ATTACHMENT A

Table 1 Long-Term Cleanup Phase

Proposed Cleanup Benchmark[1]	= # of Chest X-rays Per Year[2] [Over 30 Years]	Risk of Cancer[3] (exponential)	=1 Cancer Per X People Exposed	Factor by Which EPA Acceptable Risk Range[4] Is Exceeded
100 mrem/year[5]	17 [500]	2.5×10^{-3}	400	25-2,500
500 mrem/year[6]	83 [2,500]	1.3×10^{-2}	80	130-13,000
1,000 mrem/year[7]	170 [5,000]	2.5×10^{-2}	40	250-25,000
2,000 mrem/year[8]	340 [10,000]	5×10^{-2}	20	500-50,000
10,000 mrem/year[9]	1,700 [50,000]	2.5×10^{-1}	4	2,500-250,000

Table 2 Early Phase

Proposed Protective Action Level	= # of Chest X-rays Per Year	Risk of Cancer (exponential)	=1 Cancer Per X People Exposed	Factor by Which EPA Acceptable Risk Range Is Exceeded
1,000 mrem[10]	170	8.46×10^{-4}	1,200	8-850
5,000 mrem/year[11]	830	4.23×10^{-3}	240	42-42,000

Table 3 Intermediate Phase

Proposed Levels 1st Year	Proposed Levels subsequent years[12]	# of Chest X-rays Per Year *[Over 3 Years[13]]*	Risk of Cancer (exponential)[14]	=1 Cancer Per X People Exposed	Factor by Which EPA Acceptable Risk Range Is Exceeded[15]
2,000 mrem 1st year		333	1.7×10^{-3}	600	17-1,700
	500 mrem/year– general exposure	83 *[250]*	1.3×10^{-3}	800	13-1,300
	+500 mrem/year – food interdiction	83 *[250]*	1.3×10^{-3}	800	13-1,300
	500 mrem/year	83 *[250]*	1.3×10^{-3}	800	13-1,300

	drinking water interdiction				
	Total 1,500 mrem/yr	250 *[750]*	3.8 x 10^{-3}	260	38-3,800

Table 4 Total Dose to Public from DHS Proposed Radiation Guidelines

Phase	Proposed Dose Level	= # of Chest X-rays	Risk of Cancer (exponential)	=1 Cancer Per X People Exposed	# of cancers produced if the exposed population is 10,000 people[16]	Factor by Which EPA Acceptable Risk Range Is Exceeded
Early	5,000 mrem	833	4.23 x 10^{-3}	240	42	
Intermediate – 1st yr	2,000 mrem 1st year	333	1.7 x 10^{-3}	600	17	
Yrs 2-4 (total)	4,500 mrem	750	3.8 x 10^{-3}	260	38	
Late Phase[17]	3,000- 300,000 mrem[18]	500- 50,000	2.5 x 10^{-3} – 2.5 x 10^{-1}	400- 4	25- 2,500	
Total[19]	**14,500 – 311,500 mrem**	**2,400 – 52,000**	**1.2 x 10^{-2} – 2.6 x 10^{-1}**	**80- 4**	**120 – 2,600**	**120-12,000 - 2,600-260,000**

Endnotes

[1] The current draft Department of Homeland Security cleanup guidance, as released by the trade press, has no specific cleanup standards for the late phase cleanup, implicitly turning away from existing cleanup standards such as EPA's CERCLA requirements, and instead referring to unspecified 'benchmark" values proposed by nuclear advisory groups, and federal and state government agencies. We have therefore focused on such proposals, as from HPS and ICRP, and the DOE and NRC proposals made in an earlier draft of the DHS guidance, recognizing that there are far more protective standards in existence, such as EPA's historical cleanup standards, that could be – and should have been – adopted in the DHS guidance as the preferred benchmark.

[2] Standard chest X-ray ≈ 6 mrem. (General Accountability Office Report GAO/RCED-00-152, "Radiation Standards," fn. 3, page 7.) Doses vary by machine.

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[3] Based on the official figure for cancer incidence risk of 8.46 x10^{-4}/person-rem, as set forth in Federal Guidance Report 13 (FGR 13). (Put more simply, 8-9 people are expected to come down with cancer from their radiation exposure if 10,000 people each receive 1 rem, or if 1000 people each receive 10 rem). Federal Guidance Report No. 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides,* EPA 402-R-99-001, US EPA Office of Radiation and Indoor Air, funded by EPA, NRC, and DOE, September 1999, pp. 179, 182; http://www.epa.gov/radiation/docs/federal/402-r-99-00.pdf. FGR 13 provides estimates of fatal cancer risk of 5.75 x 10^{-4} per person-rem [5.75 x 10^{-2} per person-gray] and total cancer incidence or morbidity (fatal and nonfatal combined) of 8.46 x 10^{-4} per rem [8.46 x 10^{-2} per person-gray].

All federal agencies use approximately the same mortality risk factors, i.e. the Federal Guidance Report 13 figures cited above. See, e.g., *NRC Policy Statement on Below Regulatory Concern*, 3 July 1990, p. 8, and *NRC 10 CFR Part 20, et al. Radiological Criteria for License Termination; Final Rule*, July 21, 1997, Vol. 62 Federal Register 39058, 39061, noting its reliance on and the similarity of the Federal Guidance 13 and ICRP Publication 60 risk figures; and DOE *Environmental Assessment for the Energy Technology and Engineering Center,* DOE/EA-1345, p. C-3, March 2003. The minor differences between agencies – DOE and NRC at times use mortality figures of 5 x 10^{-4} / person-rem instead of the Federal Guidance Report 13 figure of 5.75 x 10^{-4}, particularly in pre-FGR 13 documents -- are inconsequential for the discussion here because of the high magnitude of the risk of the dose limits represented.

The agency risk estimates from radiation are in turn derived in large part from *Health Effects of Exposure to Low Levels of Ionizing Radiation,* the report by the National Academy of Sciences' Committee on the Biological Effects of Ionizing Radiation (BEIR V), 1990, which sets the risk of fatal cancer at 8 x 10^{-4} per person-rem. (See NAS BEIR V Report p. 6 and 172-3,5). EPA and other agencies rely upon the NAS numbers, but reduce the risk factor by a Dose and Dose Rate Effectiveness Factor (DDREF). No agency – nor the NAS – accepts the controversial argument put forward by some in the nuclear industry that there is a threshold below which radiation is completely safe, or may even be beneficial ("hormesis"), but all agencies depart from the linear model at low doses by reducing risks at low doses and dose rates by a DDREF of approximately 2, beyond the reduction from just linear scaling from higher doses.

When conducting site-specific risk assessments at Superfund sites, EPA uses isotopic-specific risk coefficients rather than rely on the more generic rem-to-cancer risk estimates cited here. However, this type of more accurate risk assessment is not possible prior to a radiological attack.

The assumed exposure period is 30 years, the presumption generally used by EPA's Superfund program for estimating exposure at Superfund sites (although EPA has in other instances assumed a full lifetime of exposure of 70 years.) For simplicity, we have used the official government risk figures for cancer induction from radiation exposure and the less conservative 30-year rather than lifetime exposure assumption. True risks therefore may be higher than presented here, as people may live or work at the same location longer than 30 years, and several studies (e.g., of DOE radiation workers at Oak Ridge, Hanford, and Santa Susana) suggest ten-fold higher cancer risks than assumed in Federal Guidance 13.

If the half-life of the radioniuclide(s) involved were short, there may be a reduction of dose over the 30 year exposure period and therefore a reduction in risk from the figures cited above. If, however, the radionuclide(s) half-life were long, there may be no significant dose reduction in that period. Additionally, effects of weathering would need to be taken into account, but that would involve site-specific considerations.

[4] EPA has long set the acceptable risk range for cancer induction from exposure to contaminants (chemicals and radionuclides combined) as $10^{-4} – 10^{-6}$, or one cancer per 10,000 to 1,000,000 people exposed, with the starting point for acceptable risk being one in a million, falling back to no more than one in ten thousand if there are good reasons why the one in a million level cannot be obtained. See, e.g., CERCLA statute and EPA's implementing guidance. As EPA acknowledged in an earlier draft of the DHS guidance, there may be extraordinary circumstances regarding a dirty bomb requiring, in a particular case, going outside the normal risk range, but the basic cleanup standards should be based on the existing EPA CERCLA risk range.

[5] HPS suggested lower range [*Guidance for Protective Actions Following a Radiological Terrorist Event - Position Statement of the Health Physics Society*, January 2004. Ramona Trovato, in the EPA statement quoted in our letter, says NRC estimates the cancer risk of a 100 mrem/year cleanup standard as 1 in 200 (5×10^{-3}). We give it here as 2.5×10^{-3}. NRC presumably used a longer exposure time (e.g., lifetime) than the 30 years we assumed. Our risk figures here thus might be low (i.e., underestimate true risk) on that basis alone.

[6] HPS suggested upper range; DOE & NRC suggested benchmark [*Risk Management Framework for Radiological Dispersal Device (RDD)/ Improvised Nuclear Device (IND) Incidents (Guidance for Development of Countermeasures),* Rough Draft July 18, 2003, pp. 25, made by public by the trade publication *Inside EPA*

[7] ICRP suggested lower range [*Protecting People Against Radiation Exposure in the Aftermath of a Radiological Attack-- A Report from a Task Group of the ICRP*, Final TG Draft April 2004, p. 79

[8] DOE suggested upper range for long-term cleanup standard, DHS Rough Draft July 18, 2003, p. 28. The 2,000 mrem/year proposed limit includes background, which averages in the U.S. ~330 mrem/year, most of it from indoor radon. The 2,000 mrem/year limit

with background thus would average ~1,670 mrem/year above background. The contradiction between this value and the 500 mrem/year above background recommendation in the same paragraph is not explained in the DOE appendix to the DHS draft. The X-ray equivalence and risk figures in the succeeding columns for that row are based on the 2,000 mrem/yr figure (i.e., including background). Since all other of the proposed cleanup levels do not include background, to make them comparable, one would reduce the X-ray and risk figures for this one proposed standard by 330/2,000 = 16.5% to get the contribution from the radiation from the dirty bomb alone.

[9] ICRP suggested upper range

[10] Lower range of recommended protective actions of sheltering and/or evacuation of public

[11] Upper range of recommended protective actions of sheltering and/or evacuation of public

[12] These permitted doses are additive – i.e., one is permitted 500 mrem/year from general contamination such as soil contamination, 500 mrem/year from contaminated food, and 500 mrem/year from contaminated drinking water, for a total of 1,500 mrem/year each year of the intermediate phase after the first year.

[13] These limits are for subsequent years prior to the late phase cleanup. We here assume this takes three years, but it could be longer and the doses thus higher.

[14] For 1st year, risk for dose in that year. For subsequent years, risk for the 3 years following.

[15] The World Trade Center benchmark of aggressive cleanup of chemical toxic materials in apartments–comparable to the intermediate phase here – was accomplished with a 1×10^{-4} lifetime cancer risk cleanup benchmark assuming one year of exposure. These proposed radiation cleanup standards for the intermediate phase would be many times more lax than EPA permitted for the World Trade Center cleanup—a total risk of 5.5×10^{-3}, or 55 times the risk standard used by EPA for the World Trade Center cleanup. See *World Trade Center Indoor Air Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks*, Prepared by the Contaminants of Potential Concern (COPC) Committee of the World Trade Center Indoor Air Taskforce Working Group, Peer Review Draft, September, 2002, pp. 11-12. The overall 30-year long-term cleanup benchmark used by EPA for cleanup of the surrounding area after the World Trade Center attack was also 1×10^{-4}. See *World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks* May 2003 Prepared by the Contaminants of Potential Concern (COPC) Committee of the World Trade Center Indoor Air Task Force Working Group, p. 58.

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[16] Assume, for example, a dirty bomb going off in a crowded downtown metropolitan area where 10,000 people live and/or work in the affected zone. The number could be significantly larger under some radiological weapon scenarios in highly populated areas.

[17] Uses EPA common assumption of 30-year total exposure after cleanup is completed.

[18] Lower figure is based on 100 mrem/year benchmark, upper figure based on 10,000 mrem/year benchmark

[19] Similarly, the range for total exposure--taking into account immediate, intermediate, and late phase cleanup--is bracketed by the totals including the lower long-term cleanup benchmark on the one hand and the upper long-term cleanup benchmark on the other.