

# Measurement of Bremsstrahlung Radiation with Electron Beam Energy

R. P. Srivastava, P. P. Chaurasia, G. Prasiko, A. K. Jha

Dept. of Radiation Oncology, B. P. Koirala Memorial Cancer Hospital Bharatpur, Chitwan, Nepal  
*e-mail: rajup@operamail.com*

## ABSTRACT

A Klystron powered dual photon energy electron linear accelerator 2300 C/D from Varian Associates has been installed in our center. From the radiological safety view as well as treatment planning, the output (contamination) of Bremsstrahlung Radiation with electron beam energy determined accurately. It has been found 0.5% to 4.7% with increasing the electron beam energy which is the clinically not much significant in the treatment of the malignant diseases with the treatment of electron beam.

**Keywords:** Bremsstrahlung, water phantom, ionization chamber, electron applicator, and symmetry.

## 1. INTRODUCTION

In 1970s, high-energy linear accelerators, having photon and multi-energy electron beam facilities, became practice in clinical use. Clinac 2300C/D from Varian Associates Inc. USA, a klystron dual photon energy 6 and 20 MV and 6 different electron beam with nominal energies of 6, 9, 12, 15, 18 and 22 Mev has been installed and commissioned in B. P. K. M. Cancer Hospital Bharatpur. The unit is isocentric at 100 cm TSD. The Clinac is facilitated with asymmetric collimators, MLC, dynamic wedge, arc therapy etc. Beam characteristics (flatness, symmetry depth dose etc) of these electron energies are studied for various field size using electron applicator. These parameters are bounded to vary from one linac to another linac and need to be ascertained for each machine. With electron beam treatment, the dose in a patient is contributed by bremsstrahlung interaction of electrons with collimator, chamber, scattering foil etc. The x-ray contamination dose from linac depends on its collimation system. The physical properties and contamination of x-ray of the available six electron energies were studied.

## 2. MATERIALS AND METHODS

After the installation, initial quality acceptance procedure was carried out as per procedure given in literature. Ass measurements were carried out using Radiation field analyzer (Wellhofer water Phantom) 3D water phantom dosimetry system. The chamber has an effective volume 0.13 cc Radiation field was centered on the field probe surface center and the reference probe was mounted in the corner of electron applicator. Beam characteristics for all electron energies for various size applicators have been studied. Electron beam parameters like  $R_p$ ,  $E_{p,0}$  etc were obtained using IAEA, TRS-277 protocol. The formula for these is:

The following empirical relation relates the most probable energy at the surfaces to the practical range,

$$E_{p,0} = C_1 + C_2 R_p + C_3 R_p^2, \text{ where } C_1 = 0.22 \text{ Mev}, C_2 = 1.98 \text{ Mev/cm and } C_3 = 0.0025 \text{ Mev/cm}^2$$

$$\text{So that, } E_{p,0} = 0.22 + 1.98 R_p + 0.0025 R_p^2$$

This equation is valid for large field sizes and for most of the existing accelerators.

The mean energy at the Phantom surface is

$$E_0 = 2.33 R_p$$

This formula is valid for large field sizes and in the energy range 5 to 35 Mev.

Energy Mev	$R_{p50}$ cm	$R_{p100}$ cm	$R_p$ cm	$E_{p,0}$ Mev	$E_0$ Mev	Contamination of x-ray.
6	2.28	1.03	3.01	6.20	5.32	0.5%
9	3.5	2	4.33	8.84	8.15	1%
12	4.75	2.83	5.98	12.15	11.06	1.87%
15	6.23	2.20	7.51	15.23	14.52	2.43%
18	7.4	2.05	8.98	18.20	17.24	3.8%
22	8.57	1.22	10.86	22.02	19.96	4.7%

All the data's are tabulated.

### 3. RESULTS

From the central axis depth dose various parameter which were determined are tabulated in table 1 % range. Energy parameter ( $R_p$ ) is found to be independent of field size and increase with increasing energy. As field size increase more electrons are scattered from the edges into the irradiated volume towards the central axis so that the percentage depth dose increase with field size nearing the maximum  $R_p$ . The contamination of x-ray increases with increasing the energy of electron beam. Its value increases from 0.5 to 4.7% depending on the energy. Beam flatness and symmetry in cross plane and in plane were measured for all electron energies and found to be well with in the acceptable limits.

### 4. DISCUSSION AND CONCLUSION

All clinically significant characteristic parameters of electron beam 6,9 12,15,18, and 22 Mev from 23 clinac 2300 C/D have been studied. The characteristics of these electron beams are found to be satisfactory result. Small amount of Bremsstrahlung x-ray contamination becomes critical for to all body electron irradiation such as in the treatment of Mycosis fungoids. So that such type of treatment will be possible in BPKMCH in the near future.

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