U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Cost-Benefit Analysis – NRC Staff Guidance Updates

September 2017

Tina Ghosh and Amy Sharp

Office of Nuclear Regulatory Research

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Background

- NRC performs cost-benefit analyses as part of:
  - Cost-justified substantial safety enhancements (i.e., backfit analyses)
  - Regulatory analyses
  - Environmental assessments
- MACCS provides inputs to cost-benefit calculations
  - Averted economic consequences
  - Averted dose

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”
  - 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”

Two-Phased Approach

- Phase 1 – Administrative and methodology enhancements
  - Revise and restructure regulatory cost-benefit guidance documents
  - Refocus and expand guidance on cost-benefit analysis across the agency
  - Update data, methods, and references
- Phase 2 – Address potential changes in policy and methodology and maintain/update guidance
  - Process for addressing emergent policy issues identified by gap analysis
  - Revised guidance on Severe Accident Risk Analysis
  - MELCOR Accident Consequence Code System (MACCS)
  - Periodic review of cost-benefit guidance

NUREG-1530 Rev 1, “Reassessment of NRC’s Dollar per Person-Rem Conversion Factor Policy”

Dollar per Person-Rem

- NUREG-1530 Rev 1 “Reassessment of NRC’s Dollar per Person-Rem Conversion Factor Policy”
- 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 Federal Register 65694*

*https://www.federalregister.gov/d/95-30888

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.

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.

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).

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 (DOT's) VSL ($9.3 million) and the Environmental Protection Agency's (EPA's) VSL ($8.7 million) in 2014 dollars.

Basis for VSL Sensitivity Analysis

- The NRC has adopted the EPA practice to use a central VSL estimate without a probability distribution.
- This practice is consistent other Federal agencies practices in the use of VSL, notably:
  - EPA guidance states, “Until updated guidance is available, the Agency determined that a single, peer-reviewed estimate applied consistently best reflects the SAB-EEAC advice received to date.”
  - DOT guidance prescribes “a sensitivity analysis of the effects of using alternative VSL values. Instead of treating alternatives values in terms of a probability distribution, analysts should apply only a test of low and high alternative values…”.

Cancer Risk Coefficient

- NUREG-1530 (1995) uses the total 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-only risk coefficient of 5.8×10^{-4} per rem
- Based on public comments received, the staff selected the EPA's cancer mortality risk coefficient.

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.

NUREG/BR-0058 Rev 5, “U.S. NRC Regulatory and Cost-Benefit Analysis Guidance”

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

NUREG/BR-0058 Update

- 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.

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

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

Phase 2 Appendices

- Data Sources
- Historical Data
- Severe Accident Risk Analysis
- NEPA Cost-Benefit Analysis
- Morbidity
- Replacement Power Costs

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Appendix H: Severe Accident Risk Analysis

Purpose

- PRAs and consequence analyses conducted to evaluate
  - Safety goal screening
  - Public health (accident) attribute
  - Economic consequences (offsite property) attribute
- Guidance and best practices recommended for use at the NRC in performing PRAs and consequence analyses as part of regulatory and backfit analyses
- Provides sources of information and an overview of the tools and methods used to estimate changes in core damage frequency, public health risk, and offsite economic consequences risk

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Background

- NRC formally endorsed the use of PRA methods in 1995
  - "The use of PRA technology should be increased in all regulatory matters to the extent supported by the state-of-the-art in PRA methods and data"
  - This policy statement introduced the concept of risk-informed regulation and solidified the role of PRA methods and results in regulatory decisionmaking.
- The accident at Fukushima initiated a number of major regulatory analyses using state-of-the-art PRA and severe accident consequence analysis approaches
  - Filtered vents analysis, SECY-12-0157
  - Containment protection release reduction for Mark I and II containments, SECY-15-0085
  - Spent fuel pool study supporting evaluation of expedited transfer or spent fuel, SECY-13-0112 and COMSECY-13-0030
  - Mitigation of beyond-design basis events, SECY-15-0085

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Contents

- PRA Model Selection Guidance
- Risk Metrics for Substantial Safety Benefit Evaluation
- Accident Sequence Analysis
- Severe Accident Progression Analysis
- Offsite Consequence Analysis
- Sensitivity and Uncertainty Analysis

Off-site Consequence Analysis

- Sources of information
  - "Technical Bases for Consequence Analyses using the MELCOR Accident Consequence Code System" NUREG under development
- Source term characterization
- Site and Meteorological Data
- Protective Actions Modeling

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

MACCS Updates

- Commission Staff Requirements Memorandum (SRM) to SECY-12-0110 emphasized that "improving guidance and analysis tools (such as the MACCS2 computer code) based on up-to-date data and advancements in accident consequence assessment knowledge" should be a priority
- New ATD Model (HYSPLIT) Integration
- Alternative Economic Consequences Model

References

- U.S. NRC, "Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities; Final Policy Statement." available at https://www.federalregister.gov/d/95-20237
- ICRP, 1991. 1990 Recommendations of the International Commission on Radiological Protection. ICRP Publication 60. Ann. ICRP 21 (1-3)
- ICRP, 2007. The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4)
- NUREG/BR-0058, Rev. 4 available in ADAMS at ML042820192
- NUREG/BR-0058, Rev. 5 available in ADAMS at ML17023A180
- NUREG-1530 available at ML063470485
- NUREG-1530, Rev. 1 available at ML17018A239
- 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-14-0143 available at ML14280A426
  - SRM-SECY-12-0110 available at ML13079A055