

9/19/89

RADIATION EXPOSURE LIMITS

10 CFR Part 20, "Occupational Exposure Limits"

1,250 mR/Qtr. whole body

5x(N-18) Rem whole body accumulated lifetime dose

With regard to inhalation, limits are placed on radiological conditions such that employee dose due to inhalation is less than that which would occur if the worker were to breath, for a specified period of time, limiting concentrations of radioactive material, specified by isotope in tabular form in 10 CFR Part 20.

Dose guidelines for unrestricted areas (Part 20):

- < .5 Rem/yr whole body
- < 2 mR/hr whole body
- < 100mR/7 days whole body

10 CFR Part 50, Appendix I, "ALARA Design Objectives for Exposures to Individuals in Unrestricted Areas Due to Radioactive Effluents From Nuclear Power Plants"

Liquid effluents, all pathways - < 3mR/yr whole body

Gaseous effluents, all pathways

- < 10mrad/yr gamma } Provided < 5mR/yr whole body, < 15mR skin
- < 20mrad/yr beta }

Iodine and Particulates, all pathways - < 15mR/yr to any organ

40 CFR 190 "Environmental Standards for the Uranium Fuel Cycle"

- Annual Dose Equivalent < 25 mR whole body
- < 75 mR Thyroid
- < 25 mR any other organ

Total Material Entering the Environment From the Whole Uranium Fuel Cycle

- < 50,000 Curies Krypton-85/GW-Y
- < 5 millicuries Iodine-129/GW-Y
- <.5 millicuries Plutonium-239 and other alpha-emitting transuranic radionuclides with halflives greater than 1 year/GW-Y

EPA CAA STANDARD:

Option A: 10 mrem/yr. dose limit

Option B: 10 mrem/yr. dose limit
 Target: Seeks to limit fatal cancer incidence in the population to no more than one a year

Option C: 3 mrem/yr. dose limit
 Target: Seeks to limit maximum individual risk of fatal cancer over a presumed 70-year lifetime to no more than one chance in 10,000.
Lifetime = 10^{-4}
Annual = 1.4×10^{-6}

Option C/D: 0.3 mrem/yr dose limit
 (not proposed) Result: Would result in a reduction in the incidence of fatal cancers of 0.06 a year below the calculated incidence of .13 fatalities under current regulations

Option D: 0.03 mrem/yr. dose limit
 Target: Seeks to ensure a lifetime fatal cancer risk to an individual of one chance in a million
 10^{-6}
Lifetime

CURRENT NRC LICENSEES (EPA Figures):

Maximum Individual Lifetime Risk = 1.6/10,000
 Incidence w/n 80 km (death/yr) = 0.13 deaths/yr.

40 CFR 190:

25 mrem/yr - whole body
 75 mrem/yr - any organ

Maximum individual lifetime risk of cancer = 7 in 10,000
 (EPA figure)

Proposed Pt. 20
100. mrem - general public

BRC

10 mrem
 Annual - 4×10^{-6} - 7×10^{-7}
 [Lifetime 5×10^{-5} - 3.5×10^{-4}]
 1 mrem Annual - 4×10^{-7} - 7×10^{-8}
 Lifetime - 2×10^{-5} - 5×10^{-6}
 1 mrem - Inhalation
 Lifetime 1×10^{-6}
 Safety level (accidents) 21 mrem/yr.

Source Category	Current Rules	Case-by-Case Approach A	Incidence Limit Approach B	1×10^{-4} MIR Approach C	1×10^{-6} MIR Approach D
High-level Nuclear Waste Disposal	No rule	No rule	No rule	No rule	No rule
Elemental Phosphorus Plants	21 Ci/y Po-210	10 Ci/y Po-210	10 Ci/y Po-210	0.6 Ci/y Po-210	0.006 Ci/y Po-210
Nuclear Power Reactors and Support Facilities	25 mrem/y	10 mrem/y	10 mrem/y	3 mrem/y	0.03 mrem/y
Coal-fired Boilers	No rule	No rule	No rule	No rule	NSPS Std.
DOE Facilities	25 mrem/y	10 mrem/y	10 mrem/y	3 mrem/y	0.03 mrem/y
NRC Licensees (40 CFR 190)	25 mrem/y	10 mrem/y	10 mrem/y	3 mrem/y	0.03 mrem/y
DOE Radon	No rule	20 pCi/m ² -s radon	20 pCi/m ² -s radon	2 pCi/m ² -s radon	0.02 pCi/m ² -s radon
Phosphogypsum Piles (Stacks)	No rule	20 pCi/m ² -s radon	20 pCi/m ² -s radon	2 pCi/m ² -s radon	0.02 pCi/m ² -s radon
Surface Uranium Mines	No rule	No rule	No rule	No rule	0.02 pCi/m ² -s radon
Uranium Mill Tailings (disposal)	20 pCi/m ² -s radon	6 pCi/m ² -s radon	6 pCi/m ² -s radon	2 pCi/m ² -s radon	0.02 pCi/m ² -s radon
Uranium Mill Tailings (Operations)	Phased/continuous disposal after 6 years	Phased/continuous disposal after 2 years	Phased/continuous disposal after 2 years	Phased/continuous disposal immediately	Cease operations
Underground Uranium Mines	Bulkheads	1,500 Ci/y radon ground level or 5,000 Ci/y radon 30m stack	ground level or 30m stack	1,500 Ci/y radon 5,000 Ci/y radon	500 Ci/y radon

Summary of Risk Levels for EPA options:
(Risk Coefficient = $4.8E-4$ (est.))

- B: Seeks to limit fatal cancer incidence in the population to no more than one per year.
- C: Seeks to limit MIR of fatal cancer over a presumed 70-year lifetime to no more than $1E-4$.
- D: Seeks to limit MIR of fatal cancer over a presumed 70-year lifetime to no more than $1E-6$.

NRC BRC Policy:
(assuming 70-year lifetime)

Risk Coefficient =	$5E-4$ (500/m.)	$3.5E-4$ (350/m.)	$7E-5$ (70/m.)
(fatal cancers/rad)			
1 MREM	$4E-5$	$2E-5$ (20/m.)	$5E-6$ (5/m.)
10 MREM	$4E-4$	$2E-4$ (200/m.)	$5E-5$ (50/m.)

Maximum individual risk

0.03 mrem/yr $\approx 10^{-6}$ lifetime risk $\approx 1.4 \times 10^{-8}$ annual risk

3 mrem/yr $\approx 10^{-4}$ lifetime risk $\approx 1.4 \times 10^{-6}$ annual risk

10 mrem/yr $\approx 3.3 \times 10^{-4}$ lifetime risk $\approx 5 \times 10^{-6}$ annual risk

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- 10⁶

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10 CFR 20:

100 mrem limit on continuous exposure from all sources using man made sources of radiation (other than medical)

300 mrem/yr. total background
(natural) (200 = radon)

1% = 3 mrem/yr. etc

Maximum individual risk of
fatal cancer =
 1×10^{-4} / yr.

4 mrem/yr. any individual
forever

Nuclear Fuel Cycle = 10 mrem/yr.