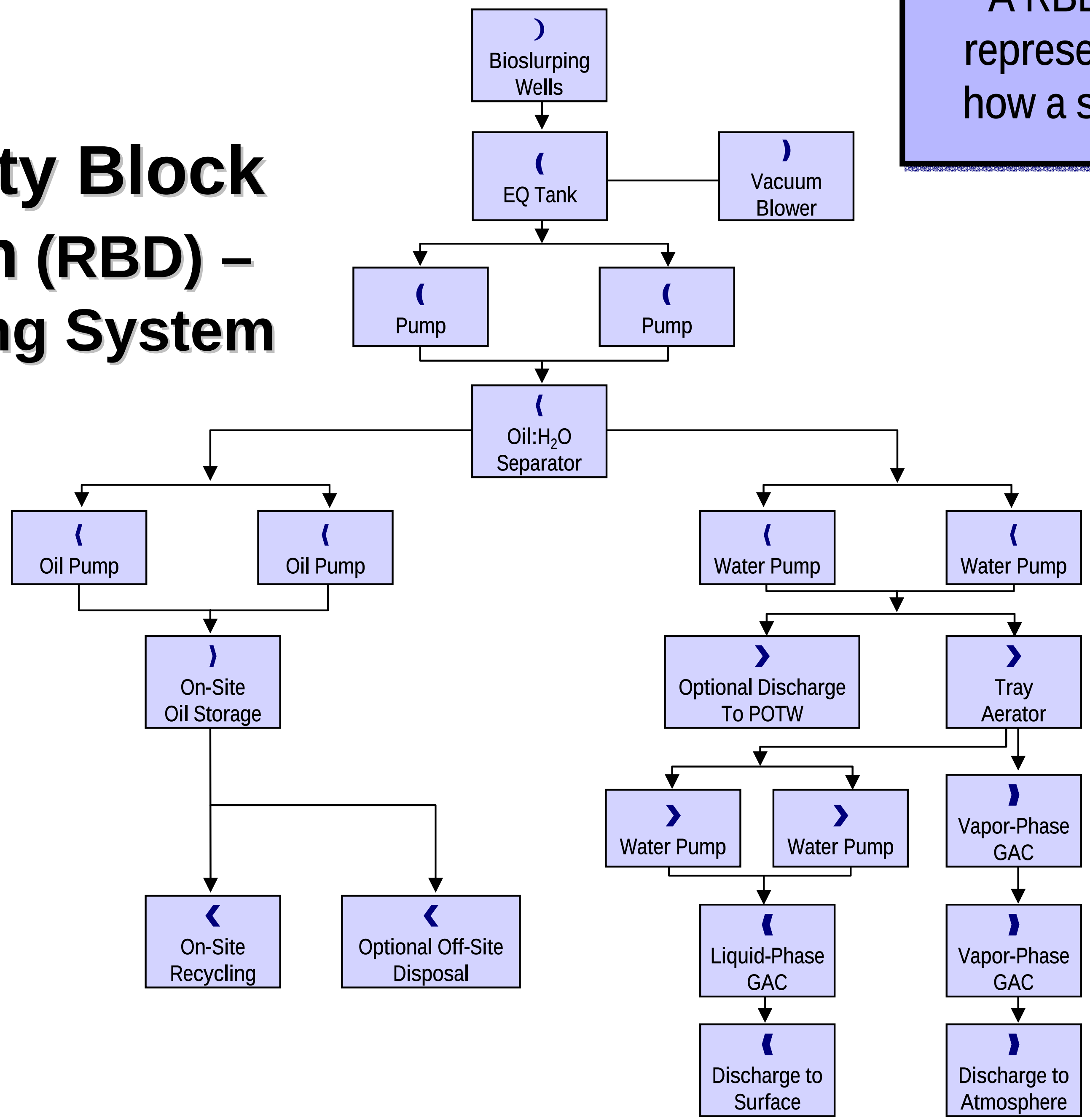
Data Analysis to Predict Failure and Address Reliability

- Determine the relative probability of failure scenarios.
- Predict the reliability of equipment, products, parts, and systems.
- Provide a basis for comparing two or more designs.
- Establish a failure reporting system.
- Guide mitigation measures.

Reliability Block Diagram (RBD) – Bioslurping System

A RBD is a graphic representation showing how a system functions



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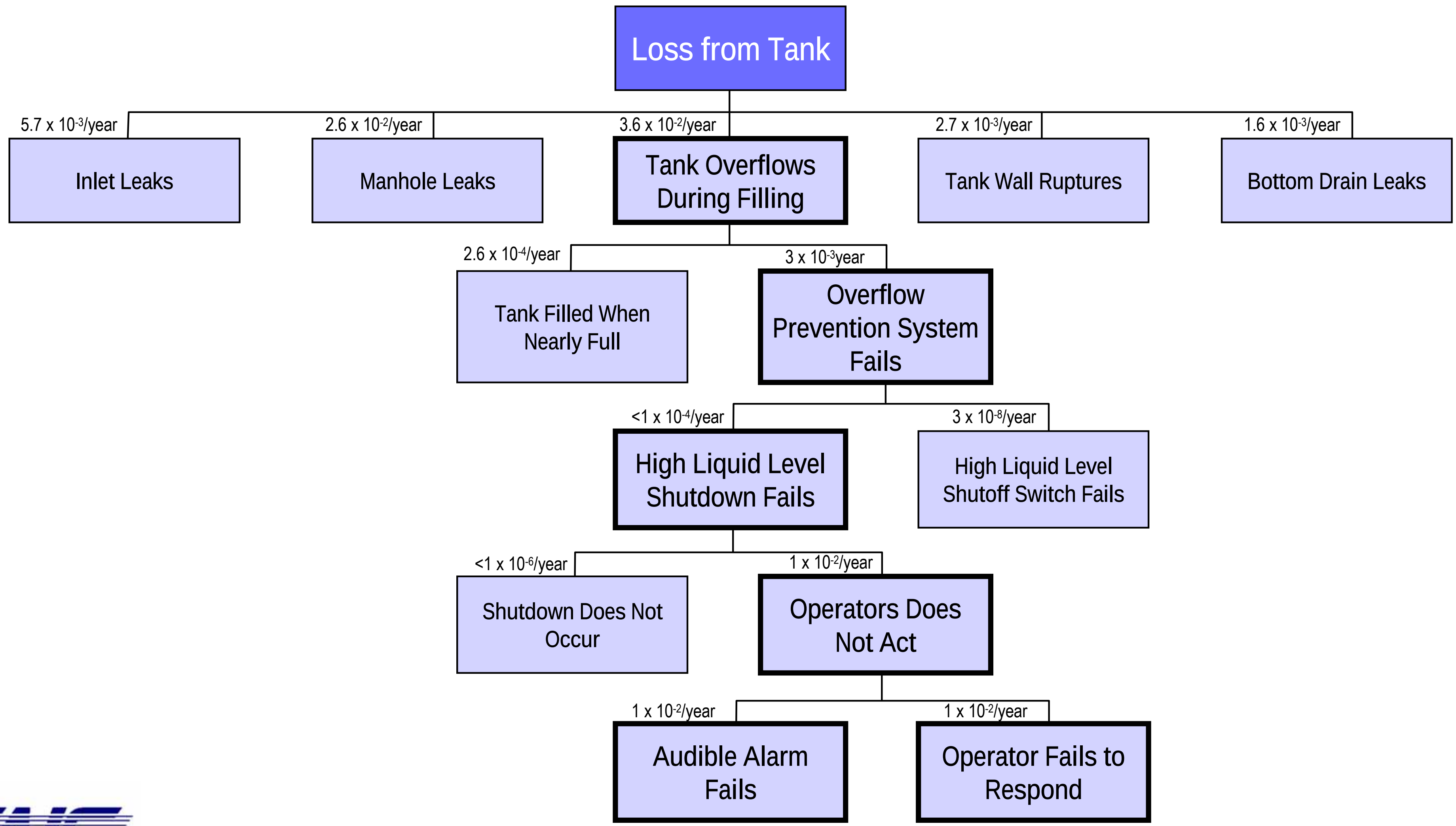
Example Event Tree Analysis for Waste Loss from a Storage Tank



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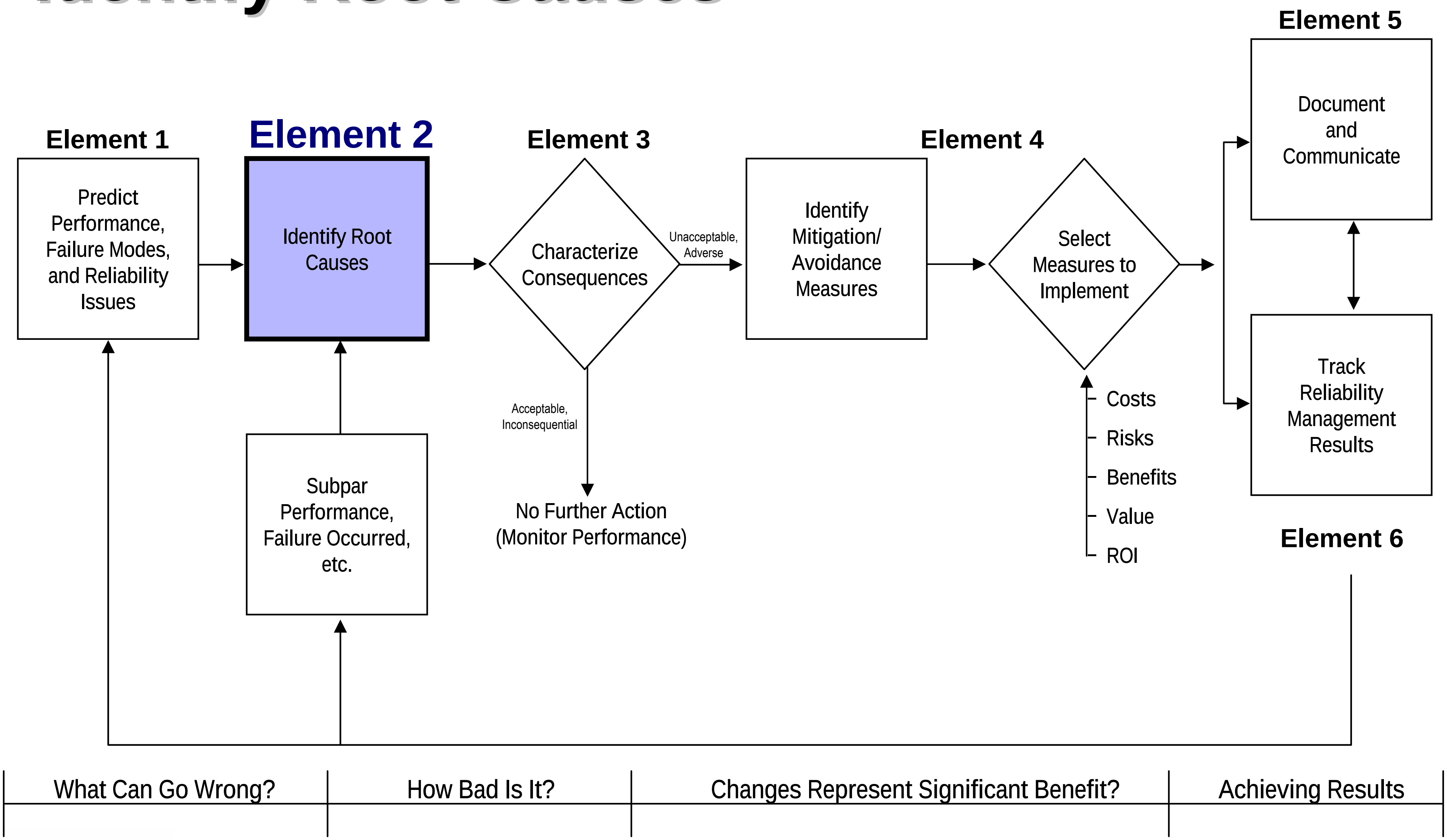
Identify Root Causes



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Cause and effect mechanisms are not always intuitive nor obvious. Often what is observed is the symptom of a problem or a combination of problems, but is not the problem itself.

Root Cause Failure Analysis (RCFA)

- ***Obj*** – Purposeful Determination of underlying cause(s).
- ***Approach:***
  - Systematically consider the possible ways that failure could have occurred.
  - Gather and organize facts to rule out possibilities.
  - Develop a technically defensible loss scenario.
  - Identify key causal factors and underlying root causes of the loss scenario.
  - Develop defensible loss avoidance recommendations.
- ***Example:*** Pump motor failure.

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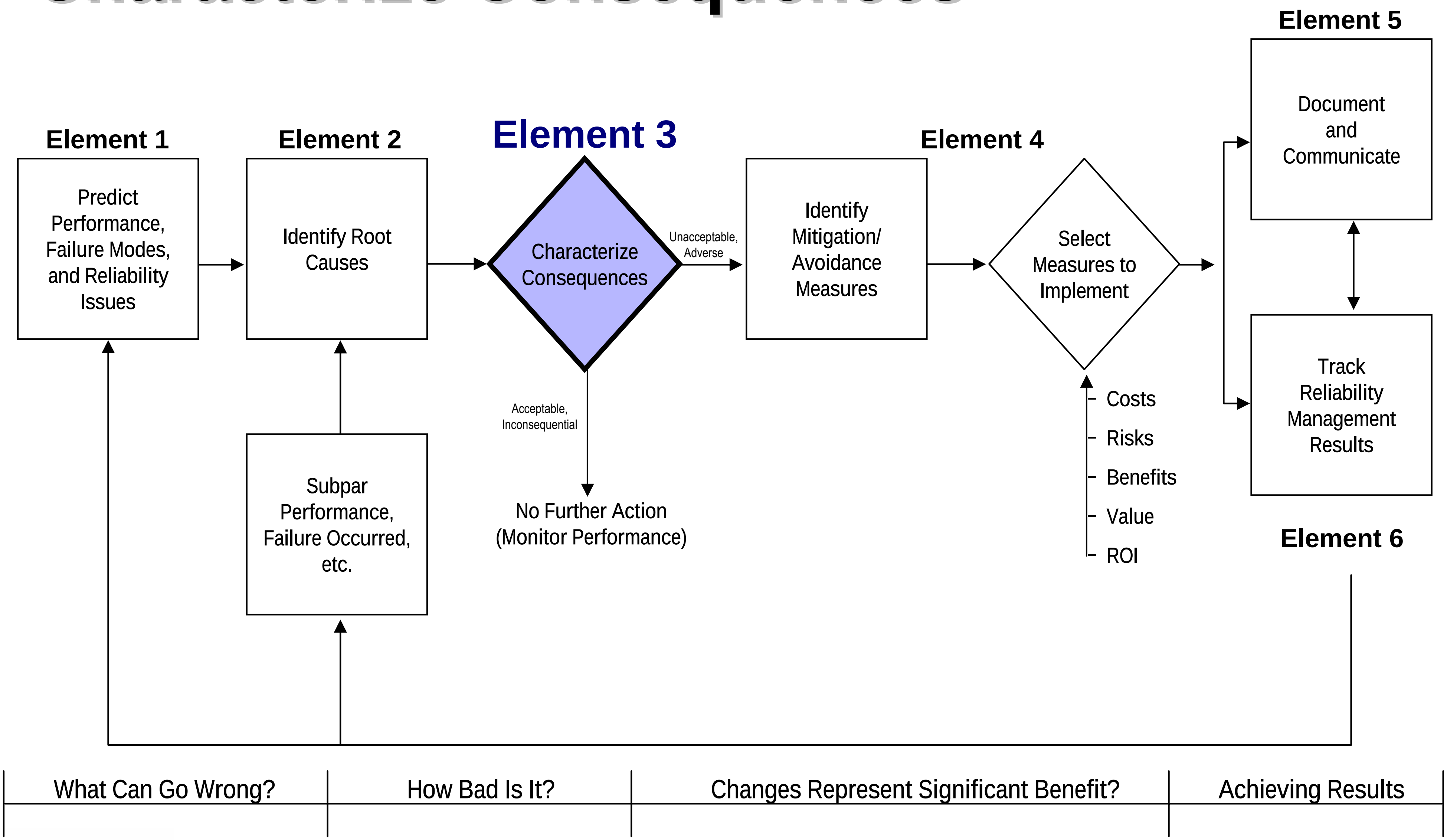
Characterize Consequences



The significance of the failure consequence determines the degree of mitigation necessary.

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Actions Supporting Consequence Analysis Planning

- Identify specific design, construction, and operation criteria.
- Define reliability management and administrative procedures.
- Establish quality control programs and criteria.
- Conduct design and construction reviews.
- Assess facility/equipment siting issues.
- Measure operations/maintenance and equipment performance.
- Evaluate mitigation system effectiveness.

Failure Mode and Effects Analysis (FMEA)

- Identify all potential failure modes
- Identify the fundamental causes of each failure.
- Determine results and symptoms of each failure.
- Evaluate the severity of consequence of each failure.
- Determine the probability of failure occurrence.
- Identify necessary and appropriate avoidance and corrective actions.

FMEA evaluates the various ways equipment can fail, the effects of the failure on the process or system, and identifies possible avoidance mechanisms.

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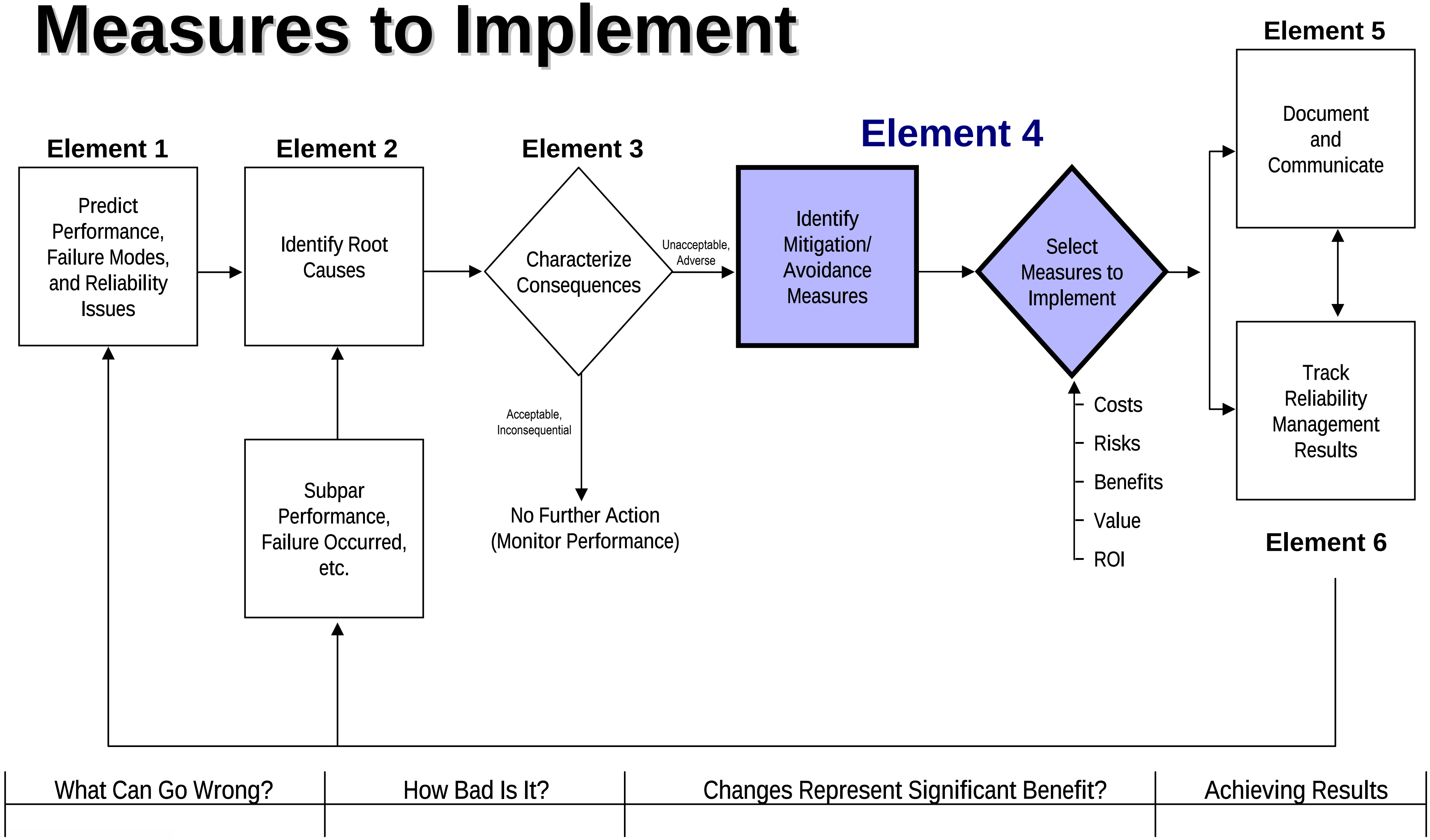
Identify Mitigation/Avoidance and Select Measures to Implement



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Consequence characterization and mitigation measure identification/implementation enhance reliability by minimizing or reducing potential failure(s) from occurring, but cannot guarantee that failure(s) will not occur.

Developing Mitigation/Avoidance Measures

- Assign a probability of occurrence.
- Determine the potential consequences.
- Identify several mitigation measures.

To Choose Among Multiple Mitigation Choices, Consider These Factors:

- Effectiveness
- Implementability
- Monetary and nonmonetary costs
- Value

External hazards Analysis (EHA)

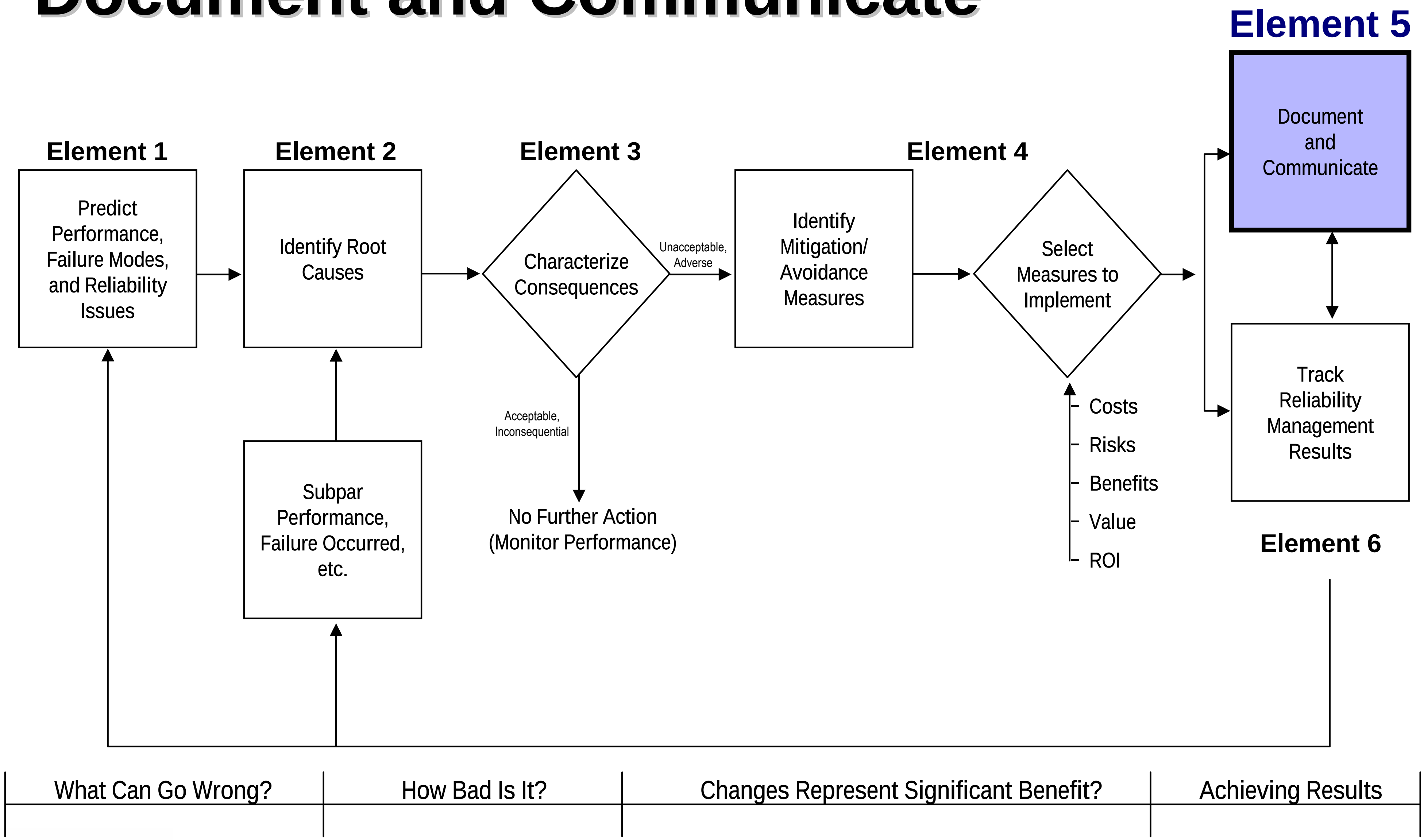
- ***Obj*** – Identify external factors (natural and human-induced) having the potential to initiate failure.

- ***Approach:***
  - Systematically consider the possible external hazards.
  - Determine hazard intensity required for failure.
  - Perform process response and vulnerability evaluation.
  - Develop a technically defensible sequence scenario.
  - Develop defensible consequence and loss avoidance recommendations**.**

- ***Example:*** SVE Freezing/Condensate Induced Piping Failure

Weakness of EHA is lack of ability to rigorously estimate process vulnerability.

Document and Communicate



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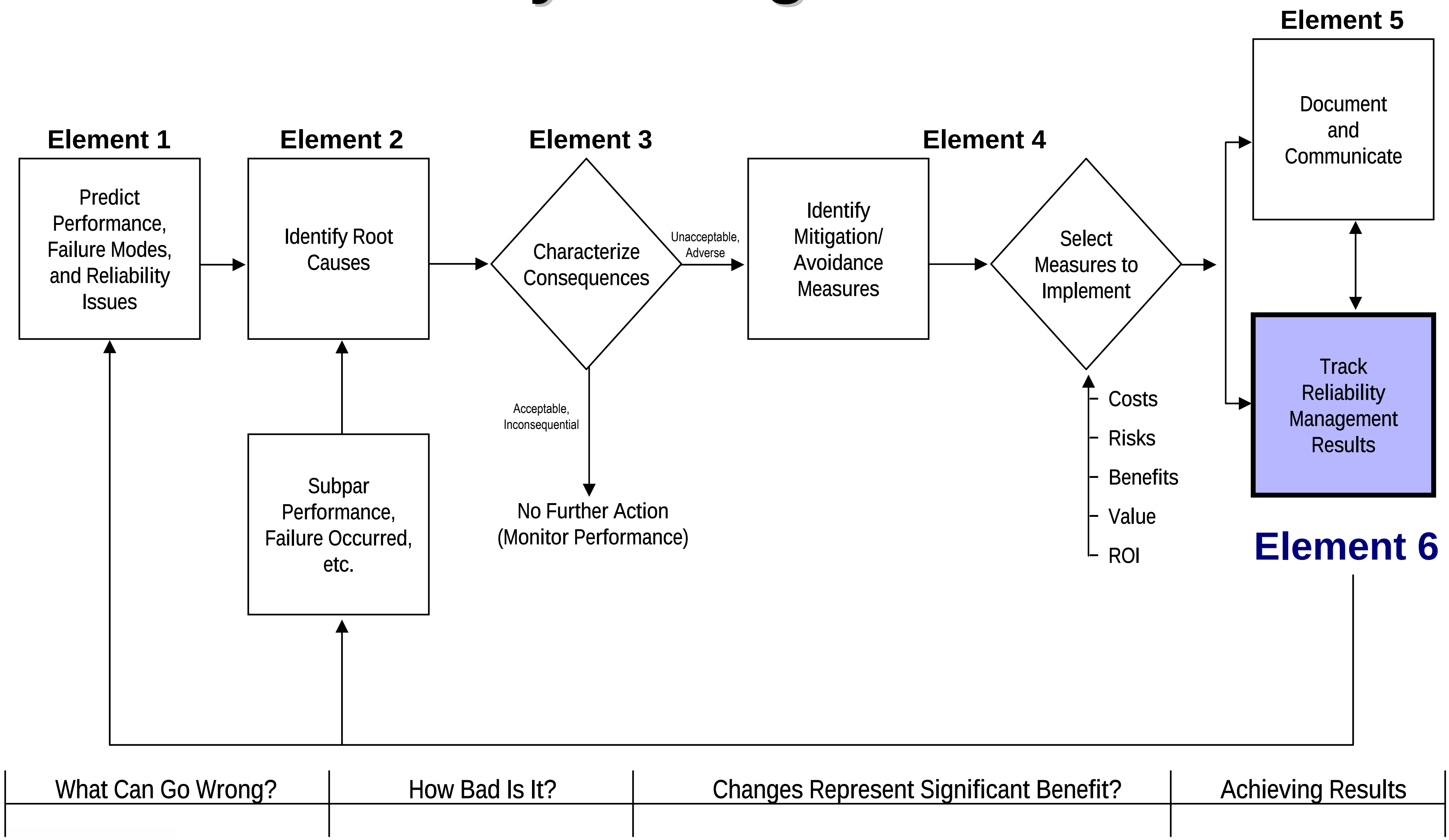
Reliability Management Encompasses These Important Activities

- Communicating the need for reliability improvement.
- Documenting and sharing the results of a reliability assessment.
- Communicating the need to implement mitigation/ avoidance measures.
- Documenting and sharing the results from tracking reliability performance.
- Communicating lessons learned to other projects/programs.

Track Reliability Management Results



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Tracking reliability management program results provides many benefits:

- Accelerated improvements in process performance (e.g., maximized mechanical integrity, reduced maintenance costs).
- Improved work environment (e.g., optimized performance, improved safety, more efficient energy use)
- Maximized integrity (e.g., accelerated quality performance, increased reliability)

Tracking

Tracking Involves	Tracking Results In
• Documents benefits received. • Validates cost:benefit assumptions. • Compiles critical information for future analysis.	• Accelerated/continuing improvement. • Improved work environment. • Maximize system/program integrity.

Summary and Conclusions

- The classical concept of Reliability Management (RM) is directly applicable, and represents potential monetary and non-monetary value at all stages of the remediation program.
- Proven RM tools exist to support these efforts.
- Effective RM involves implementation of a multi-element program with various RM tools used in support of each program element.
- The RM program is only as successful as the documented value of those identified improvements and mitigation measures actually implemented.

The End

Thanks!