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Cost-Benefit Guidance Update

ACRS

Regulatory Policies and Practices Subcommittee Meeting
February 7, 2017

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Purpose

- Provide an overview of the plan to update agency-wide cost-benefit guidance
- Obtain ACRS subcommittee endorsement of NUREG-1530, Revision 1, “Reassessment of NRC’s Dollar per Person-Rem Conversion Factor”
- Discuss proposed changes to NUREG/BR-0058, Revision 4, “Regulatory Analysis Guidelines of the U.S. NRC” and address ACRS subcommittee feedback

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Background

- Fukushima Dai-ichi accident initiated questions regarding how NRC considers potential economic consequences (EC) of a nuclear accident
- SECY-12-0110, "Consideration of EC within the U.S. NRC's Regulatory Framework"
- Staff Requirements Memorandum (SRM)-SECY-12-0110
  - SECY-14-0002, "Plan for Updating NRC's Cost-Benefit Guidance"
  - SECY-14-0143, "Regulatory Gap Analysis of the NRC's Cost-Benefit Guidance and Practices"

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Background (cont'd)

- SRM-SECY-12-0157, "Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments"
  - SECY-14-0087, "Qualitative Consideration of Factors in the Development of Regulatory Analyses and Backfit Analyses"
- Government Accountability Office (GAO) Audit Report Findings
- Office of Inspector General (OIG) Audit Report Findings

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Plan Overview

SECY-14-0002, "Plan for Updating NRC's Cost-Benefit Guidance"

- Other staff initiatives
- Related NRC initiatives
- Two-phased approach
- Price Anderson Act

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Other Staff Initiatives

- Replacement energy guidance
- Dollar per person-rem conversion factor guidance
- Regulatory gap analysis
- Qualitative factors
- Cumulative effects of regulation (CER)

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Two-Phased Approach

- Phase 1 – Administrative and methodology enhancements
  - Revise and restructure documents (NUREG/BR-0058 and NUREG/BR-0184, "Regulatory Analysis Technical Handbook")
  - Refocus and expand guidance on cost-benefit analysis across the agency
  - Update data, methods, and references
  - Address audit findings and case study recommendations

- Phase 2 – Address potential changes in policy and methodology and maintain/update guidance
  - Further refinement of cost estimate values
  - Process for addressing emergent policy issues identified by gap analysis
  - Consequence and probabilistic methodology review
  - MELCOR Accident Consequence Code System (MACCS)
  - Periodic review of cost-benefit guidance
  - Begin after Phase 1
  - Activities will be ongoing

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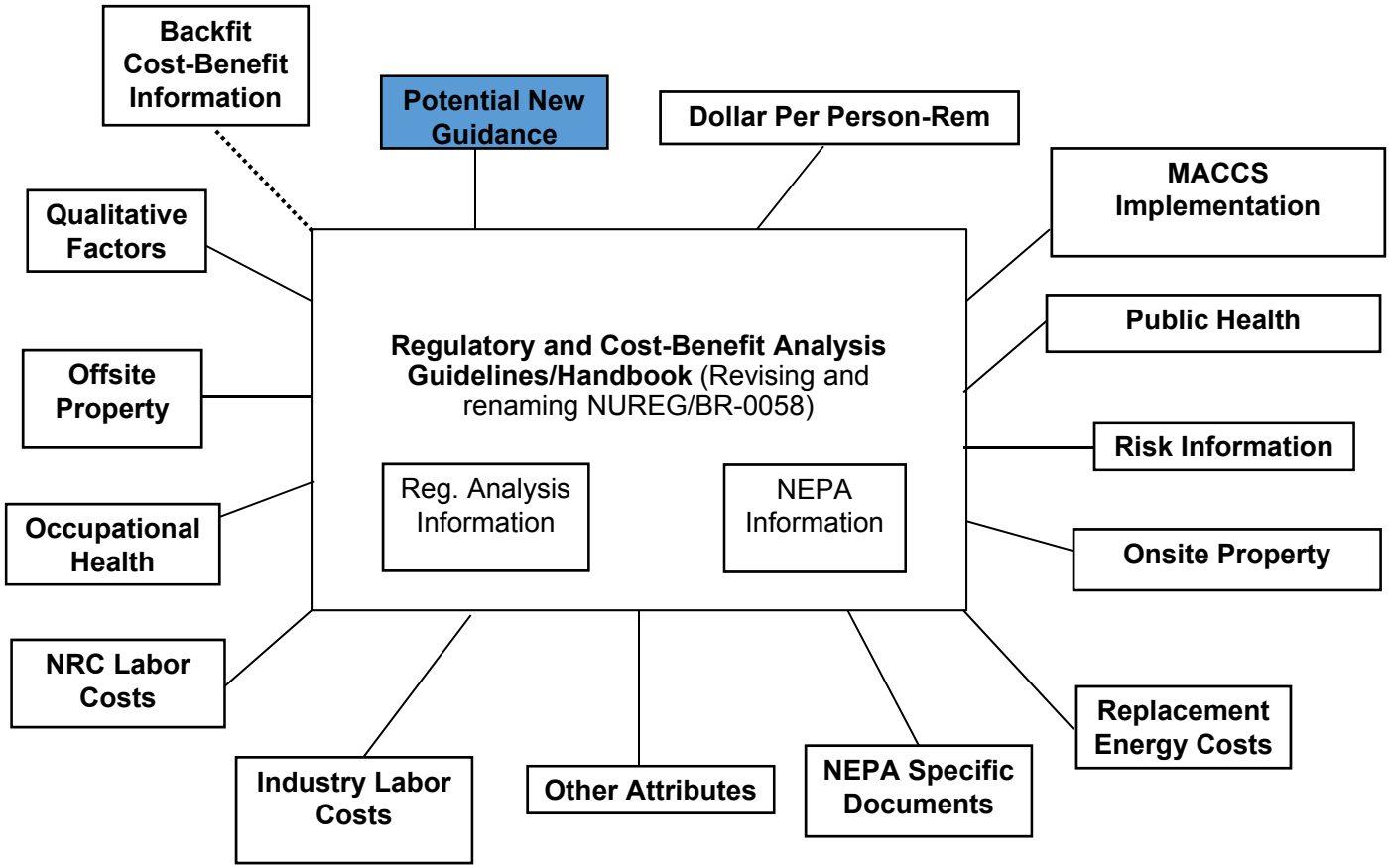
Mapping of Cost-Benefit Guidance Structure



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Public Interactions

- Six public meetings/workshops
  - May 24, 2012 (ML12130176)
  - August 29, 2012 (ML12283A373)
  - July 29, 2013 (ML13227A201)
  - May 28, 2014 (ML14114A034)
  - July 16, 2015 (ML15189A470)
  - March 3, 2016 (ML16084A165)
- Five ACRS meetings (public)
  - October 2012
  - November 2012
  - June 2014
  - September 2014
  - December 2014
- One Commission Meeting (public)
  - September 11, 2012
    - Representatives from U.S. Environmental Protection Agency (EPA), Union of Concerned Scientists, American Nuclear Insurers, Health Physics Society, and Nuclear Energy Institute attended meeting

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NUREG-1530, Revision 1, "Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy"

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NUREG-1530, Revision 1 Topics

- Definition
- Background
- Calculating the dollar per person-rem
- Proposed changes
  - Value of a statistical life (VSL)
  - EPA cancer mortality risk coefficient
  - Dollar per person-rem value
  - Two significant figures
  - Methodology for keeping figure current
  - Dose and dose rate effectiveness factor
- Regulatory applications
- Summary of public comments
- Next steps

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Dollar per Person-Rem

- ***Definition:*** This factor translates radiological dose "to a monetary value and, as such, allows for direct comparison between the potential health and safety benefits and the costs of a proposed regulatory initiative."
  - 60 FR 65694
- In short, dollar per person-rem is the dollar-value of the health impact of radiation dose.

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Background

- The NRC first used a dollar per person-rem value in 1974. The value set was $1,000 per person-rem.
- This value was revisited, resulting in the publication of NUREG-1530 in 1995, which established a value of $2,000 per person-rem and separated the offsite economic consequences from this factor.
- In 2009, the staff began research to update the dollar per person-rem value.
- SECY-12-0110 indicated that the staff would update guidance documents relating to cost-benefit analyses, including NUREG-1530. The Commission approved the staff's recommendation in 2013.

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Calculating Dollar per Person-Rem

How is dollar per person-rem calculated?

- The NRC multiplies a current VSL by a cancer risk coefficient.
- NUREG-1530, published in 1995, uses a VSL of $3 million and a cancer risk coefficient of 7.0×10^{-4} per person-rem from International Commission on Radiological Protection (ICRP) 60 published in 1991. This approximates a dollar per person-rem value of $2,000.
- Currently, NUREG-1530 does not provide a method for adjusting this value into real dollars.

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Proposed Changes to NUREG-1530

- Update the dollar per person-rem conversion factor from $2,000 to $5,200 per person-rem for the best estimate.
- Vary the dollar per person-rem conversion factor by plus or minus 50%, resulting in low and high values of $2,600 and $7,800 per person-rem, respectively.
- Report dollar per person-rem factor to two significant figures.
- Propose methods for maintaining the dollar per person-rem conversion factors.
- Provide guidance to staff on when to use the dose and dose-rate effectiveness factor (DDREF).

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Value of a Statistical Life (VSL)

- VSL concept used widely throughout the Federal government to monetize the health benefits of a safety regulation.
- VSL is **NOT** a value placed on a human life, but a value that society would be willing to pay for reducing health risk.
- NRC utilizes the willingness-to-pay (WTP) method for calculating VSL, consistent with other Federal agencies.
- NRC used the research done by other Federal agencies in calculating VSL.
- The NRC staff applied a best estimate VSL calculation of $9 million in 2014 dollars in NUREG-1530, Revision 1.
  - This estimate is derived from the average of the Department of Transportation's VSL ($9.3 million) and the EPA's VSL ($8.7 million) in 2014 dollars

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Cancer Risk Coefficient

- NUREG-1530 (1995) uses the cancer risk coefficient value from ICRP 60, published in 1991, of 7.0×10^{-4} per person-rem.
- ICRP 103 (2007) presents an updated cancer risk coefficient of 5.7×10^{-4} per person-rem.
- In 2011, the EPA published a cancer mortality risk coefficient of 5.8×10^{-4} per rem (90% confidence interval: 2.8×10^{-4} to 1.0×10^{-3}).

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Cancer Risk Coefficient (cont'd)

The staff selected the EPA's cancer mortality risk coefficient based on:

- Public comment
- U.S. population

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Dollar Person-Rem Value

- VSL x cancer mortality risk coefficient = dollar per person-rem
- ($9 million) x ($5.8 \times 10^{-4}$ per person-rem) = $5,200 per person-rem for the best estimate
  - For **sensitivity analyses**, the dollar per person-rem conversion factor varies by ± 50%.

Estimate	Dollar per Person-Rem (2014 dollars)	VSL Sensitivity Values (2014 dollars)	Cancer Mortality Risk Coefficient (per person-rem)
Best	$5,200	$9.0 Million	5.8×10^{-4}
Low	$2,600	$4.5 Million	2.9×10^{-4}
High	$7,800	$13 Million	8.7×10^{-4}

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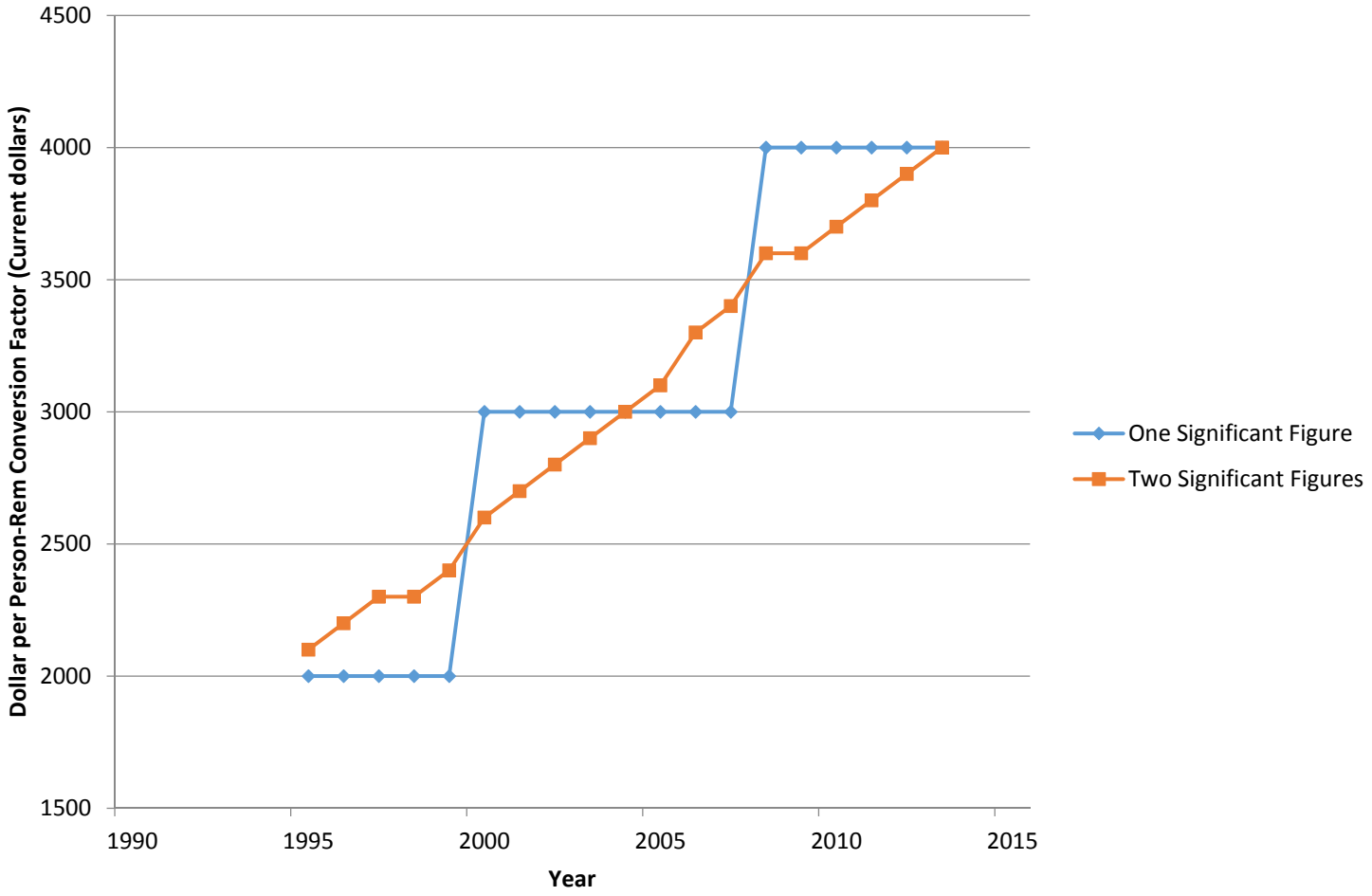
Effect of Two Significant Figures



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Methodology for Keeping Factor Current

- NRC proposed formula for keeping the dollar per person-rem factor current is:

$$\text{Dollar per Person-Rem}_{\text{current year}} = (\text{Dollar per Person-Rem}_{\text{base year}}) \times (\text{Inflation}) \times (\text{Real Income Growth})^{\text{Income Elasticity}}$$

- The staff would inform the Commission if the EPA adopts a new cancer mortality risk coefficient.
- The staff would reevaluate its baseline values for VSL and cancer mortality risk coefficient periodically and provide a recommendation to the Commission whether to update guidance and regulations if the conversion factor is expected to change by more than $1,000 per person-rem.

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Dose and Dose Rate Effectiveness Factor (DDREF)

- Intrinsic to the EPA cancer mortality risk coefficient is a judgment that the per person-rem health detriment below certain doses and dose rates would be lower by a factor of 1.5, compared to the higher dose and dose rates where human health effects have been observed.
- This factor is called the DDREF and is included in the EPA cancer mortality risk coefficient and the NRC staff's proposed dollar per person-rem conversion factor.
- This factor would be removed for special cases involving high dose or high dose rates.

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Summary of Public Comments

- 38 individual comments received
- Topics of comments include:
  - ICRP vs EPA cancer risk coefficient
  - Significant figures
  - Method of keeping the factor current

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Next Steps

- ACRS recommendation to the Commission
- Commission review
- Publication

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NUREG/BR-0058, Revision 5, "U.S. NRC Regulatory and Cost-Benefit Analysis Guidance"

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Proposed Changes

- Refocuses and expands guidance on cost-benefit analysis across the agency.
- Focuses on quantification and methods for creating realistic estimates.
- Provides methods for assessing factors that are difficult to quantify.
- Incorporation of cost estimating best practices.
- Expands on the treatment of uncertainties.
- Enhances transparency of analysis for the decisionmaker.

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NUREG/BR-0058 Overview

- Regulatory Analysis
- Backfitting and Issue Finality
- National Environmental Policy Act (NEPA)
- Cost Estimating and Best Practices
- Treatment of Uncertainty
- Qualitative Factors Assessment Tools
- Regulatory Analyses Related to American Society of Mechanical Engineers (ASME) Code Changes
- Special Circumstances and Relationship to Other Procedural Requirements
- Phase 2 Appendices

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Appendices Overview

Phase 1 Appendices

- Qualitative Factors Assessment Tools
- Cost Estimating and Best Practices
- Treatment of Uncertainty
- Guidance on Regulatory Analyses Related to ASME Code Changes
- Special Circumstances and Relationship to Other Procedural Requirements

Phase 2 Appendices

- Data Sources
- Historical Data
- Severe Accident Consequence Analysis
- NEPA Cost-Benefit Analysis
- Backfitting Cost-Benefit Analysis Procedures
- Morbidity
- Replacement Power Costs

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Regulatory Analysis

- A formal, highly-structured, reasoned analysis of a proposed government agency requirement containing estimates of costs and benefits that are quantified to the fullest extent possible
- Includes societal cost-benefit analysis
- An analytical tool provided to decisionmakers
  - Rationale for action
  - Enhances transparency of analyses
  - Consistency with Executive Orders on regulatory analysis and related issues
  - Compliance with Office of Management and Budget guidance and Executive Orders

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When are Regulatory Analyses Performed?

Regulatory analyses are performed for:

- Rules
- Bulletins
- Generic Letters
- Regulatory Guides
- Orders
- Standard Review Plans
- Standard Technical Specifications
- Branch Technical Positions

Regulatory analyses are not performed for:

- Licensing Actions
- Topical Reports
- Regulatory Issue Summaries
- Information Notices
- Policy Statements
- Inspection Reports
- Generic Letters (transmittal of information)

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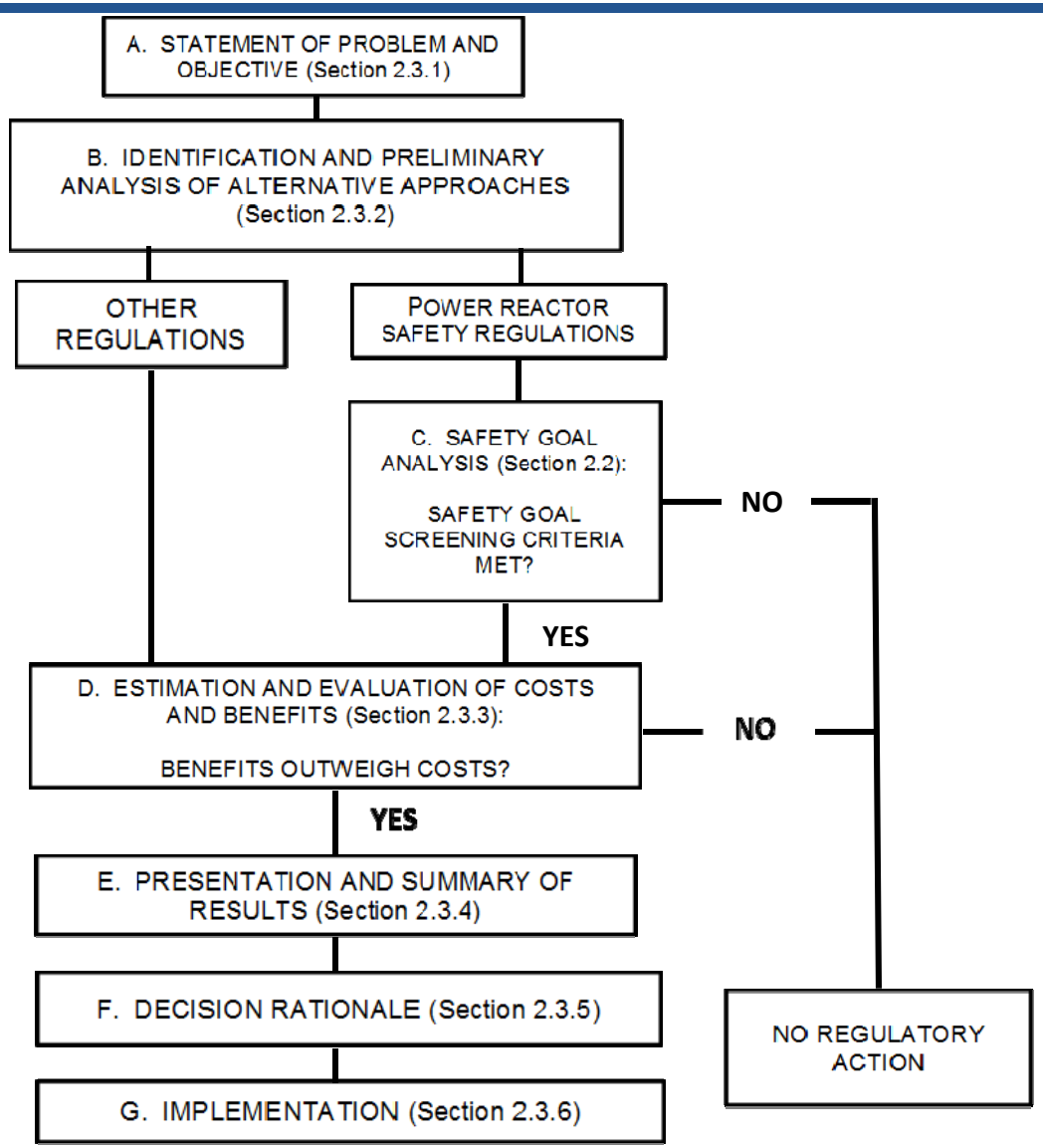
Steps for Conducting a Regulatory Analysis



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Attributes Considered in Regulatory and Cost-Benefit Analyses

- Public Health (Accident)
- Public Health (Routine)
- Occupational Health (Accident)
- Occupational Health (Routine)
- Offsite Property
- Onsite Property
- Industry Implementation
- Industry Operation
- NRC Implementation
- NRC Operation
- Other Government
- General Population
- Improvements in Knowledge
- Regulatory Efficiency
- Safeguards and Security Considerations
- Environmental Considerations
- Other Considerations

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Estimation of Costs and Benefits

To the extent applicable, attributes to be assessed include the following:

Cost estimates:

- costs to licensees
- costs to the NRC
- costs to State, local, or tribal governments
- adverse effects on health, safety, or the natural environment
- adverse effects on regulatory efficiency or scientific knowledge needed for regulatory purposes
- adverse effects on the efficient functioning of the economy and private markets

Benefit estimates:

- reductions in public and occupational radiation exposure
- enhancements to health, safety, or the natural environment
- averted onsite impacts
- averted offsite property damage
- savings to licensees
- savings to the NRC
- savings to State, local, or tribal governments
- improved plant availability
- promotion of the efficient functioning of the economy
- reductions in safeguards risks

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Safety Goal Screening Criteria

Change in Core Damage Frequency (ΔCDF)/RY	$1x10^{-2}$	$1x10^{-1}$
$1x10^{-3}$	Proceed To Cost-Benefit Portion of Regulatory Analysis	Proceed to Cost-Benefit Portion of Regulatory Analysis* (Priority)
$1x10^{-4}$	Management Decision Whether to Proceed with Cost-Benefit Portion of Regulatory Analysis	Proceed to Cost-Benefit Portion of Regulatory Analysis
$1x10^{-5}$	No Action Taken**	Management Decision Whether to Proceed with Cost-Benefit Portion of Regulatory Analysis
$1x10^{-6}$		

Estimated Conditional Containment Failure Probability***

* A determination is needed regarding adequate protection or compliance. The extent to which costs are considered is discussed in NUREG-1409.

** Unless an office director decides that the screening criteria do not apply (see Additional Consideration of Containment Performance)

*** Conditional upon core damage accident that releases radionuclides into the containment (see Additional Consideration of Containment Performance)

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Backfitting and Issue Finality

Regulatory analysis

- Required for all regulatory actions that involve backfitting licensed facilities and all regulatory actions that impose generic requirements
- Should account for the costs and averted costs discussed in NUREG-1409, "Backfitting Guidelines"

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National Environmental Policy Act (NEPA)

- Cost-benefit analysis in 10 CFR Part 51
- Environmental Justice
- Public and occupational health impact analysis

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Cost Estimating and Best Practices

- Incorporated best practices
- Characteristics of a high quality cost estimate
  - Credible
  - Well-documented
  - Accurate
  - Comprehensive

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Cost Estimating and Best Practices (cont'd)

Improvements in cost estimating practices

- Expand guidance to incorporate cost estimating best practices
- Describe methods and procedures recommended for use in preparing cost estimates that are specific to all work
- Describe practices relative to estimating life cycle costs

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Cost Estimating and Best Practices (cont'd)

Development Process

- Planning
- Inputs
- Preparation
- Review
- Reconciliation
- Documentation

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Treatment of Cost Estimate Uncertainty

- Past NRC Regulatory Analysis
  - Point estimates
  - Sensitivity analysis on a case-by-case basis
  - Infrequent use of uncertainty analysis
- Current Regulatory Analysis
  - Parametric estimates
  - Sensitivity and uncertainty analyses performed
  - Revised guidance reflects this new approach

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Qualitative Factors Assessment Tools

This Appendix

- Establishes a structured process for when quantification is not practicable
- Provides guidance and best practices for use in evaluating qualitative factors
- Provides a number of standard methods
- Increases transparency and consistency

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Qualitative Factors Assessment Tools (cont'd)

Toolkit Methods

- Qualitative Narrative
- Cost Effectiveness Analysis
- Threshold Analysis
- Bounding Analysis
- Rank-order/weight based analysis
- Maximin and Maximax Analysis
- Conjunctive and Disjunctive Analysis
- Lexicographic Analysis
- Decision Matrix
- Outranking Methods Technique

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Regulatory Analyses Related to ASME Code Changes

- Consensus Standards
  - May involve hundreds or thousands of individual provisions already agreed upon by industry
  - Participants have broad and varied interests
  - Consistent with the National Technology Transfer and Advancement Act
- No Proposed Change to Current Cost-Benefit Analysis Guidance

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Special Circumstances

- Safety goal screening
- Sunk costs
- Treatment of industry initiatives
- Criteria for the treatment of individual requirements
- Intergenerational cost-benefit assessments
- Procedural requirements

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Phase 2 Appendices

- Data Sources
- Historical Data
- Severe Accident Consequence Analysis
- NEPA Cost-Benefit Analysis
- Backfitting Cost-Benefit Analysis Procedures
- Morbidity
- Replacement Power Costs

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Status and Next Steps

- Draft NUREG/BR-0058, Revision 5 is with the Office of Nuclear Reactor Regulation (NRR) for review/concurrence
- Draft guidance document and status update is due to the Commission on February 22, 2017
- ACRS full committee meeting scheduled for March 9, 2017
- 60-day public comment period begins March 20, 2017
- Goal is to issue document for use by March 2018
- Phase 2 begins after March 2018 issuance of document

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Backup Slides

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Acronyms

ADAMS	Agencywide Documents Access and Management System
ALARA	As low as is reasonably achievable
ASME	American Society of Mechanical Engineers
CER	Cumulative effects of regulation
CFR	Code of Federal Regulations
DDREF	Dose and dose rate effectiveness factor
EC	Economic consequences
EDO	Office of the Executive Director for Operations
EPA	U.S. Environmental Protection Agency
FR	Federal Register
GAO	U.S. Government Accountability Office
ICRP	International Commission on Radiological Protection
IRR	Internal rate of return
MACCS	MELCOR Accident Consequence Code System
ML	Main library
NEPA	National Environmental Policy Act
NRR	Office of Nuclear Reactor Regulation
NPV	Net present value
NUREG	NRC technical report designation
OIG	Office of the Inspector General
SAMA	Severe accident mitigation alternative
SAMDA	Severe accident mitigation design alternative
SRM	Staff Requirements Memorandum
VSL	Value of a Statistical Life
WTP	Willingness to Pay

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References

- CRGR Charter
- GAO Audit Report, GAO-15-098
- GAO Cost Estimating and Assessment Guide, GAO-09-3SP
- ICRP 60, 1991
- ICRP 103, 2007
- NEI Cumulative Impact Case Study Analysis and Recommendations available at ML14028A455
- NUREG/BR-0058, Rev. 4 available at ML042820192
- NUREG/BR-0058, Rev. 5 available at ML17023A180
- NUREG/BR-0184 available at ML050190193
- NUREG-1409 available at ML032230247
- NUREG-1530 available at ML063470485
- NUREG-1530, Rev. 1 available at ML17018A239
- OIG Report OIG-15-A-15, Audit of NRC's Regulatory Analysis Process available at ML15175A344

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References (cont'd)

- SECYs
  - available at http://www.nrc.gov/reading-rm/doc-collections/commission/ or in ADAMS
  - SECY-12-0110 available at ML12173A478
  - SECY-14-0002 available at ML13274A519
  - SECY-14-0087 available at ML14127A458
  - SECY-14-0143 available at ML14280A426
  - SRM-SECY-12-0110 available at ML13079A055
  - SRM-SECY-12-0157 available at ML13078A017
  - SRM-SECY-14-0087 available at ML15063A568

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Regulatory Applications

- Radioactive effluent system design approval decisions
  - 10 CFR Part 50 Appendix I
- Accidental releases
- 10 CFR Part 20 As Low As Reasonably Achievable (ALARA) program
- Regulatory analyses
- Backfit and issue finality analyses
- Environmental analyses
  - Specifically severe accident mitigation alternatives (SAMA) and severe accident mitigation design alternatives (SAMDA) analyses

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Cost Estimating and Best Practices

Methods

- Engineering Build-up Estimating Method
- Parametric Estimating Techniques
  - End Product Unit Method
  - Physical Dimension Method
  - Capacity Factored Method
  - Ratio or Factor Method

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Cost Estimating and Best Practices (cont'd)

Other Estimating Methods

- Level of Effort
- Specific Analogy
- Expert Opinion
- Learning Curve
- Count Deliverables Method
- Full-Time Equivalent Method
- Percentage Method

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Cost Estimating and Best Practices (cont'd)

- Cost Estimating Inputs
- Cost Estimating Characteristics and Classifications
- Cost Estimating Methods
- Methods of Estimating Other Life-Cycle Costs
- Cost Estimating Development Process
- Cost Estimating Outputs
- Cost Estimating Expectations
- Five Enclosures

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Cost Estimating and Best Practices (cont'd)

Cost Estimating and Best Practices Enclosures

- Enclosure B-1: Cost Estimate Review Criteria
- Enclosure B-2: Definitions
- Enclosure B-3: Independent Cost Review and Independent Cost Estimate Guidance
- Enclosure B-4: Expectations for Quality Cost Estimates
- Enclosure B-5: Cross Reference to GAO-09-3SP

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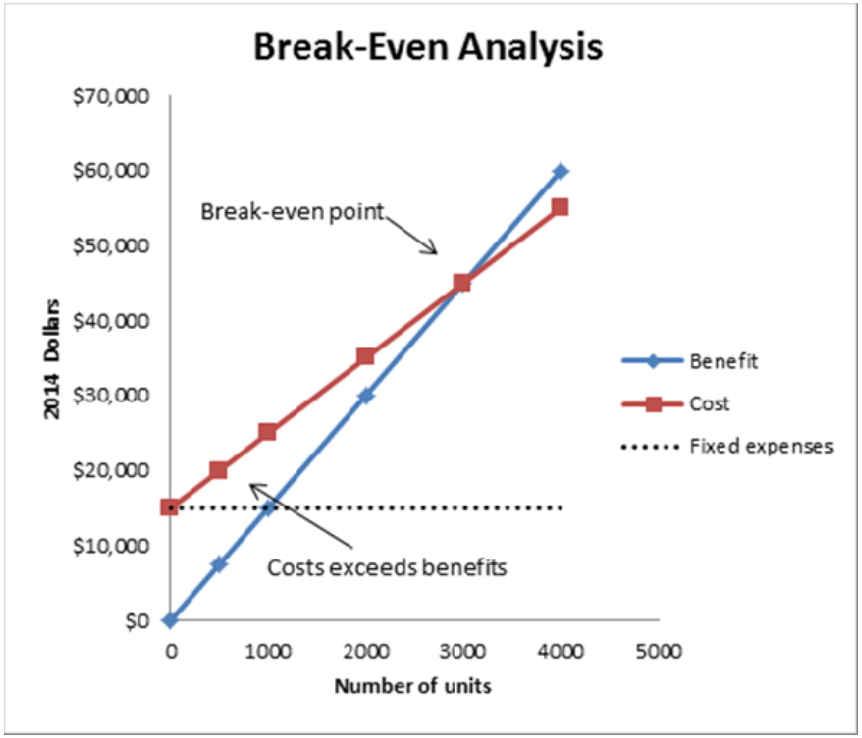
Break-Even Analysis

- Allows decisionmakers to understand the significance of qualitatively considered benefits
- Shows how small the value of the qualitatively considered benefit would need to be before the proposed action would yield zero net benefit



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Two Significant Figures

- NUREG-1530 currently rounds the dollar per person-rem factor to one significant figure.
  - Actual calculated value is $2,100 per person-rem, but rounded down to $2,000 per person-rem.
- If NRC updated this value consistently, new values would only occur when the dollar per person-rem factor can be rounded up to the nearest significant figure.
  - e.g., would increase from $2,500 to $3,000 due to rounding, but $2,400 would round down to $2,000.
- Using two significant figures will allow for more gradual changes to the factor.
- Consistent with the accuracy of the input parameters of VSL and cancer mortality risk coefficient.

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Cost-Effectiveness Analysis

- Compares the costs of alternative ways of producing the same or similar outcome
- Can provide an approach to identify options that achieve the most effective use of the available resources without requirement monetization
- Example
  - Effectiveness measures could include the number of events prevented, the number of lives saved, or cases of cancer reduced per unit cost

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Internal Rate of Return (IRR)

- IRR is the discount rate that would give a net present value of zero based on expected cash flows
- However, this methodology can produce unusual results in certain cases
  - The IRR cannot be found at all
  - Mathematically, more than one IRR may exist, and deciding which one to use is difficult
  - IRR does not distinguish between alternatives of different sizes
- Because of the above limitations, the Office of Management and Budget/Office of Information and Regulatory Affairs do not recommend that IRR be used as a criterion for choosing mutually exclusive alternatives.

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Decision Analysis Tools

- Almost all decision analysis methodologies rely upon the construction of a decision matrix
- Decision matrix employs numerical scores to communicate the merit of each alternative
- The goal of using a decision matrix is to transparently present the NRC staff's rationale

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Qualitative Factors

Commission direction SRM-SECY-14-0087

The focus of the update should be on capturing best practices for the consideration of qualitative factors.

- The updated guidance should provide a toolkit to the analysts to help them clarify their thinking with regard to how they considered qualitative factors.
- The guidance should support regulatory analyses that clearly present the analyst's consideration of qualitative factors in a transparent way that decisionmakers, stakeholders, and the public can understand.
- The updated guidance should not be overly complicated or prescriptive in such a way that would hinder decisionmaking.

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Qualitative Factors

- NRC guidance notes that even inexact quantification with large uncertainties is preferable to no quantification
- Staff qualitatively considers factors in regulatory analyses and backfit analyses for various reasons
- Current practice consistent with NRC guidance and Commission direction
- NRC Risk-Informed Decisions
- Adequate Protection Determinations
- Cost-Justified Substantial Safety Enhancements

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Basic Definitions

- Discounting – Method of bringing costs and benefits occurring at different times to a common time period
  - Cost = $10 in Year 1, Benefit = $100 in Year 2
  - Discount rate is 7%
  - Net present value (NPV) of Cost in Year 0 = $10/(1+0.07)1 = $9.3
  - NPV of Benefit in Year 0 = $100/(1+0.07)2 = $87.3
  - Net Effect in Year 0 terms = $87.3 - $9.3 = $78
- Bundling – The aggregation of different requirements within a regulatory action that results in a particular requirement appearing to be cost-beneficial, when it isn't
  - If individual requirement is necessary, it doesn't need to be analyzed separately
  - If individual requirement is supportive but not necessary, it should be included only if it makes the bundled initiative more cost-beneficial
  - If individual requirement is unrelated, it should be included only if it makes the bundled initiative more cost-beneficial and it passes the backfit test

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Estimating Costs Associated with a Plant Modification