

THE CURRENT STATE OF RADIATION PROTECTION IN THE UNITED STATES

By P.J. Seel and Adam Stein

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1. Executive Summary

The United States lacks a cohesive radiation protection framework. Seventy-nine regulations across ten federal agencies create a system where acceptable risk levels vary by up to 100,000-fold depending on jurisdiction rather than actual hazard. This fragmentation increases compliance costs, creates standards that are confusing for both workers and the public, and obscures the technical debates over the underlying radiation safety sciences.

Advanced reactor developers must navigate incompatible requirements from NRC's dose-based limits, EPA's risk-based air emission standards, and EPA's environmental standards: separate analyses for the same fundamental risk. Some As Low As Reasonably Achievable (ALARA) goals for reactor effluents are set so low they render broader limits functionally meaningless.

These inconsistencies stem from competing regulatory philosophies, not science. The NRC and DOE use dose-based frameworks accepting optimization through cost-benefit analysis. The EPA uses risk-based frameworks under the Clean Air Act, back-calculating doses from acceptable cancer risks. Agencies recognize each other's approaches but cannot legally reconcile them.

Substantial improvements are achievable through executive branch action. A graded approach distinguishing dose limits, action levels, and de minimis thresholds would

keep the U.S. regulatory system generally aligned with international standards while leading the way on reasonable safety standards. Full harmonization will require Congressional action to reconcile the Clean Air Act's risk-based mandates with the Atomic Energy Act's dose-based framework.

2. Issue

Radiation protection standards in the United States are discontinuous, conflicting, and often disconnected from clear policy objectives. This landscape reflects seventy years of institutional evolution and policymaking. The result is a system that creates barriers to progress, complicates compliance, and obscures the scientific principles that should guide radiation protection. The discontinuity in regulations implies an acceptable level of risk that can vary by thousands of times across regulations.

Inconsistent radiation limits increase design and compliance burdens. Advanced reactor developers must demonstrate compliance with NRC's dose-based occupational limits under 10 CFR Part 20, EPA's risk-based air emission standards under 40 CFR 61, *and* EPA's environmental radiation standards under 40 CFR 190, each requiring different modeling assumptions and documentation. A single facility design may need separate analyses for the same radionuclide release using incompatible regulatory requirements. Further, some single-source goals are so low as to invalidate the purpose of a much larger limit, such as ALARA annual effluent standards being 25-30 times smaller than the annual public dose limit. This increases licensing costs and timelines without improving protection.

Protections vary based on jurisdiction rather than exposure. Workers at DOE sites follow 10 CFR 835 with a 50 mSv annual limit, while workers at NRC-licensed facilities follow 10 CFR Part 20 with the same numerical limit but different administrative requirements for monitoring, training, and dosimetry. Agreement State programs add another layer of variation, with 40 states implementing NRC-compatible but not identical frameworks that can differ in implementation details, inspection frequencies, and enforcement

approaches. Public exposure limits vary across air emissions, drinking water, and fuel-cycle operations despite referring to the same physical quantity and endpoint.¹

Sometimes limits are set as single source controls, and others as all source.

3. Scope and Consistency of Current Regulations

Across 10 federal agencies there are 79 radiation protection rules. Some are overlapping and complementary, while others contradict one another. These federal standards cover drinking water limits, air emissions, occupational dose limits, medical dose reporting, emergency exposure guidance, waste disposal, and performance requirements.

The NRC, DOE, and EPA form the core of the federal radiation protection structure. NRC and DOE inherited their mandates from the Atomic Energy Act, taking on the regulatory and promotional functions of the former Atomic Energy Commission, respectively. The AEC's dual mandate generated lingering distrust, leading to the creation of the Federal Radiation Council to unify federal guidance. The FRC's responsibilities were later transferred to the EPA. Radiation protection recommendations are also informed by the National Academies and the National Council on Radiation Protection and Measurements (NCRP). These bodies provide independent scientific advice, but their recommendations do not resolve inconsistencies between agencies on how to implement regulations.

Agency	DOD	DOE	DOT	EPA	FAA	FDA	IAEA ²	NASA	NRC	OSHA	US Total
Rule Count	14	8	3	11	3	5	16	4	27	4	79

Different agencies apply fundamentally different regulatory philosophies. These differences often matter as much as the regulations themselves.

¹ 0.1 mSv from 40 CFR 61, 0.04 mSv from 40 CFR 141, and 0.25 mSv from 40 CFR 190, respectively.

The NRC and DOE use a dose-based framework. Protection relies on dose limits intended to provide adequate protection. Operational decisions are guided by ALARA, which uses a cost-benefit framework to optimize exposures. NRC's approach implicitly tolerates a lifetime cancer risk on the order of one in one thousand when justified by benefit and optimization. The DOD directly references the NRC's 10 CFR 20. OSHA continues to rely on the AEC-era standards it inherited in 1971 and has never updated them. The FAA uses only occupational recommendations similar to NRC limits, without binding standards.

The EPA provides the starkest example of complexity. The EPA relies on a risk-based framework under the Clean Air Act. Its mandate includes all potential environmental releases of radioactive material. The EPA operates within a risk-based framework that requires estimating cancer risk for hypothetical exposed individuals. These calculations involve large uncertainties yet are tied to statutory requirements that differ fundamentally from the dose-based frameworks used by NRC and DOE. Further, because of some of the ALARA controls, such as the 0.03 mSv (3mrem) effluent limits, the overall limits become functionally useless.

For hazardous air pollutants, including radionuclides, EPA applies a cancer risk range of one in one million to one in ten thousand. EPA begins with risk acceptability, then back-calculates permissible doses or emissions. This approach applies the same statutory structure to all pollutants and includes limited opportunities for optimization. The AEC set doses that reflected operational considerations at the time and which attempted to foresee possible risks, since low dose exposure was only somewhat more uncertain than now but which used ALARA to compensate for the uncertainties in the dose range.

These philosophical differences create enduring coordination challenges. The 1992 EPA-NRC Memorandum of Understanding reflects the ongoing tension. Both agencies formally recognize each other's approaches, but the systems do not fully align and are arguing on a 0.01 mSv (10 mrem) margin of safety that is only a small fraction of the background dose every human gets throughout the year from natural sources.

For instance, EPA's drinking water standard effectively limits public exposure to 0.04 mSv (4 mrem) per year, while DOE allows up to 1 mSv (100 mrem) per year for public exposure from its facilities, a 25-fold difference for the same endpoint. NRC's numerical design objectives for nuclear plant effluents target 0.03 mSv (3 mrem) per year for liquid pathways and 0.05 mSv (5 mrem) per year for gaseous pathways, yet occupational limits permit 50 mSv (5,000 mrem) per year, a factor of 1,000 higher. NASA's career dose limits for astronauts can reach 4,000 mSv (400 rem) over a lifetime, which is 40,000 times the EPA drinking water standard.

Some variation is appropriate. But these distinctions do not require six orders of magnitude of variation. A coherent risk framework, one that distinguishes between de minimis thresholds, administrative action levels, and regulatory limits while accounting for voluntary versus involuntary exposure, could compress this range to approximately two orders of magnitude while maintaining appropriate protection across all scenarios. Workers accept a greater amount of risk responsibility in choosing a position, and the regulations safeguard both them and the public in situations they might not directly control. However, the ALARA goals suggest a difference of risk magnitude that is neither scientific nor representative of choosing to be a rad worker.

The current system has lost coherence as a hazard management framework, where values are sometimes shoehorned to fit between agencies. When the same physical quantity (effective dose) is subject to limits that vary by factors of 10,000 to 100,000, the system cannot provide clear guidance to practitioners, meaningful protection standards for the public, or a basis for informed policy decisions.

4. Towards Coherence

Substantial improvements can be achieved through administrative action. A graded approach should clarify three types of regulatory values:

- **Dose limits**, which are legal caps grounded in statute or regulation.

- **Action levels**, which are administrative triggers for optimization or further analysis.
- **De minimis thresholds**, where exposures are too small for meaningful regulatory concern.

This structure aligns with international frameworks and accommodates uncertainty at low doses. It maintains statutory responsibilities while harmonizing terminology, dose models, and risk concepts across federal agencies. However, full harmonization requires Congressional action to reconcile the Clean Air Act's risk-based mandates with the existing dose-based framework used by other agencies. These statutory conflicts cannot be resolved through executive coordination alone.

The Interagency Steering Committee on Radiation Safety (ISCORS) exists to help in this kind of harmonization, but agency participation and follow-through is voluntary and lacking.

5. Recommendations

1. Align regulations with clear and observable risk objectives.

Within existing statutory frameworks, agencies should ensure regulatory transparency in how dose limits translate to risk thresholds estimates that maintain consistency with Congressional risk ranges, including the Clean Air Act cancer-risk window. These should be for **risks that are scientifically observable** in a reasonable population, acknowledging persistent low dose uncertainty. Even if science cannot define a definitive threshold for risk, a policy threshold of data certainty could.

2. Establish unified national radiation protection principles.

Federal guidance coordinated across EPA, NRC, DOE, DoD, OSHA, HHS, and the states should establish unified definitions of dose, risk, optimization, dose modeling conventions, radon conversion factors, and de minimis thresholds to resolve

longstanding inconsistencies. One agency or collaborative body should have final authority to set appropriate risk and dose limits for future cohesion.

Agencies should adopt consistent ICRP-based dosimetry and unified terminology for stochastic and deterministic effects, occupational and public exposure, emergency worker guidance, and radon dose conversion. Harmonized conventions improve communication, reduce duplication, and support consistent protection outcomes.

3. Reconcile statutory frameworks for radiation protection.

Agencies can implement most changes without Congressional action. To fully harmonize regulations, Congress needs to reconcile the risk-based requirements of the Clean Air Act with the Atomic Energy Act. This reconciliation should preserve appropriate regulatory flexibility while establishing consistent high-level objectives for public protection across all exposure pathways. Statutory authority should be updated to enable agencies to align environmental standards, occupational protections, medical uses, cleanup decisions, and emergency response with modern understanding of dose and risk.