Damages from a major release of ^{137}Cs into the atmosphere of the U.S.

Jan Beyea

Consulting in the Public Interest

Jbeyea@cipi.com

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Paper to appear in

- Science and Global Security
- Co-authors:
  - Edwin Lyman, UCS
  - Frank von Hippel, Princeton
- Addendum to:
  - “Reducing the hazards from stored spent fuel in the US”
  - By R. Alvarez, J. Beyea, K. Janberg, J. Kang, E. Lyman, A. Macfarlane, G. Thompson and F. von Hippel

Any consequence calculation is assumption dependent

- Major assumptions here:
  - – Release magnitude (3.5 and 35 MCi)
  - – Clean-up threshold (15 Ci/km^2)
  - – Possible decontamination factors (3-8)
  - – Efficiency of efforts (100%)
    - Depends on degree of pre-planning
  - – Indirect costs (assumed zero)
    - Administration, population control, litigation

The decision making process for protection of the public could be difficult

- because technical aspects of decontamination effectiveness and calculated risk would need to be considered, and
- because social/political factors need to be considered.

- In the absence of advanced planning, decision makers would need to improvise,
  - and this could lead to problems and increased costs.

Manning *(1992)* describes problems in response to accidents

- violations of law,
- issuance of inaccurate information,
- withholding of information,
- tendency of decisionmakers under pressure to make decisions arbitrarily
  - and then attempt to provide a suitable *ex post facto* justification.

- In all of the cases discussed, these problems resulted
  - when unanticipated events occurred, with a lack of advance planning.

  - Manning, P. K. (1992), "'Big Bang' Decisions: Notes on a Naturalistic Approach," in *The Uses of Discretion, K.* Hawkins (ed.), Oxford University Press, New York.

NRC's planning catch-22

- If NRC plans for a spent-fuel release
  - Nuclear opponents will say it is an admission that such an accident is likely
- Perhaps, plan in the context of releases from a dirty bomb?
- Clean up standard, in particular, needs to be debated ahead of any accidental release.

- “Existing radiological cleanup laws, regulations, models and criteria must be updated and coordinated
  - to provide for long-term remediation of radiological dispersal events (“dirty bombs”)

  - Elcock, D., Klemic, G. A. and Taboas, A. L. Response to a Radiological Dispersal Event (or “Dirty Bomb”). *Environ Sci Technol,* 2004: 38:2505-2512.

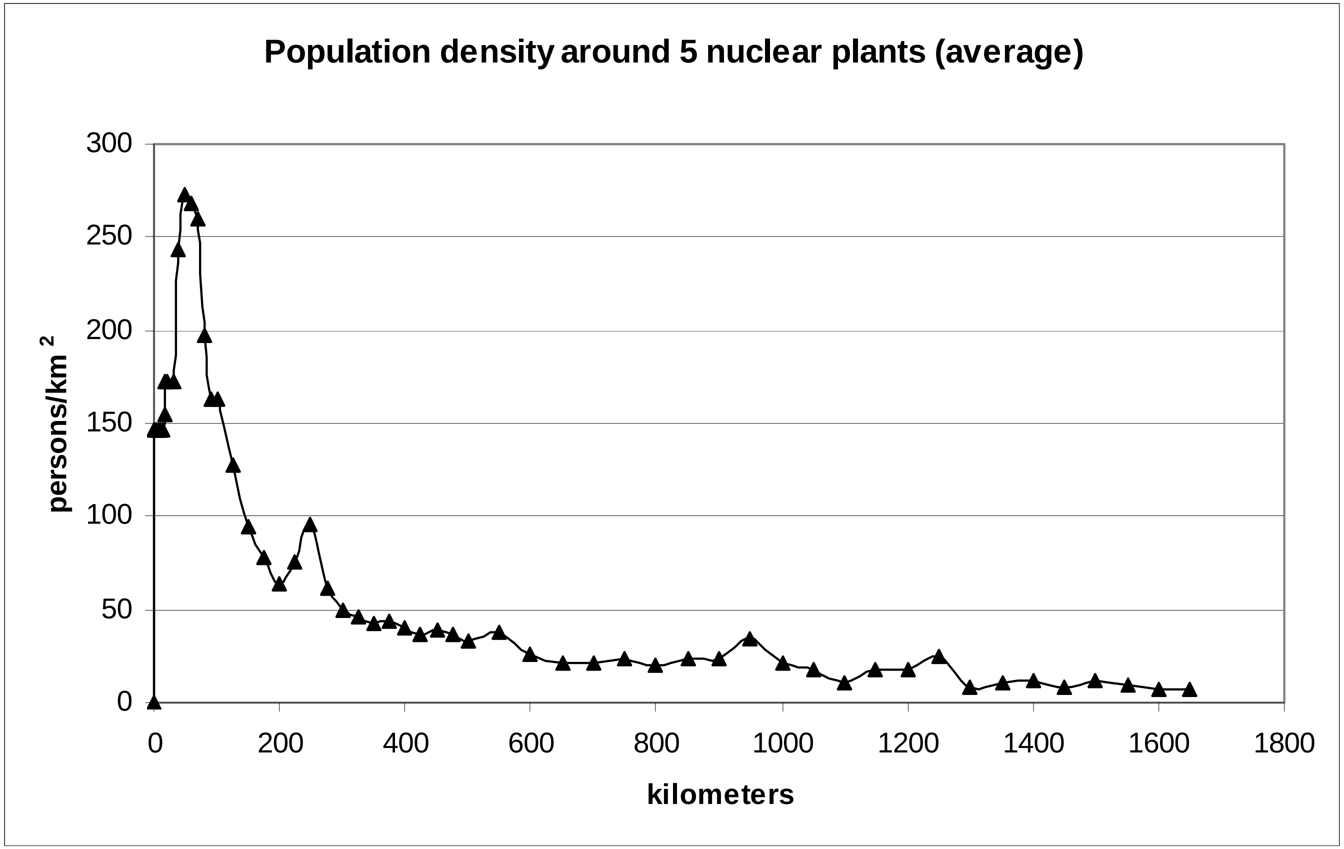
Threshold assumption (15 Ci/km^2) and EPA recommended dose limits

Period	**Dose** (rem)	^{137}**Cs Contamination Level** (Ci/km^2)	
		EPA	**MACCS2**
First year after release	2	44.4	41
Second year after release	0.5	17.2	14.4
Cumulative 50-year dose	5	8.2	6

Sites considered

- Catawba, near Rock Hill, South Carolina;
- Indian Point, on the Hudson near NYC;
- LaSalle County near Springfield, Il;
- Palo Verde, near Prescott, AZ;
- Three Mile Island, near Harrisburg, Pa.

Average population density



This graph is not in paper

Major changes from first paper

- Realistic population distributions
  - which causes estimated (delayed) cancer deaths to come way down.
- Improved cost estimates
- Corrected discounting error

- Economic costs similar
- Probably understated

Cost estimates

- Depend heavily on Chanin & Murfin
  - Well-thought out study
  - Tried to be realistic
- Major assumptions of C & M:
  - No administrative and control costs
  - No errors

  - Chanin, D. I. and Murfin, W. B. *Site restoration: estimation of attributable costs from plutonium-dispersal accidents.* Albuquerque: Sandia National Laboratory, 1996, SAND96-0957.

Per capita contamination cost assumptions used in our MACCS2 runs

Decontamination Factor	**<3**	**<8**	**>8**
Decontamination	$19,000	$42,000	$0-42,000
Compensation	$25,000		$132,000
Relocation	0	$3,600	$3,600
Waste disposal	$14,000	$15,000	$0-15,000
Total	$58,000	$85,600	$90,600-135,600

Estimates of economic losses ($billions) and cancer deaths

Site	Release (MCi)	Total Costs	Condemned Property	Other losses[1]	Temporary relocation	Decontam-ination[2]	Cancer Deaths[3]
Catawba	**3.5**	71	10	32	0	29	3100
	35.0	547	145	192	11	199	7650
Indian Point	**3.5**	145	43	42	5	56	1500
	35.0	461	282	85	8	86	5600
LaSalle	**3.5**	54	2	23	1	27	2100
	35.0	270	10	121	7	131	6400
Palo Verde	**3.5**	11	1	5	0	5	600
	35.0	80	24	26	2	29	2000
Three-Mile Island	**3.5**	171	13	65	6	87	2300
	35.0	568	278	134	11	144	7000
Averages	**3.5**	**91**					**1900**
	35.0	**385**					**5700**

[1] Heavily contaminated furnishings, business inventory and vehicles. Also depreciation of property when radioactive decay is required in addition to DF = 8 before reoccupation is possible.
[2] Including disposal of radioactive decontamination waste at a cost of $167/m^3.
[3] Assuming an average dose-reduction factor of one third due to shielding by buildings and ground roughness and one cancer death per 2000 whole-body rem population dose.

Break-even probability

- Was: 0.7 to 5% over next 30 years
- Now: 1.4 to 5%

- If consider suggestion of Richard Garwin to remove every 5th assembly,
  - get 4 times lower cost and 4 times lower break-even probability

Remove 1/5th of the assemblies:

Then every fuel assembly next to an empty channel, but does not reduce ^{137}Cs inventory by factor of 4