A Proposed Process to Define Optimization-Exempt Dose Values

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Disclosures

- I have received funding from several Federal agencies, including NRC.
- I am an NRC-licensed SRO.
- I am an NCRP Council Member.
- I am a funded collaborator on the Million Person Study.

Faculty Profile

Disclaimer

Views and opinions expressed are my own and have not been reviewed or approved by my employer or any other organization.

Scope

- Stakeholder Discussion Topic 3
- Insights on defining dose values below which ALARA efforts would not be required by regulation.

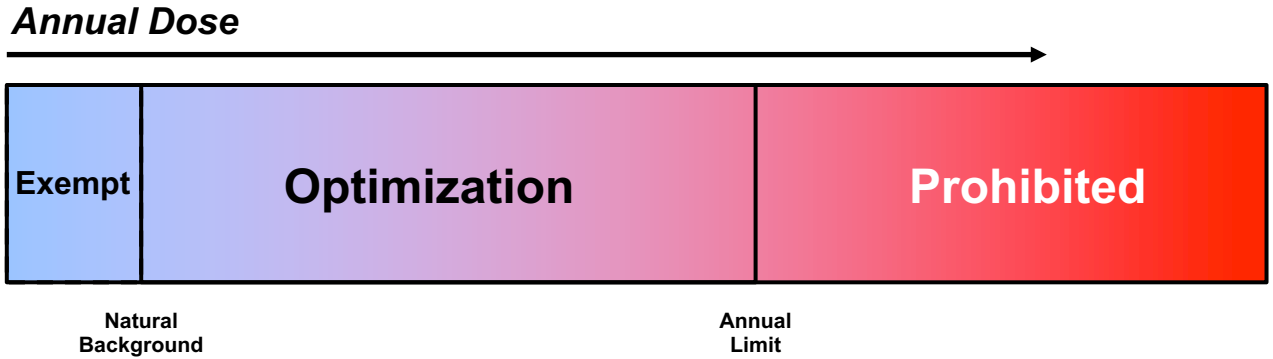
Problem

- Regulator's Dilemma (Weinberg, 1985)
  - Risks of small exposures highly uncertain
  - Still need regulatory structure
- Society has finite resources
- Optimization should be the focus!
- ALARA as currently implemented can result in great costs with little benefit

De Minimis Dose Concept

- Establish an optimization lower bound
- Possible methods
  - Smallest measurable value
  - Natural background variability
  - ***Modeled risks***

De Minimis Risk, **Whipple (Ed.), 1987**



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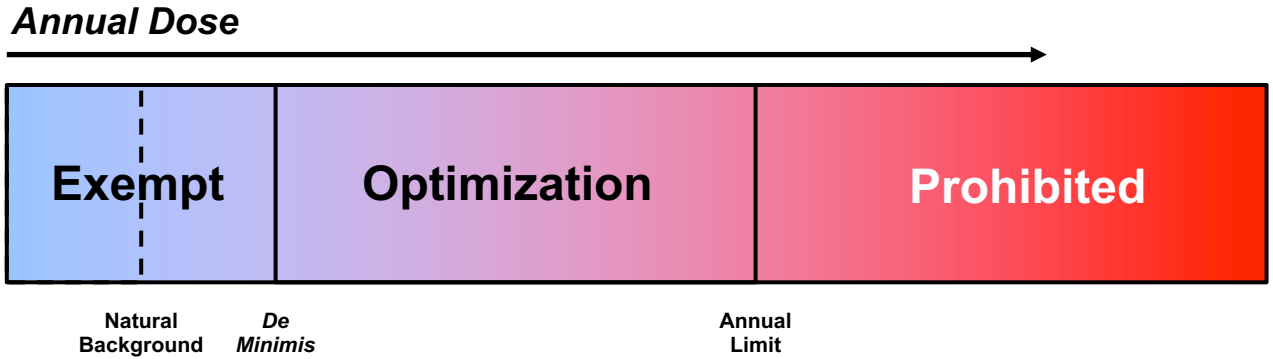

Existing Recommendations

- NCRP and ICRP recommend *de minimis*
- Negligible Individual Dose
  - NCRP Report No. 116 (1993)
  - NCRP Report No. 180 (2018)
  - 1 mrem = 0.01 mSv (universal smallest value)
- Process to define *de minimis*
  - NCRP Report No. 121 (1995)
  - ICRP Publication 103 (2007)

Defining Optimization-Exempt Doses

- Limited quantities (annual)
  - *Modeled* excess number of deaths, *N*
  - *Modeled* average excess individual lifetime risk, *R*
- Knowledge/Assumptions Required
  - Probability of exposure
  - Dose-risk model
- Variables
  - Effective dose, *E* (or similar quantity)
  - Population size, *P*

Defining Optimization-Exempt Doses

- Values for limited quantities (annual)
  - ***Subject to stakeholder input and debate***
  - $N = 1$ (ICRP Pub. 103)
  - $R = 10^{-5}$ (1 in 100,000)
- Other values used in this example
  - 100% probability of exposure
  - 0.05 deaths per person-Sv (EPA, 2011)
    - General public
    - Chronic, low-level exposure

Results and Reasonableness

- *R* limit determines *de minimis E* (E_{dm}) for *P* < 100,000 people *for this example*
- E_{dm} = 0.2 mSv/y = 20 mrem/y
- Reasonableness check
  - Measurable? **Yes!**
  - Reasonable fraction of annual natural background exposure? **Yes!**
  - Consistent with other unregulated chemical exposures? **TBD (as of 1985, yes)**

Criticisms and Responses

- Increase in R by 10x?
  - Maybe, but for public exposures, licensees are regulated, not exposed individuals.
  - Number of exposure sources for a member of the public is likely less than 10 but may be more than 1.
- Different E_{dm} for public vs. workers?
  - Probably. Dose-risk model varies with exposed population characteristics.
  - Needs more conversation and stakeholder input.
- You assume LNT! That's a no-no!
  - Yes, because I need some way to connect dose to risk.
  - The goal is to find a ***reasonable*** lower bound for optimization.
- NRC tried this before with BRC. It didn't work.
  - Yes, I acknowledge NRC's experience with BRC.
  - Let's learn from it and try again.
  - Extensive stakeholder participation early and often!

References

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6. NCRP 2018 *NCRP Report No. 180* https://ncrponline.org/shop/reports/report-no-180-management-of-exposure-to-ionizing-radiation-radiation-protection-guidance-for-the-united-states-2018-2018/
7. Weinberg AW 1985 *Issues Sci. Technol.* https://www.jstor.org/stable/43310360
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BACK-UP SLIDES

Example Calculation

$$R = (1.0)(0.05\ \text{Sv}^{-1})\ E \text{ and } N = RP$$

$$E_{dm}^{(R)} = (20\ \text{Sv})(10^{-5}) = 0.2\ \text{mSv}$$

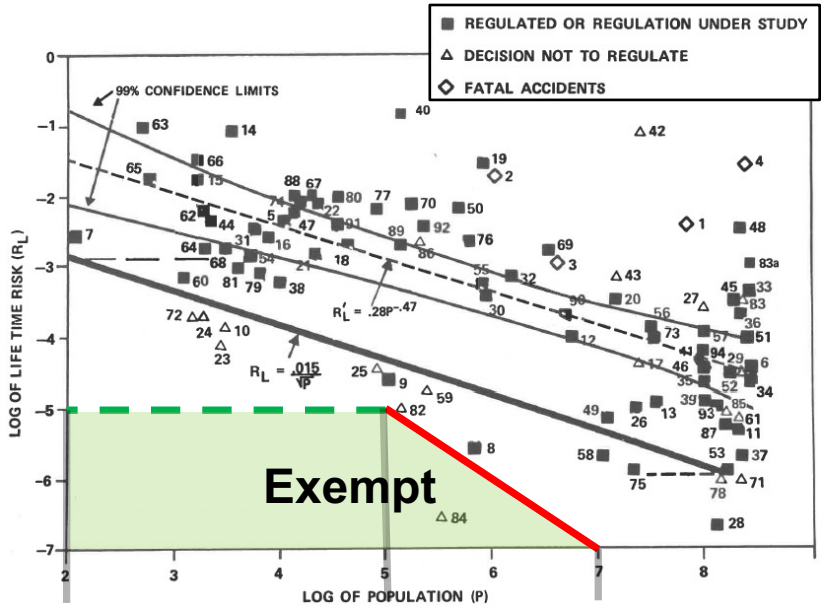
$$E_{dm}^{(N)} = (1)(20\ \text{Sv})\ P^{-1} = (20\ \text{Sv})\ P^{-1}$$

$$E_{dm} = \min(E_{dm}^{(R)}, E_{dm}^{(N)})$$

$$E_{dm} = \begin{cases} 0.2\ \text{mSv}, & P \leq 10^5 \\ (20\ \text{Sv})\ P^{-1}, & P > 10^5 \end{cases}$$

Chem./Rad. Exposure Context

Figures Modified from *De Minimis Risk,* Whipple (Ed.), 1987 (p. 81 [L] and 71 [R])



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20 mrem

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