

Review of Findings in the NAS Atomic Veterans Report on Beta Dosimetry

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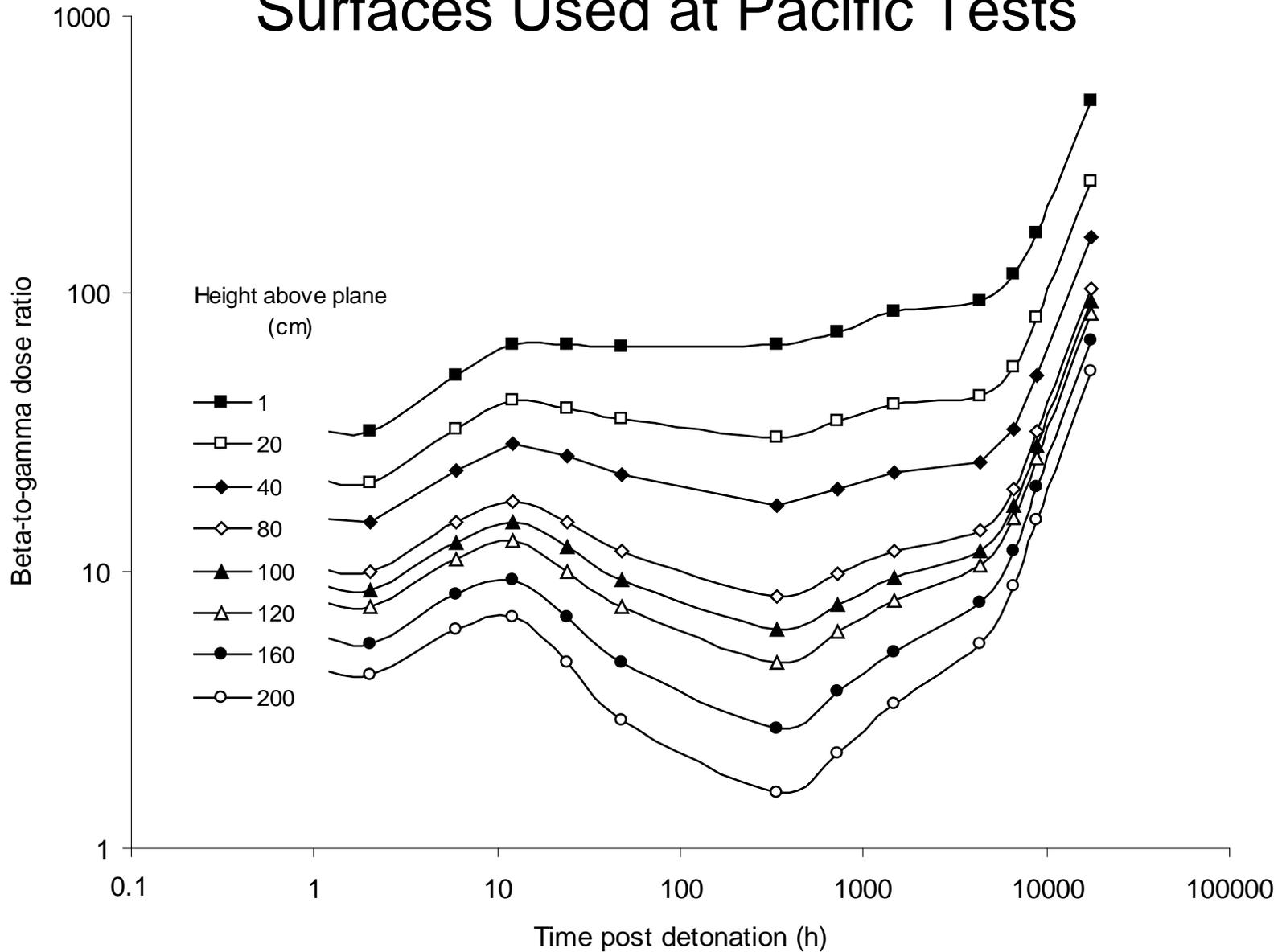
Beta Dosimetry

- Before 1998, skin doses were not routinely estimated in the NTPR program
- the Barss (2000) report generally documents the methods used in 1998 and 1999 and presents the methods used from January 2000 to the time of the NAS report
 - standing on a contaminated surface
 - being in contaminated air
 - being in contaminated water
 - contaminated skin

External Beta Dosimetry

- External beta doses from contaminated surfaces are calculated by applying a beta-to-gamma dose ratio to an estimated upper-bound gamma dose
- Different ratios are used for fallout and activation
 - The dose ratio depends upon
 - Whether the test was in the Pacific or Nevada
 - Time after detonation
 - Height above ground
- Doses to skin or lens are sum of beta and gamma doses

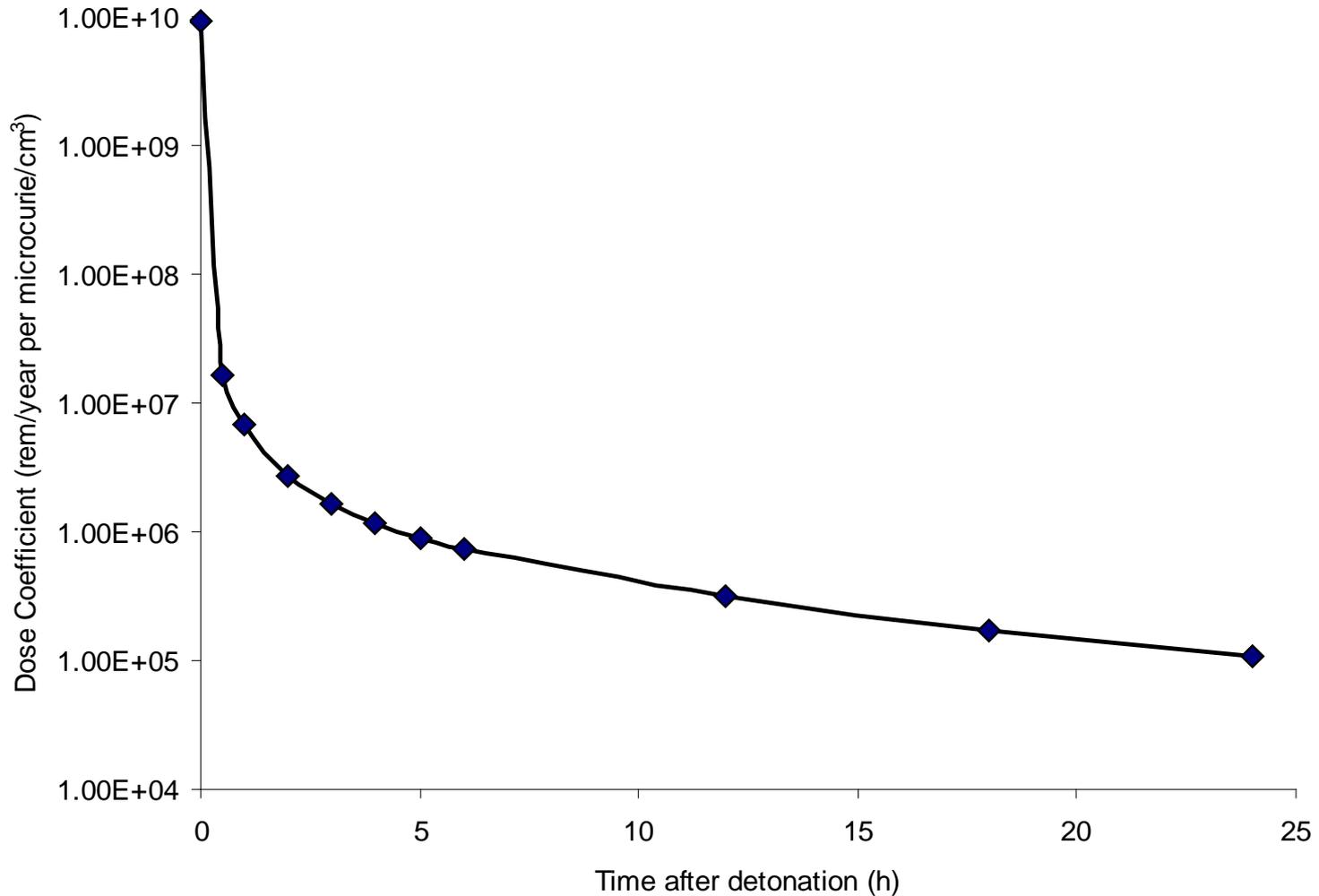
Beta to Gamma Dose Ratios for Contaminated Surfaces Used at Pacific Tests



Contaminated Air Beta Dosimetry

- Beta dose is estimated using
 - Dose coefficients
 - Spectra
 - Exposure time
- The composite dose coefficients provide equivalent dose rates from electrons per unit concentration of radionuclides in air
- Composite dose coefficients depend on time after detonation
- Doses to skin or lens are sum of beta and gamma doses

Composite Beta Dose Coefficient for Immersion in Fallout-contaminated Air



Contaminated Water Beta Dosimetry

- The approach for submersion in water is similar to that for air, but it accounts for the different densities of water and air

Beta Dose from Skin Contamination

- Gamma dose is not an indicator of skin dose from contamination
- Dose coefficients based on radionuclides deposited on or near the skin surface are used
- Dose coefficients are nearly constant for average beta energies greater than 0.1 MeV

Beta Dose from Skin Contamination

- A dose coefficient for skin of $9 \text{ rem h}^{-1} \text{ per } \mu\text{Ci cm}^{-2}$ of skin can be used
 - Accounts for potential presence of an external backscatter surface
 - For contaminated gloves, a dose-reduction factor of 0.5 is assumed
- The VARSKIN code can be used where an assumption of uniform large-area contamination is inappropriate

Beta Dose from Skin Contamination

- Skin contamination is to be based on measurements when available
 - Information is provided to guide estimates of skin contamination based on measurements expressed in terms of dose or exposure rate

Conclusions on Beta Dose From the 99 Cases

- Beta-particle doses from standing on contaminated ground are calculated by applying a beta-to-gamma ratio to an upper-bound gamma dose
- Committee was concerned that uncertainties in gamma doses may be underestimated in some cases. This could lead to...
 - Underestimates of credible upper-bound gamma doses and consequently
 - Underestimates of beta-particle doses

Conclusions on Beta Dose From the 99 Cases

- Uncertainties are not estimated for the beta-to-gamma ratios. However...
 - Beta-to-gamma dose ratios depend on the time since detonation and the distance from the source to the exposed tissue
 - Errors in dose ratios may result in substantial uncertainties of beta-to-gamma dose ratios
- Committee found that beta components of skin doses are questionable

Conclusions on Beta Dose From the 99 Cases

- Skin or clothing contamination was not considered a pathway for skin dose.

However...

- Some participants took multiple showers for decontamination
- Presumably contaminated dirt was brushed from troops with brooms
- A contemporaneous report indicated that contamination was found frequently on the clothing and bodies of persons on ships

Conclusions on Beta Dose From the 99 Cases

- “Minor radiation burns” were seen on personnel who were below decks on the USS *Phillip* when vents were opened during a period of fallout
- Contamination estimates were not made for troops potentially contaminated while marching or working. However...
 - Published articles on the subject exist in Health Physics
- Committee regarded neglect of skin contamination as important with respect to skin cancer claims

Uncertainty for External Beta Doses from Contaminated Surfaces

- The NTPR program did not perform uncertainty analyses for beta-particle dosimetry
- They concluded that enormous resources would be needed to
 - quantify uncertainties in model parameters
 - propagate uncertainty of each model parameter to obtain overall uncertainty
- The program relied on arguments that dose estimates were “high-sided”

Uncertainty for External Beta Doses from Contaminated Surfaces

- The argument included the statement that in some comparisons the beta-to-gamma dose ratios in use were...
 - in reasonably good agreement with previous calculations
 - in reasonably good agreement with available measurements
 - at worst, overestimated the measurements by a factor of 2-3

Uncertainty for External Beta Doses from Contaminated Surfaces

- No discussion of factors that might cause underestimation of beta doses, such as
 - errors in estimating time since detonation
 - underestimates of distances from contaminated surfaces
 - underestimates of exposure times

Uncertainty for External Beta Doses from Other Pathways

- No discussion of uncertainty of beta doses for
 - beta-particle doses from immersion in air
 - beta-particle doses from immersion in water
 - beta-particle doses from skin contamination

References

- Barss, N. M. 2000. Methods and Applications for Dose Assessment of Beta Particle Radiation. McLean, VA: Science Applications International Corporation;, Report SAIC-001/2024.
- Black, R. H. 1962. Some Factors Influencing the Beta-Dosage to Troops. Health Physics 8: 131-141
- Morgan, K. Z. 1946. Final Report of the Alpha, Beta Gamma Survey Team, August 6, 1946 (excerpt located in Case #57).
- Schwendiman, L. C. 1958. Probability of Human Contact and Inhalation of Particles. Health Physics 1:352-355.

Review of Findings in the NAS Atomic Veterans Report on Procedures and QA

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Procedures

- According to DTRA their SOPs and 32 CFR 218 serve as the written guidelines and procedures for the conduct of dose reconstructions
- However the committee found that ...
 - The SOPs are a statement of approach and general principles rather than a manual of procedures used to reconstruct doses
 - The SOPs are incomplete, are out of date
 - They contain no references to supplement the text
 - Many methods used to estimate doses or upper bounds are not discussed
 - Details of the reconstruction methods are neither discussed nor referenced

Procedures

- The SOPs provided to the committee contain a provision for periodic review and updating
- However...
 - The SOPs had not been modified since 1997
 - Significant changes had occurred in the program
 - An example is the routine assessment of beta dose to skin that began in 1998
 - Important because claims filed for skin cancer have risen dramatically since 1997
- QA is not discussed in any detail in the SOPs

QA

- The QA procedures were a proprietary part of the contractor's proposal and not seen by the committee
- However, the random sample of 99 case files contained little evidence of uniform application of basic QA measures
 - Dose calculations were usually not signed, dated, or initialed by the analyst
 - Many of the typed assessments included typed initials of analysts and dates, but several did not
 - In files containing several recalculations of dose, the lack of dates made it difficult to determine which was the most recent

QA

- Poor quality control resulted in errors in the calculation or reporting of dose...
 - A reported dose failed to account for a film-badge exposure during an earlier test series (case #2)
 - A participant was assumed to be present during GREENHOUSE for less time than indicated by his service record (case #2)
 - A dose memorandum referenced an incorrect unit dose report (case #84)
 - A dose report assigned 0.4 rem but the referenced memorandum gave 0.8 rem (case #87)
 - A dose memorandum and a letter from NTPR to the veteran give the dose as 1.0 rem, but the database had 1.8 rem (case #88)

QA

- Dose assessments were supposed to be reviewed before release to VA or to the veteran
 - Dose assessments transmitted to VA or the veteran indicated final approval by signature of the DTRA program manager. However...
 - Files generally contained no documentation to show that the reviews occurred or by whom

QA

- The committee did not see a written process by which the NTPR program reviewed its documents
- Published reports of the NTPR program did not indicate that they had been subjected to peer review
- Some reports contained erroneous technical statements, which suggested to the committee that effective peer review had not occurred

Conclusion on Procedures and QA

- In the committee's view, the lack of a manual of standard operating (including QA) procedures led to inconsistencies in dose reconstructions