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# Value Impact Analysis at the NRC

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# Agenda

- Value-Impact Introduction
- Backfit Rule
- Regulatory Analysis
- Economic Factors
- Severe Accident Mitigation Alternatives (SAMA)

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# Value-Impact Analysis (Regulatory Analysis)

Compares the monetary cost (the "impact") of the proposed action and the benefits ("the value") it produces

- Value - The beneficial aspects anticipated from a proposed regulatory action such as, but not limited to,
  - (1) enhancement of health and safety,
  - (2) protection of the natural environment,
  - (3) promotion of the efficient functioning of the economy and private markets, and
  - (4) elimination or reduction of discrimination or bias.
- Impact - The costs anticipated from a proposed regulatory action such as, but not limited to, the
  - (1) direct costs to the NRC and Agreement States in administering the proposed action and to licensees and others in complying with the proposed action,
  - (2) adverse effects on health, safety, and the natural environment, and
  - (3) adverse effects on the efficient functioning of the economy or private markets.

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# Value-Impact Analysis

Value attributes should include the following:

- 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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# Value-Impact Analysis

Impacts should include the following items:

- 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

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# Regulatory Analysis

- In general, a regulatory analysis is performed for all actions that would affect a change in the use of resources by NRC licensees. These actions include:
  - Imposition of generic requirements,
  - Promulgation of new guidance
  - Requests for information
  - New staff positions
- The NRC's Committee to Review Generic Requirements (CRGR) also reviews proposed requirements or staff positions that impact more than one facility.

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# The Backfit Rule

- 10 CFR 50.109 defines Backfitting as :
  - "the modification of or addition to systems, structures components or design of a facility; or the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct or operate a facility; any of which may result from a new or amended provision in the Commission's regulations or the imposition of a regulatory staff position interpreting the Commission's regulations that is either new or different from a previously applicable staff position".

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# The Backfit Rule (con't)

- Backfitting is permitted only when a regulatory analysis demonstrates that the action provides a substantial increase in protection of public health & safety and the direct and indirect costs are justified.

- However, a regulatory analysis is not required if:
  - A modification is necessary to bring a facility into compliance with a license, a Commission requirement, or a written commitment by the licensee
  - A regulatory action is necessary to ensure that the facility provides adequate protection to the health and safety of the public and is in accord with the common defense and security
  - A regulatory action involves defining or redefining what level of protection to the public health and safety or common defense and security is regarded as necessary for adequate protection.

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# Regulatory Analysis Process

- Key Steps
  1. Identify the problem and establish the analysis objective
  2. Identify alternative approaches to the problem and perform a preliminary analysis of the approaches
  3. Safety goal screening evaluation (if required)
  4. Estimate and evaluate values and impacts
  5. Prepare the decision rationale for selecting the proposed actions
  6. Develop an implementation schedule for the proposed actions.

# Regulatory Analysis Process (con't)

- Safety Goal Screening
  - Only applicable to generic safety enhancement backfits subject to the substantial additional protection standard.
  - Applied to an affected class of plants

| CHANGE IN CORE DAMAGE FREQUENCY (ΔCDF)/RY | 1E-02 | 1E-01 |
|---|---|---|
| 1E-03 | PROCEED TO V/I PORTION OF REGULATORY ANALYSIS | PROCEED TO V/I PORTION OF REGULATORY ANALYSIS* (PRIORITY) |
| 1E-04 | MANAGEMENT DECISION WHETHER TO PROCEED WITH V/I PORTION OF REGULATORY ANALYSIS | **PROCEED TO V/I PORTION OF REGULATORY ANALYSIS** |
| 1E-05 | NO ACTION TAKEN** | **MANAGEMENT DECISION WHETHER TO PROCEED WITH V/I PORTION OF REGULATORY ANALYSIS** |
| 1E-06 | | |

ESTIMATED CONDITIONAL CONTAINMENT FAILURE PROBABILITY***

# Accident Related Health Effects

Population dose can be calculated (e.g., MACCS code) or an appropriate conversion factor can be used to determine health effects

- Changes in public health and safety from radiation exposure and offsite property impacts should be examined over a 50-mile radius
- Long term doses are those incurred after the first year after an accident

$$\text{Avoided Public Dose } [D_{PA}] \text{ (person-rem/facility-yr)} = \sum_{\text{Release Categories}} \left[\text{Reduction in Release Category Frequency (events/facility-yr)}\right] \times \left[\text{Population Dose Factor for Release Category (person-rem/event)}\right]$$

| Plant Type | Release Category | Accident Progression Characteristics | | | | | | Population Dose | |
|---|---|---|---|---|---|---|---|---|---|
| | | CF Time | PDS | SP Bypass | RB Bypass | CCI | CF Mode | Total (Person-Rem) | % Long Term |
| BWR | RLAS7 | No CF | Tran | None | Sm/None | Shallow | No CF | 3.33E+2 | 65 |
| | RGG1 | CFatVB | STSB | Early/Late | Large | Flooded | Rupture | 5.77E+6 | 75 |
| | RGG2 | CFdurCD | | None | | | | 2.74E+6 | 90 |
| | RGG3 | Late CF | | Late Only | | | | 2.35E+6 | 80 |
| | RGG4 | CFdurCD | | Early/Late | | No CCI | | 2.70E+6 | 93 |
| | RGG5 | No CF | | None | | | No CF | 1.18E+2 | 59 |

# Accident Related Health Effects (con't)

- Conversion factors that reflect a weighted sum of all accident categories can also be used when appropriate

$$\text{Avoided Public Dose } [D_{PA}] \text{ (person-rem/facility-yr)} = \left[\text{Reduction in Accident Frequency (events/facility-yr)}\right] \times \left[\text{Population Dose Factor (person-rem/event)}\right]$$

Table 5.4 Weighted population dose factors for the five NUREG-1150 power reactors

| Reactor | Type | Person-rem Within 50 miles from the Plant |
|---|---|---|
| Zion | PWR | 1.95E+5 |
| Surry | PWR | 1.60E+5 |
| Sequoyah | PWR | 2.46E+5 |
| Peach Bottom | BWR | 2.00E+6 |
| Grand Gulf | BWR | 1.93E+5 |
| Average | | 1.99E+5 |

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# Monetary Value for Radiation Dose

- An additional conversion factor is needed to translate person-rem to dollars when considering the value/impact of:
  - Public health (accident)
  - Public health (routine)
  - Occupational health (accident)
  - Occupational health (routine)

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# Monetary Value for Offsite Release

- $1000 per person-rem used from 1974-1995
- This conversion factor used as a reference point in NRC regulatory analyses including those involving
  - Routine emissions
  - Accidental releases
  - 10 CFR Part 20 as low as reasonably achievable (ALARA) programs
- In 1995 the NRC revised the conversion factor to $2000 per person-rem.
  - Based on probability of a health detriment due to radiation dose times the value of a health detriment (assumed to be $3 million)

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# Monetary Value for Offsite Release

- The $1000 per person-rem conversion historically served as a surrogate for all offsite consequences (health and offsite property) and was applied without discounting
- The new $2000 per person-rem accounts solely for health effects and is subject to present worth considerations

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# Monetary Value for Offsite Release

- Monetary value adjusted to present value based on a 3% and 7% discount rate
  - The 3 percent rate approximates the real rate of return on long-term government debt which serves as a proxy for the real rate of return on savings. This rate is appropriate when the primary effect of the regulation is on private consumption.
  - The 7 percent rate approximates the marginal pretax real rate of return on an average investment in the private sector, and is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector.

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# Presentation of Values and Impacts

- **Safety goal evaluation**
- **Value/Impacts**
  - net value calculation (summation of positive and negative attributes)
  - ratio of values to impacts, where the numerator reflects the sum of all quantifiable present-worth estimates classified as values, while the denominator does likewise for impacts
  - ➢ *The US Office of Management and Budget (OMB) cautions against the use of value impact ratios*
- **Supplementary considerations (nonmonetary and nonquantified attributes)**
- **Uncertainty analysis and/or sensitivity analysis results**

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# Severe Accident Mitigation Alternative (SAMA)

- SAMA: additional feature or action which would prevent or mitigate the consequences of serious accidents
- SAMA analysis includes consideration of:
  - hardware or procedure changes
  - core damage prevention or consequence mitigation
  - full scope of accidents (e.g., internal and external events)
- The term "SAMA" is equivalent to the term "SAMDA" (Severe Accident Mitigation Design Alternative) used in previous reviews and in new reactors reviews

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# Major Steps in a SAMA Evaluation

1. Identify and characterize leading contributors to core damage frequency and offsite risk
2. Identify SAMAs that can reduce specific risk contributors
3. For each SAMA, estimate the approximate:
   - reduction in risk (ΔCDF and Δperson-rem)
   - dollar value of the reduction in risk, including averted: public exposure, offsite property damage, occupation exposure and onsite costs (cleanup and replacement power)
   - implementation cost

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# Major Steps in a SAMA Evaluation

- Assess the impact of key uncertainties on above factors via bounding assumptions and sensitivity analyses

4. Screen out SAMAs that would not be cost-beneficial even when uncertainties are considered
5. For remaining SAMAs, perform a more detailed cost-benefit analysis to determine whether they warrant implementation. Disposition based on further probabilistic and deterministic considerations

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# Insights from Previous SAMA Evaluations

- In general, the estimated CDFs for operating plants are low (i.e., <1E-4 per year) and many of the weaknesses uncovered thru the IPE/IPEEE process have already been addressed
- It is difficult to identify changes to plants that both: (1) reduce risk substantially, and (2) are cost-beneficial
  - risk generally driven by multiple sequences; SAMA generally acts on only one contributor
  - risk reduction potential highest at operating plants, but cost of implementing design change much higher too
  - cost of design changes lower in ALWRs, but residual risk so low that even complete elimination would not warrant spending substantial funds

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# Insights from Previous SAMA Evaluations

- Cost-beneficial changes most likely for operating plants where reduction in CDF could be on the order of 1E-5 per year
  - with consideration of averted onsite costs, could justify spending several $100,000
  - cost-beneficial SAMAs most likely limited to procedure changes and minimal hardware changes
- It is possible to identify low cost design changes that might meet cost/benefit criteria, but unless these changes produce significant reduction in total risk they should not be pursued as SAMAs
- "Averted Onsite Costs" (AOSC) is a critical factor in cost-benefit analyses, and tends to make preventive SAMAs more attractive than mitigative SAMAs

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# Resources:

- *Regulatory Analysis Guidelines of the U.S Nuclear Regulatory Commission*. NUREG/BR-0058, 2004.
- *Regulatory Analysis Technical Evaluation Handbook.* NUREG/BR-0184, 1997.
- *Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document*. NEI 05-01[Rev A], (2005)
- NUREG-1437 Series (Environmental Impact Statements for License Renewal)
- *Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy*, NUREG-1530 (1995)