



BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

Upton, Long Island, New York 11973

(516) 282-4214
FTS 666

Radiological Sciences Division
FAX (516) 282-5810

August 19, 1992

Mr. Stewart Schneider
U.S. Nuclear Regulatory Commission
Division of Regulatory Operations
Office of Nuclear Regulatory Research
5650 Nicholson Lane, ML-007
Rockville, MD 20582

Dear Stewart:

As you requested, as part of our work on FIN A-3990, we have reviewed EPRI Report Number TR-100048 "Threshold Levels for Nonstochastic Skin Effects from Low-Energy Discrete Radioactive Particles", dated April 1992. This report summarizes only the low-energy (Co-60 and Ca-45) studies done at PNL for EPRI using 3-mm and 11-mm diameter discrete sources. It is therefore of limited value in understanding and predicting effects of "hot particles", which can be much smaller and higher in energy. We note the following:

1. The PNL studies do not conflict with BNL studies since we use much smaller (~ 0.25 mm) sources with higher energy emissions.
2. The PNL studies can best be compared to those of Hopewell et al. (1,2), although the definitions of end points scored are somewhat different.
3. It is remarkable that the PNL report does not refer to Hopewell's results for Pm-147 since that source has a maximum beta particle energy of 0.225 MeV, nearly the same as that for Ca-45 (0.252 MeV) and Co-60 (0.314 MeV). We have used the data in ICRP Publication 59 to estimate Hopewell's ED_{50} values for doses averaged over 1 cm^2 and at 50- μm depth to permit comparisons with the PNL data. Results are as follows for Hopewell's 2-, 5-, and 9-mm diameter Pm-147 sources.

9312300050 920819
PDR TOPRP EXIEPRI
C PDR

<u>Source</u>	<u>Study</u>	<u>ED₅₀ (Gy)*</u>	<u>Comment</u>
3 mm Co-60	PNL	~ 150	Open sores
3-11 mm Co-60	PNL	~ 60	Skin Disturbance
3-11 mm Ca-45	PNL	~ 60	Skin Disturbance
2 mm Pm-147	Hopewell	~ 11	{ Acute epidermal necrosis { Dose at 50 μm estimated at 1/2 that at 16 μm
5 mm Pm-147	Hopewell	~ 62	
9 mm Pm-147	Hopewell	~ 180	

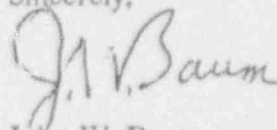
* Dose averaged over 1 cm² at 50-μm depth is tissue estimated using data in ICRP 59 to adjust doses for area differences.

It should be noted that Hopewell reports results for Pm-147 as "acute epidermal necrosis" or "acute epithelial breakdown". The "open sores" in the EPRI study for Co-60 probably reflect primarily effects from gamma dose.

4. Assuming the PNL end point referred to as "skin disturbances" is approximately the same end point as Hopewell's acute necrosis, the results for Ca-45 (ED₅₀ ~ 60 Gy for both 3- and 11-mm diameter sources) are in good agreement with the 5-mm diameter Pm-147 data of Hopewell (62 Gy).
5. Hopewell's ED₅₀ values for 2-mm and 9-mm diameter Pm-147 sources are lower (11 Gy) and higher (180 Gy), respectively, than the PNL data for 3- and 11-mm diameter Ca-45 sources. These data thus confirm the old point Jack Bell and we have made that for particles ≥ 1-mm diameter smaller particles are more effective in producing deterministic effects than larger particles for the same dose averaged over 1 cm² or dose expressed as β particles emitted from a source.
6. One might think that results reflect differences in end point definitions, especially since PNL included erythema in its definition of "skin disturbance". Note, however, that data on Figure 5-1 indicate that 30% of the observations at 40 Gy showed "skin Disturbances" for both 3- and 11-mm diameter Ca-45 sources. Since only 3 spots were given this dose for each source (one on each animal per source), the results indicate one "skin disturbance" for each source. The related data on Figures 5-4 and 5-5 each show one result scored as "scaly" at 4 Krad (40 Gy). Thus, these two scaly results account for all the Ca-45 disturbances at 40 Gy (4 Krad). Therefore, it is concluded that the "disturbance" being scored is "scaly" and not simply "erythema" for these two low-dose points. This again suggests a correspondence between Hopewell's acute necrosis and PNLs "scaly" end points.
7. The dosimetry results presented are interesting and useful, however, the details of the exposure apparatus are not sufficient to judge how well the sources were held in place, how much backscatter should be expected, if dosimetry measurements were made with the same backscatter, etc. It is of some interest to note that the low-energy betas from Ca-45 and Co-60 are attenuated significantly in the 250-μm thick sources and the 20-μm thick aluminum cover of the sources. This causes the biological and dosimetry results to reflect what might be expected from even lower energy unshielded sources.

In conclusion, these results do not conflict with BNL results and, in our opinion, tend to confirm some of the Hopewell data. They do not add much to our understanding of the limits that should apply for 0.1- to 1-mm diameter particles, and leave the question of a threshold for Co-60 in doubt due to the self absorption in the sources and the 20- μ m thick aluminum windows (5.4 mg/cm²) employed on the sources.

Sincerely,



John W. Baum
Division Head
Radiological Sciences Division

JWB/kr

cc: J. Bell, NRC
J. Buchanan, NRC
A.L. Carsten
D. Kaurin
C. Slavinsky