Radiation Risks in Everyday Life

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Problems with Communicating Radiation Risk to the Public

- Engineers and scientists communicate risk with the language of numbers … the public deals with risk emotionally
- Voluntary vs. involuntary
- Exotic vs. everyday
- Credibility of big government and big business
- Association of nuclear power with nuclear weapons
- Inability of public to accept cost-benefit arguments
- The “outrage” factor (radiation, cancer, babies)
- Hyperbole (enormous, huge, astronomical, widespread)
- Logarithmic vs. linear scales of safety
- Validity of LNT at low doses
- Inappropriate collective dose impacts

Theoretical Risk from Background Radiation

Radiation Risk from Background/Lifestyle Sources of Radiation	Exposure (mSv/y)	Cancer Incidence Risk (75 year lifetime)*
Smoking 1 pack of cigarettes per day (polonium-210)	80	684,000 per 1,000,000
Indoor radon	2	17,100 per 1,000,000
Working in granite buildings	1	8,550 per 1,000,000
Soil and rock (Colorado plateau)	0.9	7,695 per 1,000,000
Cosmic rays (Denver at 5,000 ft elevation)	0.55	4,703 per 1,000,000
Human body (from food we eat)	0.4	3,420 per 1,000,000
Soil and rock	0.4	3,420 per 1,000,000
Cosmic rays (at sea level)	0.3	2,565 per 1,000,000
Living in a brick house	0.07	599 per 1,000,000
One round trip from LA to NY per year	0.06	513 per 1,000,000
Sleeping next to one's partner	0.02	171 per 1,000,000

* Based on BEIR VII radiation incidence risk of 0.00114 per 10 mSv

Fallacy of the Geometric Scale of Safety

Contributions to Cancer Risk	Radiation Exposure (mSv/year)	Theoretical individual cancer incidence risk*	Incremental population** cancer risk (cancer incidence)	Total population cancer risk (cancer incidence)
U.S. average cancer incidence	N/A	0.42	336	336
U.S. average natural background exposure (75 y)	3	0.026	21	336
Average background exposure from soil (75 y)	0.3	0.0026	2	336
NRC license termination dose (30 y)	0.25	0.0009	0.7	336.7
Upper EPA CERCLA risk range (1 in 10,000)	-	0.0001	0.08	336.08
Geometrical mean of CERCLA risk range (1 in 100,000)	-	0.00001	0.008	336.008
Lower EPA CERCLA risk range (1 in 1,000,000)	-	0.000001	0.0008	336.0008
Zero incremental risk level	-	0	0	336

* Using the BEIR VII cancer incidence risk of 1.14E-04 per mSv

** For hypothetical residential population of 800 in Area IV of SSFL

Other Sources of Risk Compared to the CERCLA Risk Range

Sources of Risk	10^{-4} Risk	10^{-6} Risk
Radiation cancer incidence risk from drinking orange juice (contains radioactive potassium-40)	1 small glass per day	0.4 teaspoon per day
Radiation cancer incidence risk from elevation change (increasing exposure to cosmic radiation)	Difference in risk in living in Santa Monica and the foothills of Beverly Hills (600 foot elevation)	Difference in risk between the feet and head of a 6 foot person
Fatal accident risk from driving*	Driving an extra 127 miles per year for 30 years	Driving an extra 1 mile per year for 30 years

* Non radiation fatal risk

Theoretical Radiation Risk of Potassium-40 in Orange Juice

- EPA PRG for potassium-40 in tap water at the 10^{-6} risk level is 1.93 $pCi_{K\text{-}40}/L$
  - http://epa-prgs.ornl.gov/radionuclides/prg_search.shtml
  - http://epa-prgs.ornl.gov/radionuclides/tapwater_guide.shtml
  - Assumes tap water consumption of 2 L/day each day and 30 year exposure period
- Orange Juice (OJ)
  - 2.2 gm_K/L_{OJ}
  - Specific activity = 818 $pCi_{K\text{-}40}/gm_K$
  - Activity of OJ = 818 x 2.2 = 1,800 $pCi_{K\text{-}40}/L_{OJ}$
- Using EPA risk data and models, the radiation risk of orange juice consumption is
  - 10^{-6} risk for (1.93 x 2) x 1,000 / 1,800 = 2 mL/day (half a teaspoon)
  - 10^{-4} risk for 200 mL/day (one cup)

Theoretical Radiation Risk from Elevation Change

- Background radiation exposure increases by approximately 0.05 mSv/y for every 1,000 foot increase in elevation due to cosmic ray exposure
  - http://www.epa.gov/radiation/understand/calculate.html

- BEIR VII states the cancer incidence risk of 1 Sv is 0.114 or the risk of 1 mSv is 0.000114

- A 6 foot increase in elevation (over a 30 year exposure period) is equivalent to an increase of approximately 0.009 mSv which is equivalent to a theoretical cancer incidence risk of 10^{-6}

Fatal Risk from Driving

Equivalency to Driving Fatality Risk (2008)*									
	Fatalities	Period (years)	Annual Miles Driven	Total Miles Driven	Fatal Risk (per mile driven)	Total Fatal Risk	Total Cancer Incidence Risk	Annual Radiation Equivalence** (mSv/y)	Total Radiation Equivalence** (mSv)
U.S. Driving (1 year)	37,261	1	2,850,000,000,000	2,850,000,000,000	1.3E-08				
Personal Driving (1 year)	-	1	12,000	12,000	1.3E-08	1.6E-04	-	2.8	3
Personal Driving (30 year)	-	30	12,000	360,000	1.3E-08	4.7E-03	-	2.8	83
Personal Driving (75 year)	-	75	12,000	900,000	1.3E-08	1.2E-02	-	2.8	206
Personal (30 years)	-	30	654	19,619	1.3E-08	2.6E-04	5E-04	0.15	4.5
Personal (30 years)	-	30	127	3,824	1.3E-08	5E-05	1E-04	0.03	0.88
Personal (30 years)	-	30	13	382	1.3E-08	5E-06	1E-05	0.003	0.09
Personal (30 years)	-	30	1	38	1.3E-08	5E-07	1E-06	0.0003	0.01

* http://safety.fhwa.dot.gov/facts/road_factsheet.htm

** Fatal cancer risk of 0.00057 per 10 mSv (BEIR VII)

** Cancer incidence risk of 0.00114 per 10 mSv (BEIR VII)

Input

Summary

- Theoretical radiation risks that we face every day far exceed regulatory limits that the activist community demands
- These every day risks are based on the same LNT methodology and regulatory guidance (BEIR VII, EPA) that the industry is forced to accept
- Are these risk numbers real? …. Probably not!!
- Since risk estimates at low dose rates less than background have no credibility we should not use risk to communicate with the public
- Continue to use dose as a figure of merit and compare to existing regulatory dose standards and/or background doses