Contact Dose Rates from Encapsulated Sources

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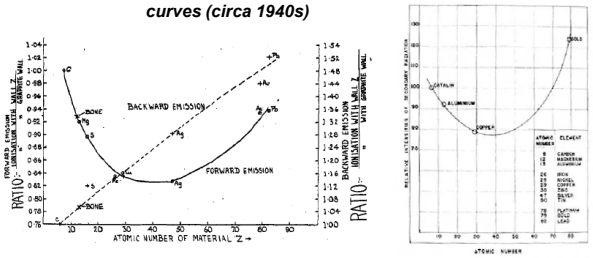
Overview: Significant levels of secondary electron radiation are emitted from the surface of sealed sources. Accurate quantification of the hazard is essential to accurate contact dose estimation. The contribution of secondary electrons to the total dose rate is examined and variation from previously accepted values for contact dose rates are presented.

Objective

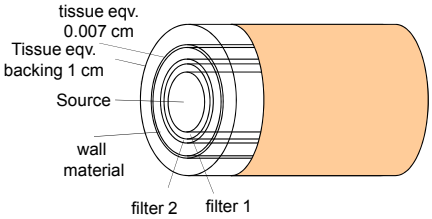
- Determine the contribution of secondary electron radiation in the contact dose rate and compare to published values for ^{137}Cs, ^{60}Co, ^{192}Ir and ^{226}Ra
- Generate revised contact dose rates from Monte Carlo modeling software and compare this to results published in NCRP Report No. 40

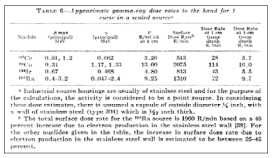
Original secondary electron curves (circa 1940s)



Methodology

The Monte Carlo radiation transport code MCNPX 2.6e, was used to create encapsulated source models based on those reported by Benner (1941) and Quimby, Marinelli, & Blady, (1939)





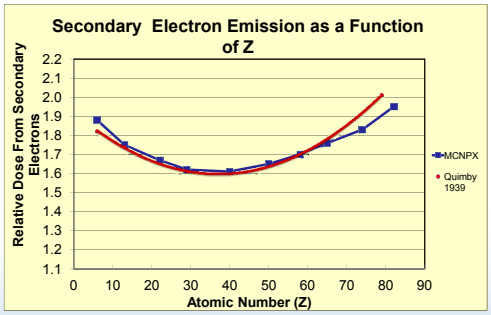
Results

- Initially, MCNPX was used to generate gamma dose rate constants, which were found to be within 10% agreement of published values (Unger & Trubey, 1982)

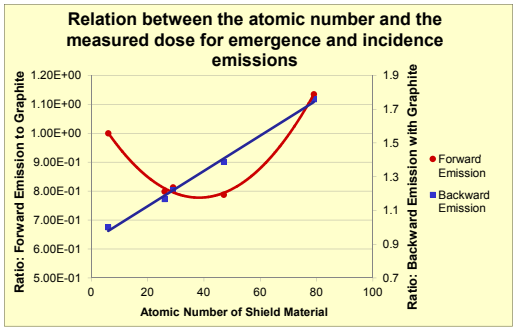
Gamma Ray Dose Constant at 1 metre

Isotope	mSv h^{-1} MBq^{-1}		
	ORNL	MCNPX	%diff
Cs-137	1.07E-04	1.01E-04	6.3
Co-60	3.69E-04	3.73E-04	1.0
Ir-192	1.63E-04	1.51E-04	7.2
Ra-226	3.13E-04	3.00E-04	4.0

- Relative contribution of secondary electrons were modeled and compared to literature (Quimby, Marinelli, & Blady, 1939) with good agreement



- Forward and backward electron emissions were modeled and compared to literature (Wilson,1941) with good agreement.



- Contact dose rates were modeled and found to be a factor of 3-4 times lower than those published in NCRP 40.

Surface Dose Rates

Isotope	mSv h^{-1} MBq^{-1}		
	NCRP40	MCNPX	%diff
Cs-137	8.32	1.83	78
Co-60	33.6	9.88	71
Ir-192	13.2	2.92	78
Ra-226	21.2	7.67	64

Conclusions

It has been found that NCRP40 published contact dose rates are higher by a factor of 3-4 than those estimated in this work. The implication is that dose calculations based on NCRP40 values will overestimate dose and lead to underestimated risk when compared to biological indicators.

References

[1] Benner, S. (1931). *On Secondary β-Rays from the Surface of Radium Containers.* Acta Radiologica [Old Series], 401-412.

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