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Radiation Safety Memo

To: D. Beavis, Chair, CAD Radiation Safety Committee

From: P. K. Job, PSD Radiation Physicist

Subject: Dose Calculations for ERL Seams using FLUKA

Ref: Memo dated July 8, 2014 to RSC

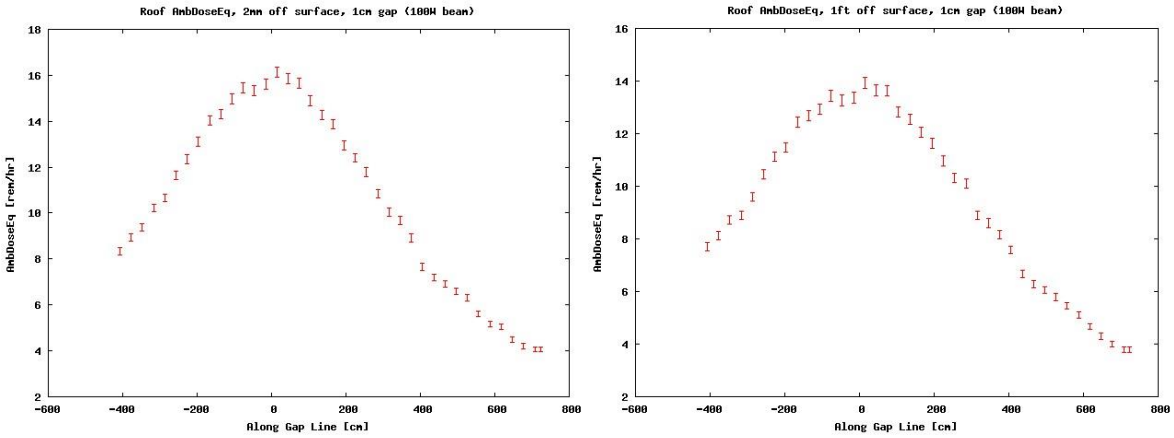
Date: January 20, 2015

There are series of seams on roof and lateral wall of the ERL concrete shielding. Calculations had been carried out by D. Beavis using MCNP Monte Carlo program (Memo dated July 8,2014) to evaluate the radiation dose rates at the seams while ERL is operating. One of these calculations has been modelled by FLUKA Monte Carlo program to gain better confidence in the MCNP dose estimates.

The concrete shielding of the ERL enclosure is 122 cm thick normal density concrete (density 2.35 g/cm^3). The electron beam is 300 cm from the closest lateral wall and roof. The energy of the electron beam is taken as 3.5 MeV at 100 watts of beam power. 100 watt beam corresponds to 6.44x10^{17}e/h. The maximum width of the seams is taken as 1 cm. This configuration has been modelled in FLUKA. The enclosure has air at atmospheric pressure. Calculations have also been repeated without air in accelerator enclosure for better comparison with the MCNP results. The beam loss of 100 W is assumed to be taking place directly across the seam location at the beam line. The beam loss is simulated as scattering of the full beam from a 10 cm long 2 mm diameter copper target.

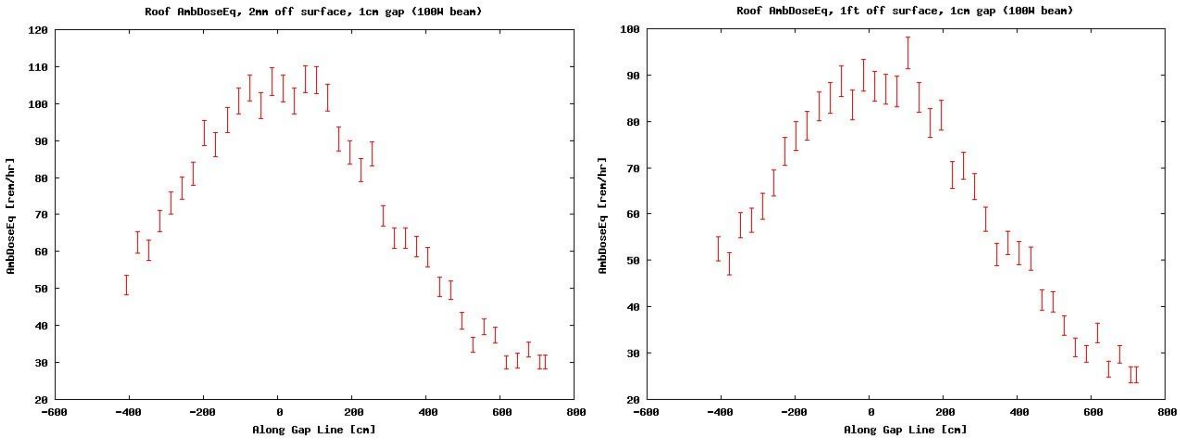
Ambient dose equivalent rates have been calculated on contact and at 30 cm from the roof and lateral wall seam surfaces.

Figures 1 and 2 give the dose rates on contact and at 30 cm from the seam of 1 cm shield gap with air in the enclosure when 100W electron beam of 3.5 MeV is lost at the copper target directly across the seam.



Figures 1 &2 Ambient Dose Equivalent Rates at the Seams of 1 cm on Contact and at 30 cm for 100 W Beam loss with air inside the accelerator enclosure

The calculations have been repeated for the same configuration without simulating air scattering inside the accelerator enclosure. This configuration had been simulated with MCNP program and the result provided a convenient point for comparison. Figures 5 and 6 give the dose rates on contact and at 30 cm from the seam of 1.0 cm shield gap without air in the enclosure when 100W electron beam of 3.5 MeV is lost at the copper target directly across the seam.



Figures 5 &6 Ambient Dose Equivalent Rates at the Seams of 1 cm on Contact and at 30 cm for 100 W Beam loss without air in the enclosure

The dose results at 30 cm from the seam surface show excellent agreement with the MCNP result for 1 cm wide seams without air scattering inside ERL accelerator enclosure.

Table 1 Summarize the dose rate results from FLUKA calculations for the ERL roof and lateral seams.

Table 1 Summary of FLUKA Dose Rate Results

	Shield Gap	Maximum dose rate at the shield gap surface **(rem/h)**		
		MCNP at 30 cm	FLUKA at 30 cm	FLUKA on contact
With air scattering in the enclosure	1 cm	--	14	16
Without air scattering in the enclosure	1 cm	91	90	105

Conclusion

The FLUKA dose rate results without simulating air scattering inside the accelerator enclosure agree well with the available MCNP result for 1 cm wide seams reported by Dana Beavis in his memo dated July 8, 2014 to the CAD Radiation Safety Committee.

Cc: Robert Lee
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