Appendix C:
ACMUI Dose-Reconstruction Subcommittee (DRS) Comments on "Nuclear Regulatory Commission Radiation Absorbed Dose Reconstruction For Family Member Of I-131 Patient" by Drs. Carol S. Marcus and Jeffrey A. Siegel

Marcus-Siegel Comment	DRS response
"We believe that it is imperative to **reconstruct the distance before you reconstruct the dose."**	DRS agrees that a computational dose reconstruction is a useful tool complementing the empirical dose estimation technique used by Region III and the Licensee. DRS believes theoretical dose estimation in this case is warranted for two reasons (a) the Licensee contests NRC's analysis (although not on grounds of methodology) and (b) No observations are available to determine where the daughter was positioned in relation to the bedside measurement. However, DRS does not believe that inverse square law and using only one data point, as proposed by M&S, to be either state-of-the-art or adequate for this case.
The bedside distance (31.6 cm per M&S estimates) is implausibly short. A distance of 66 cm is suggested, which M&S claim reduces NRC's dose estimate by factor of 4.3.	While DRS believes that the bedside distance is implausibly short, it disagrees with the M&S critique in several important respects o There is no factual basis or industry standard to justify doubling the distance. DRS believes that using the measurement without modification is preferable to an arbitrary unjustified choice. In contrast, DRS increased the distance from 20 to 35 cm based upon geometric plausibility arguments. o Simple point source or even line source approximations are invalid so close to the patient. Near a large volume source, dose fall-off is much less rapid than inverse square law. Hence, DRS estimates only a 35% reduction in dose, not 77% as proposed by M&S.
Evaluating whole body dose as well as DDE would have been prudent. M&S believe this would have reduced NRC's dose estimate by a 6.8-fold factor.	DRS agrees that whole body dose is a better surrogate for medical risk and agrees it should be supplied to medical consultants. Based on highly limited Monte Carlo calculations, DRS believes that mean and maximum physical dose differ by about a factor of 4 assuming a cylindrical source and subject geometries and a center-to-center distance of 50 cm. However, this simplified simulation falls short of the definition of EDE.
Failing to account for tissue attenuation over the 1 cm tissue depth overestimates DDE by 10%.	M&S derive this factor by considering only primary photon attenuation. DRS believes that backscattered radiation from the daughter would likely compensate for decrease in the primary photon DDE, although detailed Monte Carlo

	simulations were not performed. In any case, this correction is small in relation to other uncertainties.
(a) Failing to use line source approximation; (b) – stepwise daily rather than continuous decay and (c) equality of two successive measurements together imply that NRC overestimated total bedside DDE by 1.5 assuming patient elbows were actually positioned at the point of measurement.	(a) Since no inverse square law corrections are made by NRC, it is unclear why the adequacy of inverse square law is relevant here. (b) DRS believes continuous decay might reduce the dose by as much as 10%. (c) More detailed information available to DRS indicates that the measurements were performed 4 hours apart, so that their equality is well within experimental error. Overall, DRS believes the dose estimation factor is only 1.1 not 1.5 in this context.
NRC estimate of integrated bedside DDE measurement is in error by 1.1*1.5 factor = 1.6	DRS rejects the attenuation correction, and the 1.5 correction above. DRS believes NRC's error in this calculation is about 10% due to ignoring continuous decay.
Based on distance implausibility, NRC estimate of DDE is in error by 4.3*1.1*1.5=6.8	For reasons explained above, DRS estimates that Region IIII overestimated DDE by a factor of 1.5*1.0*1.1=1.7 Basic reasons: DRS believes M&S theoretical calculations are too approximate and that their choice of mean daughter-patient distance too arbitrary.
Using mean body dose, NRC estimate is too high by following factors (6.8)*(1.7)*(1.5)= 17	DRS does not believe that the approximations and rules of thumb used by M&S are accurate enough to support quantitative estimates of mean whole body dose. DRS recommends Monte Carlo simulation or other more sophisticated radiation transport tools for estimating this quantity.