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S. SALMAN AHMAD
KHURSHID ANWAR
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Health Physics Division
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ABSTRACT

The Farmer Dosemeters received from the Atomic Energy Medical Centre (AEMC) Jamshoro were calibrated using the NPL Secondary Standard Therapy level X - ray exposure meter in the Secondary Standard Dosimetry Laboratory (SSDL) at PINSTECH. The results of the calibration are presented in this report.

INTRODUCTION

The dosemeters received from the Atomic Energy Medical Centre Jamshoro for calibration consist of the following components:

1. Farmer Dosemeter type 2570 Ser No. 223
2. Ionization chamber type 2571 Ser No. 341 with build up cap type 2571 (0.3 MeV to 2 MeV)
3. Reference check source type 2503/3 Ser No. 2020, 10mCi Strontium-90
4. Ionization chamber type 2581, Ser No. 134 with build up cap type 2581 (0.3 MeV to 2 MeV)
5. Ionization chamber No. R 17888 (10 to 100 KeV)
6. Farmer Secondary Standard Dosimeter type 2502, Ser No. 10274.

The Farmer Dosemeter type 2570, is a portable instrument and is designed for routine measurements in Radiotherapy Departments, Diagonostic X-ray Departments and in all applications where portability and precise measurements are important. The following three chambers are supplied and calibrated by Nuclear Enterprises with this dosemeter.

a) The 0.03 cc soft X-ray chamber which covers the energy range 10 to 60 KeV and an intensity range from 3 m Gy/S (18 rad/min) to 75 Gy/S (450 k rad/min).

b) The guarded stem 0.6 cc, Farmer ionization chamber 2571 which covers the energy range 50 KeV to 2 MeV (and up to 35 MeV with additional phantoms) and an intensity range exceeding 70 μ Gy/S (0.4 rad/min) to 0.7 Gy/S (4000 rad/min) for continuous radiation and up to 0.25 m Gy per pulse (0.025 rad/pulse).

c) The thin window 600 cc ionization chamber 2575 which covers an energy range from 10 KeV to 2 MeV and an intensity range exceeding from 80 n Gy/S (0.45 m rad/min 28m rad/h) to 0.5 m Gy/S (3 rad/min-180 rad/n).

Strontium-90 reference check sources are available for these chambers to allow the periodic verification of the integrity of the calibration of each chamber. Among many, the following are the important features of the Farmer Dosemeter 2570;

i) Fully auto-corrected digital readout with keyboard entry of pressure, temperature and chamber correction factor;

ii) Keyboard entry of time for measurement of dose and exposure;

iii) Operators error is minimized by arrangement of controls. Information display indicates mode of operation, corrections applied, dose range multiplier and unit of measurement.

iv) Provision of conveniently storing 0.6 cc ionization chamber within the instrument.

v) A build-in quartz crystal clock for accurate timing.

The Farmer Dosemeter type 2502 Ser No.10274 is an old Farmer system which was manufactured by Nuclear Enterprises sometime in late sixties. The last calibration of this dosemeter with 0.6 cc ionization was carried out by Nuclear Enterprises in sometimes June 1971. The dosemeter is still in good working condition.

CALIBRATION ARRANGEMENT AND PROCEDURE

Throughout the X-ray calibration the focus to chamber distance was 100 cm. The field size at chamber position was 12.5 cm . The allignment of the chamber position in the central axis of the beam was done using laser beams and telescope.

At each radiation quality the secondary standard chamber and the chamber to be calibrated were placed alternately at the same focal distance on the central axis of the X-ray beam and their response were compared via transmission monitor chamber.

For gamma calibration each chamber was fitted with the available build-up cap. The field size at chamber position was 10 cm x 10 cm.

SECONDARY STANDARD DOSIMETER

NPL Secondary Standard Therapy Level X-ray exposure meter consisting of a measuring assembly type 2560 Ser. No. 149 and / an ionization chamber type 2561 Ser. No. 160, was used as a reference dosemeter for the X-ray exposure meter consisting of a measuring assembly type 2560 Ser. No. 173 and ionization chamber type 2561 Ser. No. 200, was used for gamma ray calibration. These two secondary standard dosemeters have already been calibrated against a free air chamber (Primary Standard) at the National Physical Laboratory (NPL) Teddington U. K.

RESULTS AND DISCUSSIONS

The results of the calibration of each ionization chamber are presented in Table I - III over the whole energy range i. e. from 100 kV generating potential up to CO-60 radiation quality the error associated with the measurements is unlikely to exceed $\pm$ 2.0 %. Inspite of the fact that there are several manual control in the Farmer Dosemeter type 2502, it has shown very consistant results. The dosemeter is still in a good working condition.

The results of the reference check source measurement of the ionization chamber Ser. No. 341 connected with Farmer Dosemeter type 2570 Ser. No. 223 and with Sr. 90 check source type 2503/3 Ser. No. 220 were found in good agreement with the quoted values by the Nuclear Enterprises. Whereas, the results of the reference check source measurement for the other two chambers Ser. No. 364 & 134 were not provided by Nuclear Enterprises. Results of the reference check source measurements are presented in table IV & V.

Table I Radiation qualities and calibration factors corrected to ambient conditions of 20 C° and 760 mm Hg

X-RAY CALIBRATION

Farmer Dosemeter Ionization Chamber			Type 2570 Type 2571		Ser No. 223 Ser No. 341
Generating Potential	Added filter (mm)		HVL (mm)		Multiplying factor
(KV)	Cu	Al	Al	Cu	
100	-	3.4	4.0	-	1.023
135	0.38	1.0	-	0.5	1.009
180	0.60	1.0	-	1.0	0.997
220	1.57	1.0	-	2.0	0.993
250	1.94	1.0	-	2.5	0.978

COBALT-60 CALIBRATION

At Co-60 radiation quality the multiplying factor is 1.01 and it is valid only when the chamber is fitted with the build-up cap.

The above calibration factors were obtained on 31.7.84. If at any time, it is suspected that the instrument has received any damage which may affect the calibration or if the reference check source measurements of the dosemeter indicate abnormal reading then the instrument should be sent for recalibration. Normally the calibration of the instrument is valid for three years.

The calibration factors in apparent multiplying factors are given in Roentgen/Scale division, the instrument reading in apparent in scale division corrected for ambient condition of temperature and pressure multiplied with the corresponding calibration factor gives the exposure in roentgen.

Table II: Radiation qualities and calibration factors corrected to ambient conditions of 20 C^{o} and 760 mm Hg

X-RAY CALIBRATION

Farmer Dosemeter Ionization Chamber			Type 2570 Type 2581		Ser No. 223 Ser No. 134
Generating Potential	Added filter (mm)		HVL		Multiplying factor
(KV)	Cu	Al	Al	Cu	
100	-	3.4	4.0	-	1.393
135	0.38	1.0	-	0.5	1.293
180	0.60	1.0	-	1.0	1.258
220	1.57	1.0	-	2.0	1.251
250	1.94	1.0	-	2.5	1.244

COBALT-60 CALIBRATION

At Co-60 radiation quality the multiplying factor is 1.255 and it is valid only when the chamber is fitted with the build-up cap.

The above calibration factors were obtained on 31.7.84. If at any time, it is suspected that the instrument has received any damage which may affect the calibration or if the reference check source measurements of the dosimeter indicate abnormal reading then the instrument should be sent for re-calibration. Normally the calibration of the instrument is valid for three years.

The calibration factors in apparent multiplying factors are given in Roentgen/Scale division, the instrument reading in apparent in scale division corrected for ambient condition of temperature and pressure multiplied with the corresponding calibration factor gives the exposure in roentgen.

Table III: Radiation qualities and calibration factors corrected to ambient conditions of 20 C^{o} and 760 mm Hg

X-RAY CALIBRATION

Farmer Secondary Standard Dosemeter Ionization Chamber			Type 2502 Type -		Ser No. 10274 Ser No. 364
Generating Potential	Added filter (mm)		HVL (mm)		Multiplying factor
(KV)	Cu	Al	Al	Cu	
100	-	3.4	4.0	-	1.034
135	0.38	1.0	-	0.5	0.965
180	0.60	1.0	-	1.0	0.998
220	1.57	1.0	-	2.0	1.004
250	1.94	1.0	-	2.5	1.004

COBALT-60 CALIBRATION

At Co-60 radiation quality the multiplying factor is 1.029 and it is valid only when the chamber is fitted with the build-up cap.

The above calibration factors were obtained on 31.7.84. If at any time, it is suspected that the instrument has received any damage which may affect the calibration or if the reference check source measurements of the dosemeter indicate abnormal reading then the instrument should be sent for recalibration. Normally the calibration of the instrument is valid for three years.

The calibration factors in apparent multiplying factors are given in Roentgen/Scale division, the instrument reading in apparent in scale division corrected for ambient condition of temperature and pressure multiplied with the corresponding calibration factor gives the exposure in roentgen.

The electrical leakage test for the ionization chambers Ser. No. 341 and 134 was carried out and no appreciable leakage was detected. Whereas, in the case of ionization chamber Ser. No. 364 connected with Farmer Secondary Standard Dosemeters used in long irradiation measurements, the leakage correction must be taken into account.

TABLE IV: FARMER DOSEMETER TYPE 2570 Ser. No. 223

IONIZATION CHAMBER 0.6 cc	TYPE 2571	Ser. No. 341
REFERENCE CHECK SOURCE Sr-90 10 mCi	TYPE 2503/3	Ser. No. 2020 (3203 BA)
The reference check source reading was found 55.66 R for an exposure time of 250.0 seconds, at 1013 m bar, 20 C^{o} on 29.7.84.		
IONISATION CHAMBER 0.6 cc	TYPE 2581	Ser. No. 134
REFERENCE CHECK SOURCE Sr-90 10 mCi	TYPE 2503/3	Ser. No. 2020 (320 3 BA)
The reference check source reading was found 45.24 R for an exposure time of 250.0 seconds at 1013 m bar, 20 C^{o} on 1.8.84.		

TABLE V: FARMER SECONDARY STANDAR DOSEMETER TYPE 2502 Ser. No. 10274.

IONIZATION CHAMBER 0.6 cc	TYPE-	Ser. No. 364
REFERENCE CHECK SOURCE Sr-90 10mCi	TYPE-2503/3	Ser. No. 2020 (3203 BA)
The reference check source reading was found 43.80 R for an exposure time of 200 seconds, at 1013 m bar, 20C^{o} on 30.7.84.		