Risk Informed Asset Management (RIAM) for Nuclear Power Plants

Presented by

C. R. (Rick) Grantom P.E.

Presented at the

Use of PSA in Operation of NPPs and in Regulatory Decision Making

Kyiv, Ukraine

May 20, 2004

Risk Informed Asset Management (RIAM)

A Tactical and Strategic Decision-Making Tool to Achieve NPP Vision and Mission

Outline

- Introduction
- Risk Informed Asset Management (RIAM) concept
  - How it works (process, data sources, etc.)
  - Why it works
- Examples of RIAM's capabilities
- Conclusions

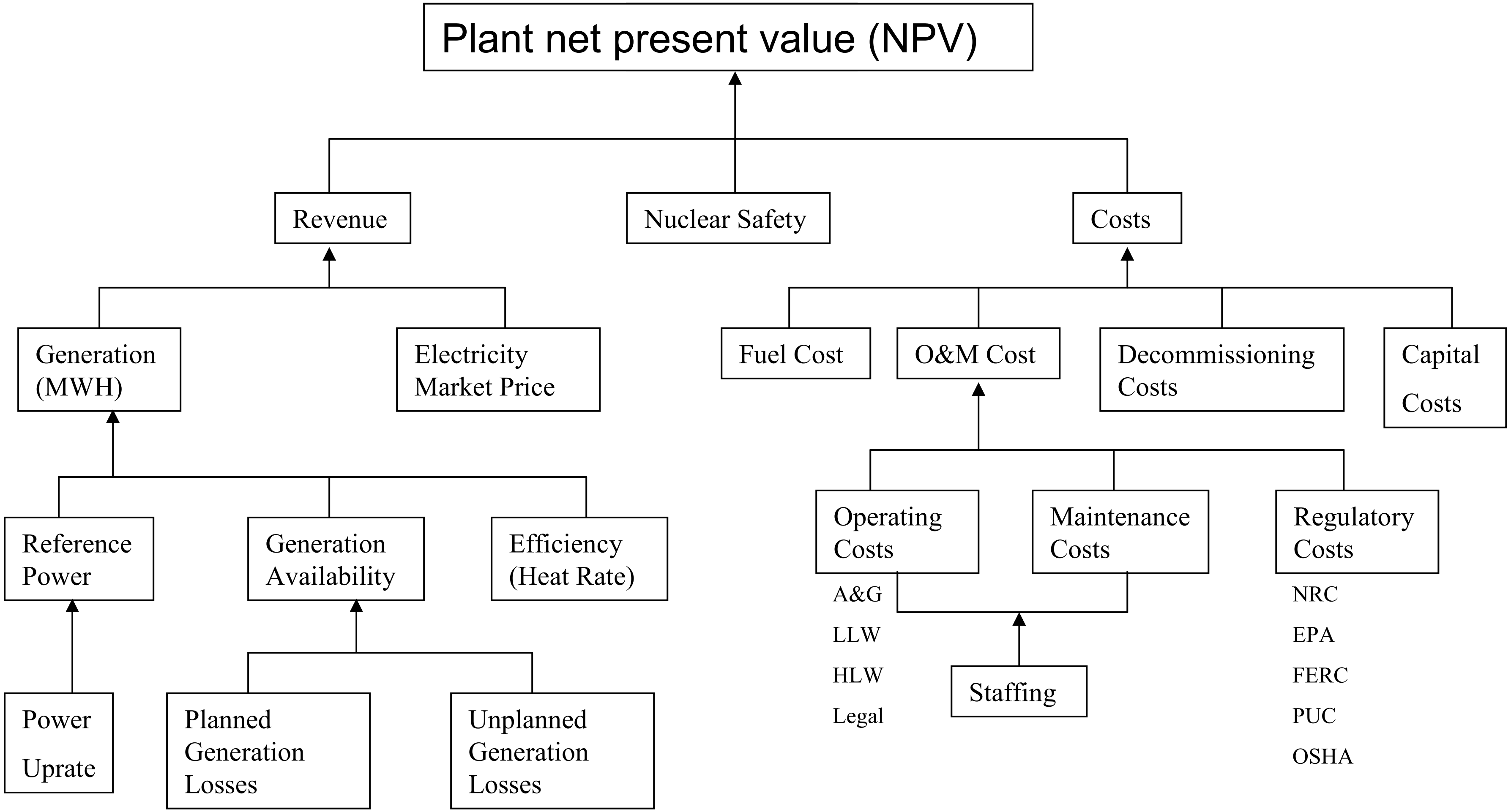
Problem Statement

- NPP mission/vision/business plan describes what is to be achieved.
  - Safety.
  - Reliability.
  - Owner Value.
  - Culture.
- Business Plan long term strategic objectives.
  - Nuclear safety.
  - Plant reliability.
  - Human performance.
  - Others.
- What is missing?
  - There is no systematic and consistent process to balance or optimize the competing effects between Vision/Mission/Business Plan objectives in a measurable ands integrated fashion.
  - How to achieve.
  - Process to be used to achieve.

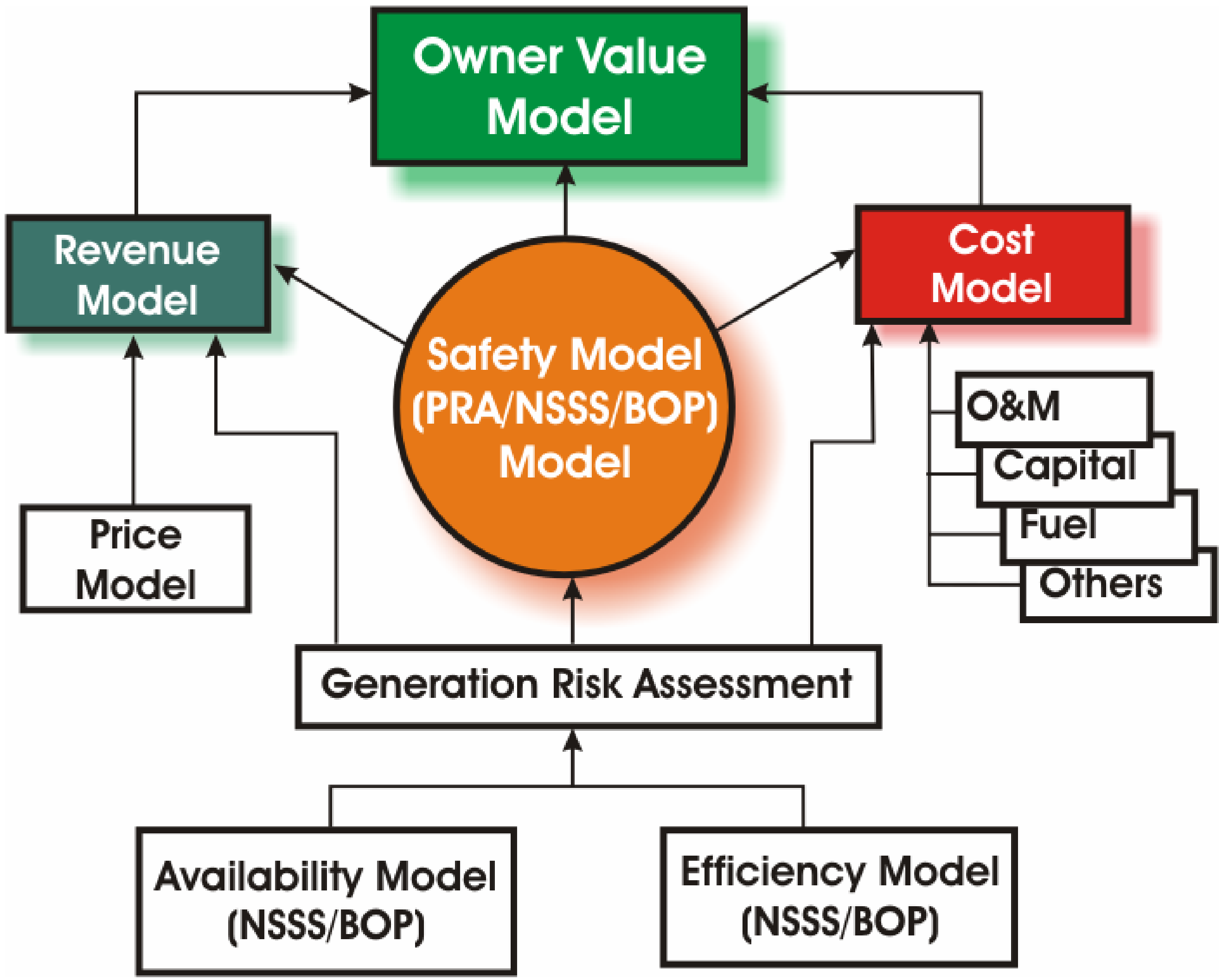
The Challenge

- A method and a process is needed to maximize ***OWNER VALUE*** while maintaining adequately high levels of nuclear ***SAFETY*** in a competitive business environment.
- Make measurable improvements in out-year production-related performance parameters.
  - Capacity factor
  - Trip rate
  - Reliability
- Do it consistent with the NPP Vision, Mission and Business Plan.

Nuclear electric generating facility value map



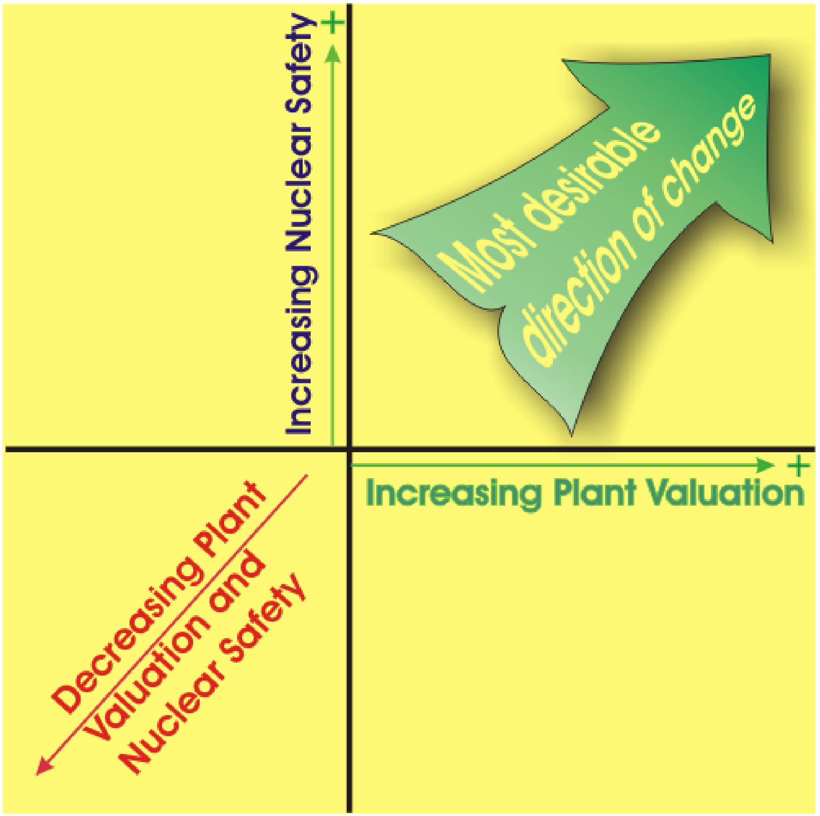
RIAM Model Overview



The RIAM Concept

In this portion of the presentation, we will focus on:

- How RIAM works.
  - RIAM objective is to deliver the best tool (using current technology) that will efficiently achieve and maximize station objectives.
    - Owner Value
    - Safety
    - Culture
- The cons of RIAM.
- The pros of RIAM.
- Why RIAM works.
  - RIAM is efficient.
  - RIAM is resourceful.
- Why is RIAM so important?



Culture is equally important to performance:

- Shift culture from regulated to deregulated
  - Deterministic, investment-centered.
  - Risk-informed, Owner value-centered.
- Tap the Power of the Team (engage the entire staff to help achieve goals).
  - Closest to the problems.
  - Most knowledgeable.
- Opportunities to improve employee attitudes & dynamics
  - Contributions are considered on a level playing field
  - Opportunity for entire staff to have highly effective input on station goals
  - Improved communication relative to decision-making.
  - Make decision process more visible and understandable.

Other Important Considerations

- Regulatory impacts on owner value and safety should be quantified to support cost/benefits with regulator (RIAM is consistent with the reactor oversight program).
- Industry standards groups' impacts on owner value and safety should be quantified to assess owner value and safety impacts:
  - INPO AP 913.
  - Answer questions (What is equipment reliability? What is equipment reliability impact on safety, owner value?)
- A (quantified) basis to measure out-year actual performance against predictions is needed.
  - Feedback to improve processes (failure analysis).
  - Success analysis (build on our successes).

RIAM Design Features

- RIAM objective is to deliver the best tool (using current technology) that will support the station objectives.
- Simulate and quantify predicted effect(s) of changes (owner value/safety).
- Provide “living” database for decision-making.
  - Use both industry and STP-specific data (foundation for RIAM simulations).
  - Useful for prioritizing issues (cost ranking, reliability ranking, regulatory impact ranking and others).
- Maximize feedback from all staff.
- Streamline and accelerate identification of changes beneficial to safety and owner value.
  - Remove layers of approvals (assess validity at lowest level possible).
  - Only bring forward viable change recommendations (continuous focus on good change investments and providing a barrier for poor change investments).
  - Reduce time of committee members and support personnel to minimum.

RIAM Negatives

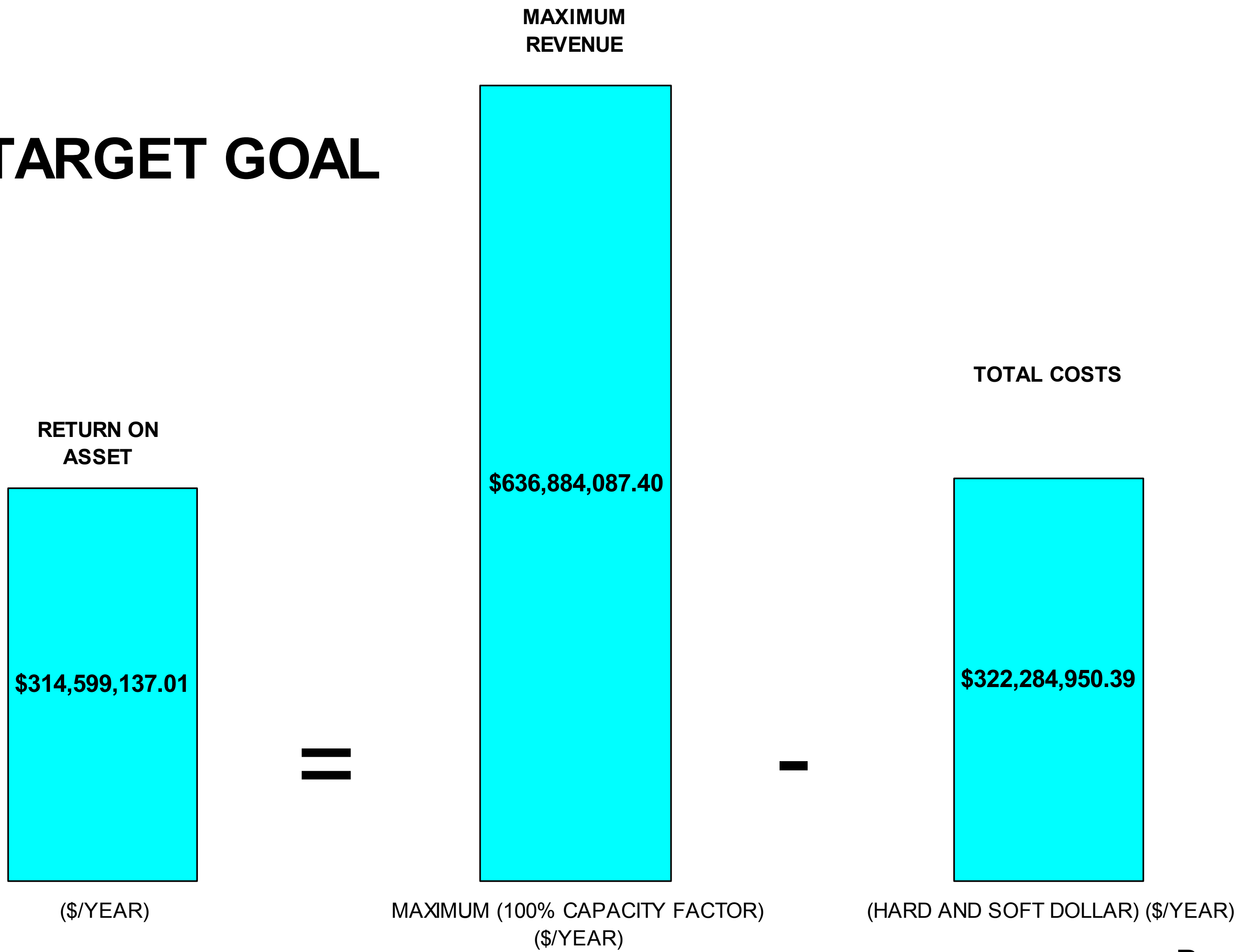
- Application cost
  - $300,000 initial investment ($30,000 spent).
  - Staff time (maintenance, update).
- Results
  - May not improve performance.
- Limits on upside potential
  - Production performance is relatively good (capacity factors at STP have been almost 90%).
  - Cost performance is relatively good
- Acceptance
  - Requires culture change

RIAM Positives

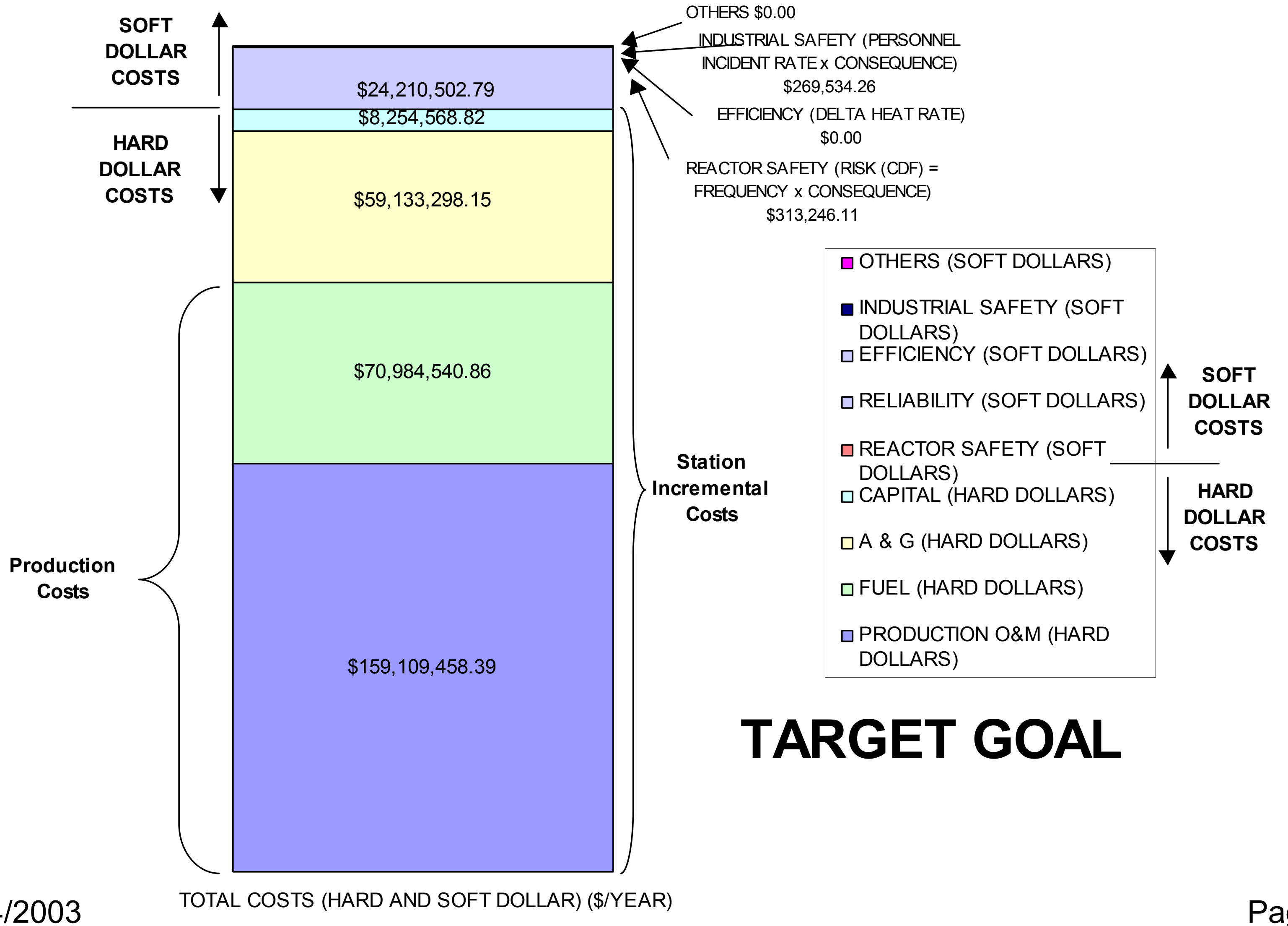
- The only station initiative which provides a process, methodology, and addresses
  - Owner value
  - Safety
  - Business acumen
  - Culture
- Potential for large payback
  - $15,000,000 recoverable lost production.
  - Small or fractional percentage of ~$300,000,000 O&M budget represents large payback.
  - Nearly unlimited upside for deterring poor change investments.
  - Demonstrated value to date (the RIAM process has already been used on selected projects, listed later).
- Others
  - Nuclear safety improvement (trip rate reduction).
  - Culture shift to owner value-based from investment-based.

Target Goal Return on Asset

TARGET GOAL

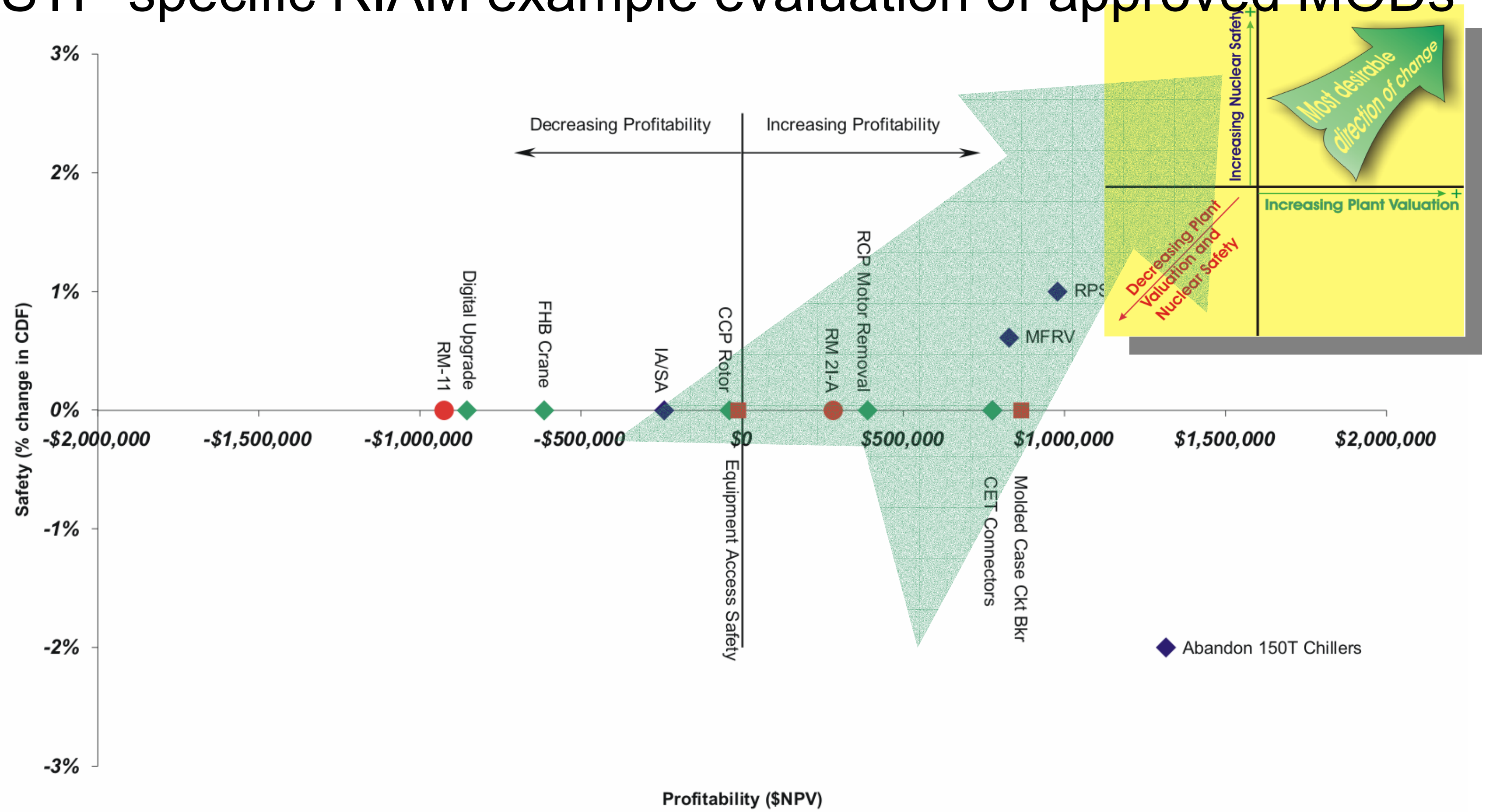


Target Goal Costs



TARGET GOAL

STP-specific RIAM example evaluation of approved MODs



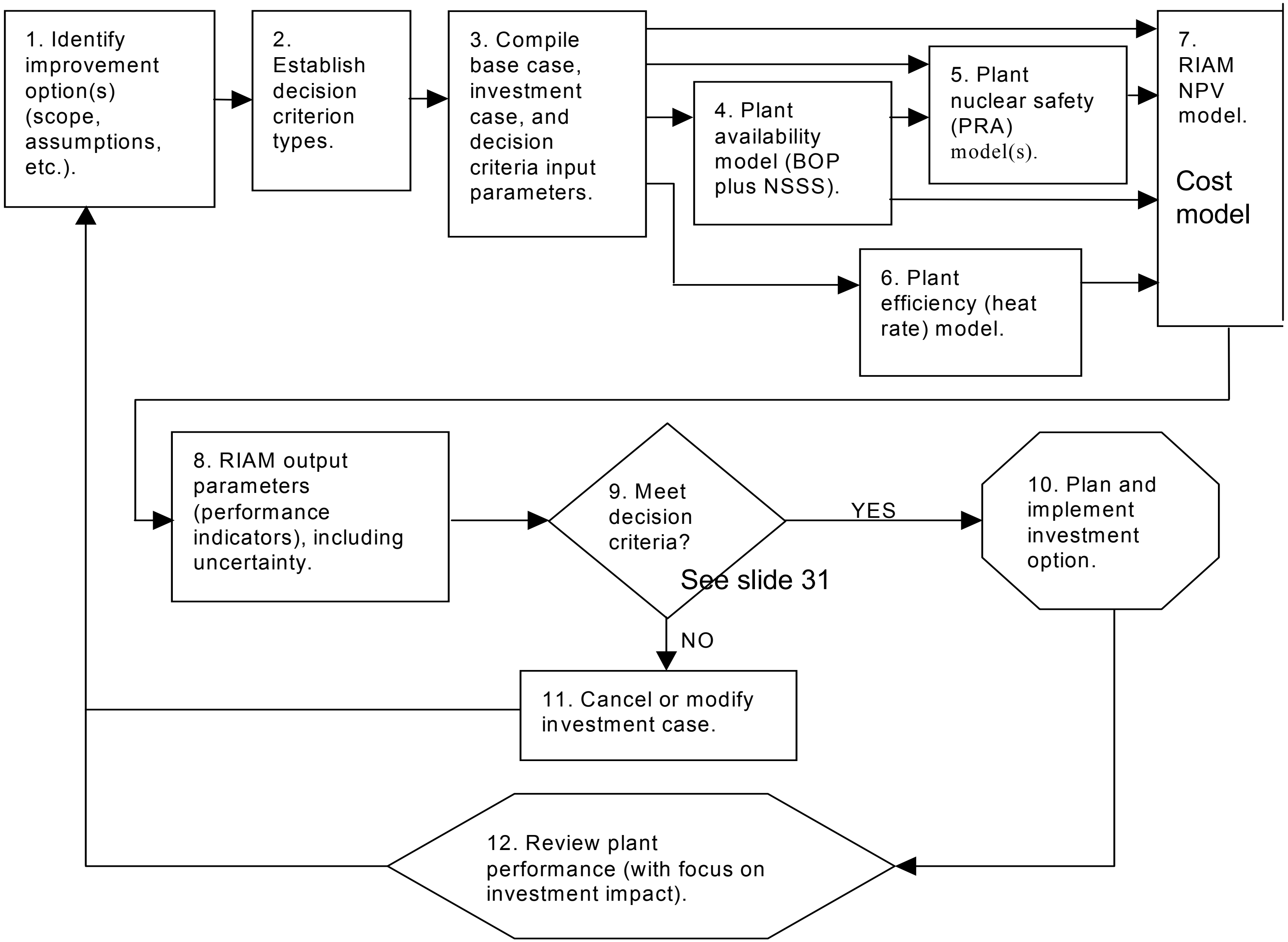
Legend

- Safety Limit Reached (Change in CDF, Technical Specifications, UFSAR, etc.)
- Profitability based on PEA Calculation (Uncertainty not included, actual failure rates not used)
- Industrial Safety Limit Reached (Industrial Safety program, Insurance program, etc.)
- Based on BOP Methodology (Level 2 Results - Uncertainty included, realistic failure rates used)

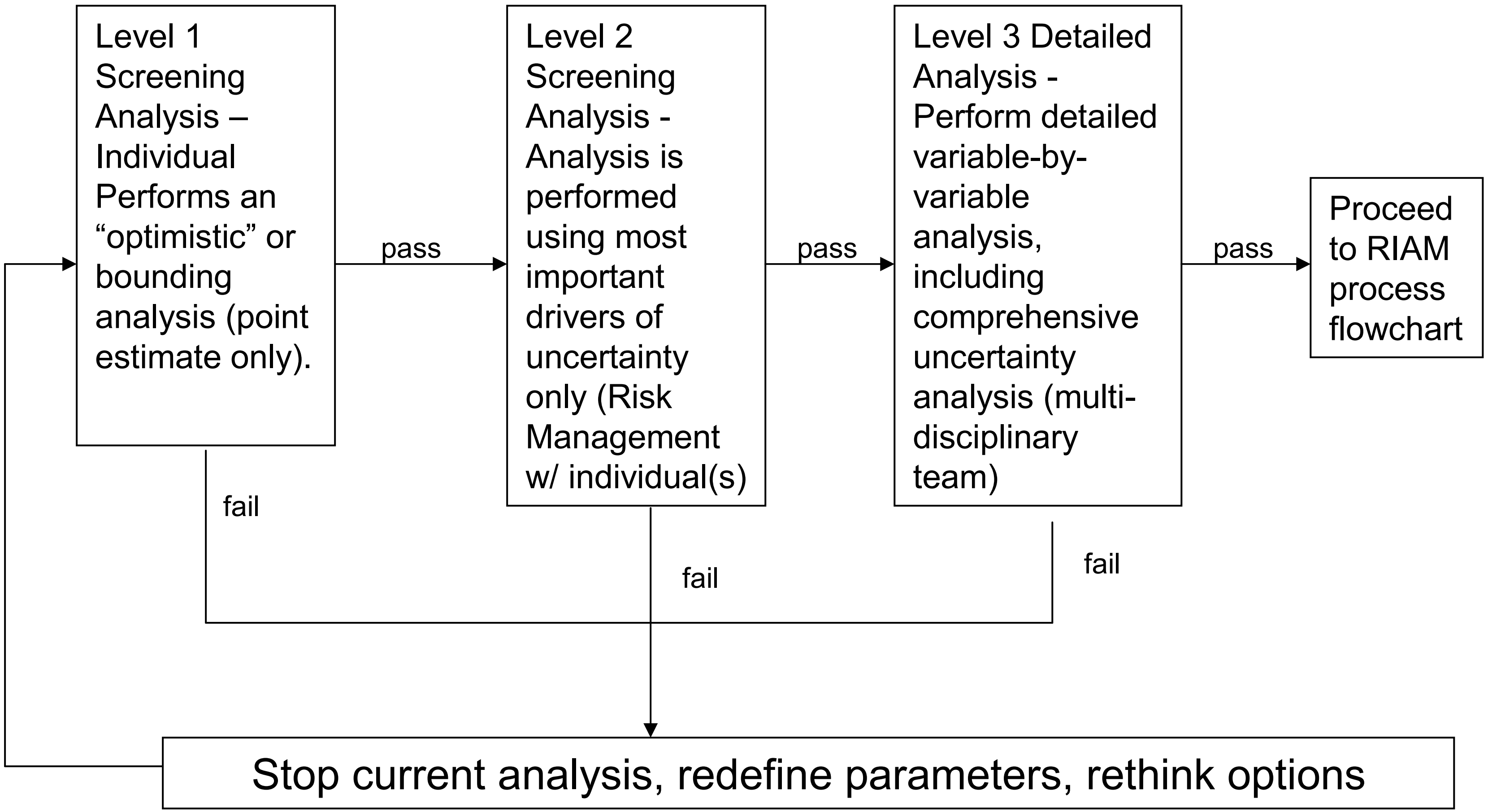
Important Elements in a Risk-Informed Approach to Change Management

- Shows areas where plant-level optimization is constrained by O&M budget. (Budgets are performed on a yearly basis and do not allow for long term investment and life cycle decisions).
- Estimated increase in profitability as a function of increased investment (i.e. O&M budget).
- Impact of changes on nuclear safety (maintain a safety budget).
- Incorporation of appropriate cost categorization scheme (similar to activity based accounting).
- Inclusion of safety impact cost analysis.
- Time-dependent power price probability distributions.
- Predictions of capacity factor (generation losses), plant reliability, etc.
- Heat rate impacts.
- Fully integrated uncertainty analysis.
- Data analysis incorporates Bayesian updating technique.
- Uses existing plant database structures at STPEGS (ORACLE/Brio).

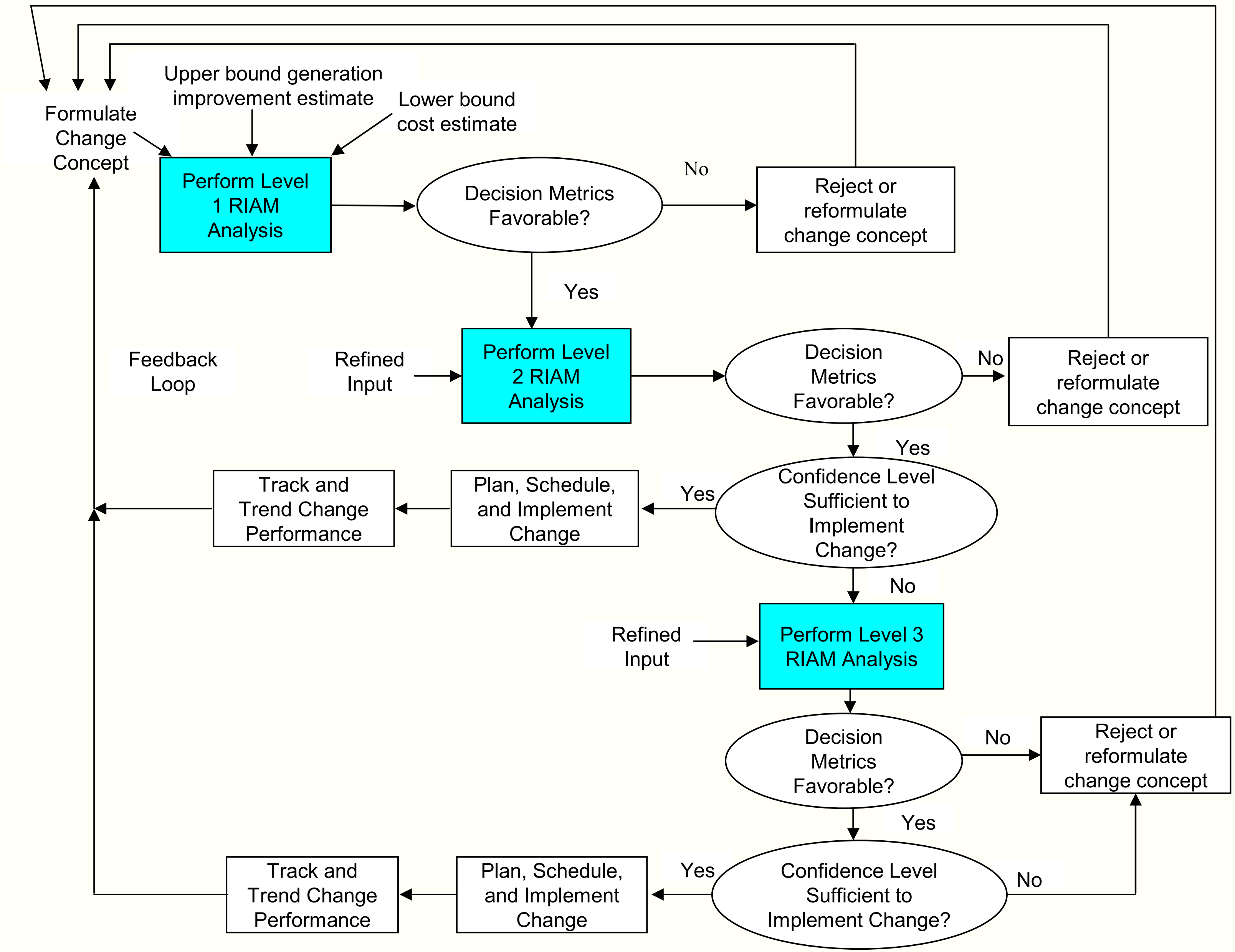
RIAM process flowchart



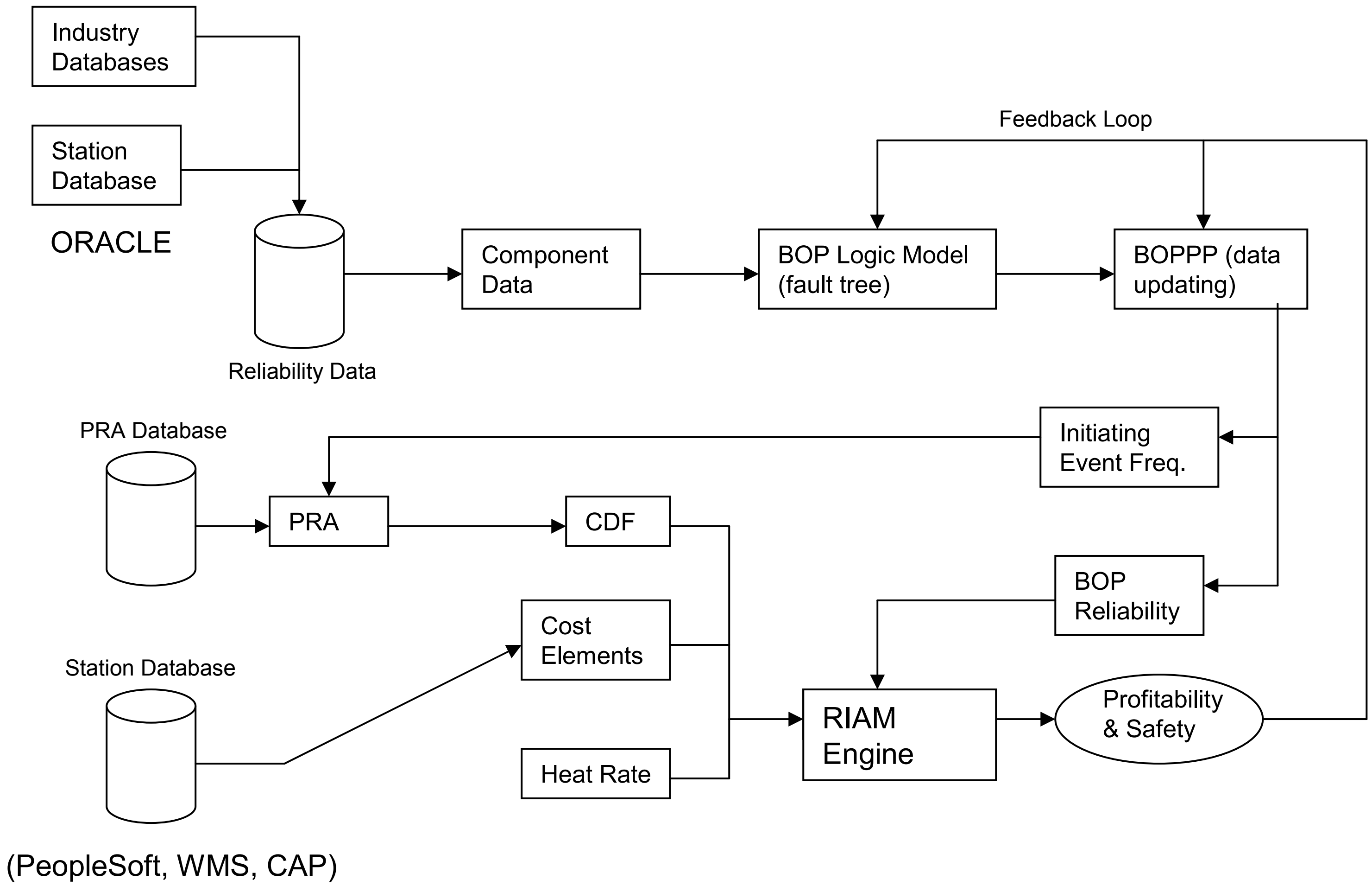
How RIAM works



RIAM Three-Phased Change Evaluation Process



RIAM Data Flow Schematic



Key RIAM input data

- Existing (plant data) inputs:
  - Plant specific equipment & human error failure rates (based on STPNOC plant data).
  - Loss of function and associated restoration of station equipment supporting power production.
- Data needed for proposed change:
  - Predicted equipment failure rates and human error failure rates.
  - Predicted event recovery times and associated changes in MWH loss profiles for related future events.
  - Implementation and maintenance costs.
  - Personnel/resource requirements.
  - Scope/frequency of activities.

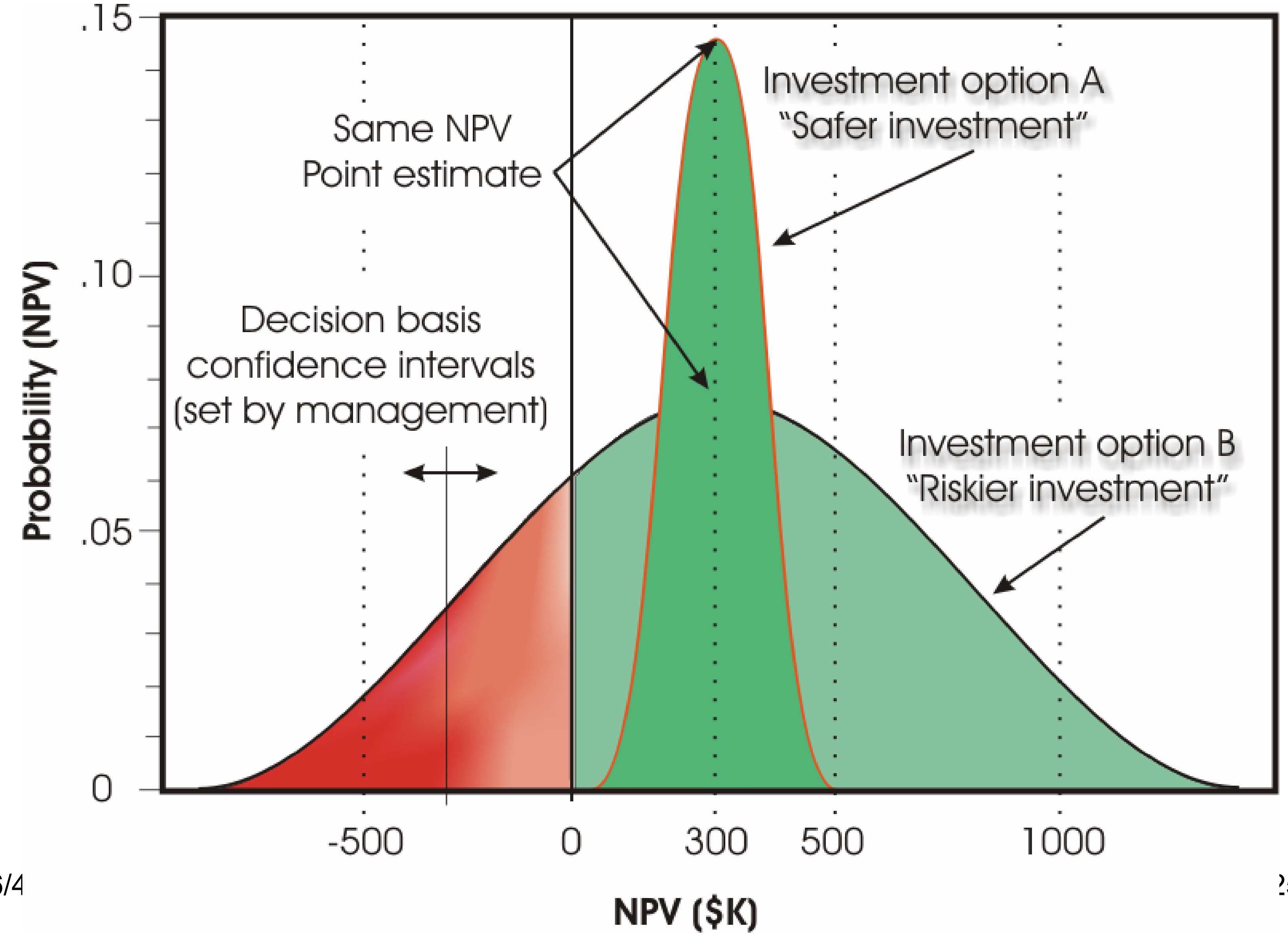
Examples of RIAM performance indicators

- Total projected revenue and cost due to change.
- Change in plant NPV over remaining life.
- Benefit-to-cost ratio and/or return on investment.
- Change in total generation (MWH).
- Change in safety metric(s) (e.g. core damage frequency).
- Change in plant efficiency (i.e., heat rate).
- Others to be identified for consistency across industry (e.g. NEI, INPO, EPRI performance/financial indicators).

RIAM Integrates Important Performance Indicators

- PERFORMANCE INDICATORS
  - PROFITABILITY
    - Net Present Value
    - EBITDA
    - Internal Rate of Return
    - Profit Margin
  - NUCLEAR SAFETY
    - Core Damage Frequency
    - Large Early Release Frequency
    - Person-REM Exposure
  - GENERATION (MWH)
    - Capacity Factor
    - Equivalent Availability
    - Forced Outage Rate
    - Unit Trip Frequency
    - Unit Heat Rate
  - COST
    - Operating Costs
    - Maintenance Costs
    - Fuel Costs
    - Capital Costs
    - Decommissioning Costs
    - A&G Costs
    - Regulatory Costs
    - Staffing
  - REVENUES
    - Market Price of Electricity

Importance of Applying Confidence Levels Developed in RIAM Applications – An Example



RIAM features

- Determination of asset net present value for station, equipment, and processes.
- Structured, systematic process for incorporating risk-informed performance-based insights into prudent change management.
- “Constraint performance measures” (i.e. safety) in addition to profitability.
- Optimized asset allocation for plant improvement.
- Uncertainty analysis to aid in decision-making.
- New station performance indicators based on owner value.

Why is RIAM so important?

- Make it easy to quickly evaluate an idea at the staff level.
- Make it easy to rank changes against station objectives for implementation “path of steepest descent”.
- Moves changes forward easily.
- Effectively focuses team efforts on enterprise objectives.
- Provides logical barrier to poor investments.
- ***NPPs need a new approach to change management if we want to improve performance over the last ten years of operation.***

RIAM Application Examples

- Completed plant studies:
  - Outage schedule and duration optimization
  - Major valves design modification case studies
  - Capital spares procurement analysis
  - Main generator rotor refurbishment/replacement
  - Main feedwater heater performance improvement
  - Instrument air system design change assessment
- Proposed plant studies:
  - Station major maintenance activity prioritization
  - Feedwater system preventive maintenance optimization
  - Procurement QA audit/spot check prioritization

Estimated Value of RIAM Applications

Investment Decision No.	Investment Decision Description	Investment Analysis Cost ($)	Investment Implementation / Maintenance Cost ($)	Total Cost ($)	Increase in Plant NPV ($)	Remarks
1	Refueling Outage Schedule Options Comparison	$180,000	$0	$180,000	$219,000,000	Benefit primarily from differential revenue impact of 21-day outages versus 30-day outages.
2	FWRV/FWIV/MSIV Design Modification	$8,000	$934,000	$942,000	$19,100,000	Benefits from both safety improvement and generation reliability improvement.
3	Capital Spares Procurement Prioritization	$16,000	$0	$16,000	$3,650,700	Benefit from reduction in previously planned procurement costs.
4	Main Generator Rotor Refurbishment / Replacement Options Comparison	$8,000	$6,032,000	$6,040,000	$33,000,000	Benefit primarily from avoided forced and planned outage time.
5	Main Feedwater Heater Performance Improvement Modification	$8,000	$0	$8,000	$3,524,900	Benefit primarily from reduction in previously planned modification costs.
6	Instrument Air System Design Modification	$8,000	$0	$8,000	$3,700,000	Benefit from reduction in previously planned procurement costs.

Summary

- Important for station goals to properly address current market conditions
  - Increase ***OWNER VALUE***
  - Maintain or improve high levels of (nuclear) ***SAFETY***
  - Culture
- RIAM is a large state space problem not easily solved without computer tools
  - Technical inputs (engineering models for safety, capacity factor, revenue, etc.).
  - Financial inputs.
- Risk-informed asset management can be used to help consistently drive performance to management vision.