
APPLICATION NOTE

RTI Electronics AB, Sweden

September, 1992



RTI Electronics

Göteborgsv. 97 / ing 50
SE-431 37 MÖLNDAL
SWEDEN

Phone: Int+ 46 31 746 36 00
Fax: Int+ 46 31 270 573

Comparison between the PMX-III dosimeter with the MX solid state detector and different dosimeters with ion-chambers

This application note describes a comparison study of four different conventional dosimeters with ion-chamber were tested and compared to a PMX-III with a MX solid state dose detector. The dosimeters used were two different Radcal models 1015, one Radcal model 2025 and one Digi-X Plus with a PRM ion-chamber. The comparison study showed that the PMX-III with the MX solid state detector can be used instead of an dosimeter with ion-chamber.

By

R&D Department , RTI Electronics AB
Ulf Toll
Stefan Horn

Equipment used

Four different dosimeters with ion chambers were compared to a PMX-III with an MX detector. The goal was to determine how well the solid state dose detector behaved compared with some commonly used dosimeters and ion-chambers. The following dosimeters were used:

Dosimeter #1

Radcal/MDH model 1015 with the 10X5-6 ion-chamber

Dosimeter #2

Radcal/MDH model 1015 with the 10X5-6 ion-chamber

Dosimeter #3

Radcal/MDH model 2025 with the 20X5-3 ion-chamber

Dosimeter #4

Digi-X Plus with a PRM 30 cc ion-chamber , model D-30DX

Dosimeter #5

PMX-III with an MX-detector/ADI type B(C)

Measurements

A calibration record was only available for the PRM chamber and therefore the Digi-X Plus with the PRM chamber was selected as the reference for these measurements. To start with all the Radcal dosimeters were compared to the reference.

The following general measuring conditions apply:

Generator:	Siemens Triplex 1023
Type:	3-phase/12-p
SDD:	100 cm
Total filtration:	3.0 mm Al
HVL at 80 kV:	3.1 mm Al
Temp:	24°C
Air pressure:	1010 mbar

Both the reference chamber and the tested chamber were placed in free air to avoid scattered radiation, see the Figure 1. It is important to remember that all ion-chambers are normally calibrated in free air. In normal use, this is not always the case, often the ion-chamber is placed on top of or close to the table.

Exposure dose was tested at four different kV settings and dose rate was tested at two different kV settings.

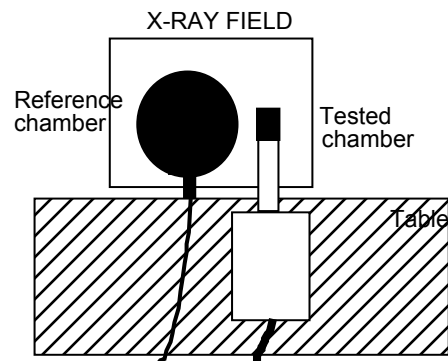


Figure 1.

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The readings from the reference chamber were corrected for temperature and pressure and corrected for the energy dependence according to the calibration record. The corrected values are shown in column "DX/PRM corr".

The results are shown in Table 1, 2 and 3. The results show that all three dosimeters perform very well compared to the reference.

Note that it is very important to set the air pressure compensation on the Radcal model 1015 to the correct value or at least close to the correct value. The scale on this control is from 600 to 1050 mbar. This will give a compensation factor from 1.7 to 0.97 that can drastically influence on the reading if set incorrectly.

kV	mA	ms	DX/PRM mR	DX/PRM corr mR	Radcal 1015 mR	Difference %
60	100	100	57.2	59.2	60.2	-1.7
80	100	100	88.3	91.6	93.6	-2.1
100	100	100	120.8	125.2	129	-2.9
120	100	100	154.1	159.7	164	-2.6
FLUORO	mA		R/min	R/min	R/min	
80	2	-	0.869	0.901	0.93	-3.1
100	2	-	1.352	1.402	1.45	-3.3

Table 1. Radcal Model 1015 (Dosimeter #1) compared with the reference.

kV	mA	ms	DX/PRM mR	DX/PRM corr mR	Radcal 1015 mR	Difference %
60	100	100	56.7	58.8	57.8	1.7
80	100	100	89.5	92.7	91.3	1.5
100	100	100	127.7	132.2	130	1.7
120	100	100	154.1	159.7	158	1.1
FLUORO	mA		R/min	R/min	R/min	
80	2	-	0.904	0.937	0.944	-0.7
100	2	-	1.449	1.502	1.49	0.8

Table 2. Radcal Model 1015 compared with the reference.

kV	mA	ms	DX/PRM mR	DX/PRM corr mR	Radcal 2025 mR	Difference %
60	100	100	55.9	57.9	58.0	-0.1
80	100	100	87.1	90.2	91.7	-1.6
100	100	100	121.9	126.4	129.5	-2.4
120	100	100	156.4	162.1	166.0	-2.3
FLUORO	mA		R/min	R/min	R/min	
80	2	-	0.932	0.966	0.982	-1.6
100	2	-	1.408	1.459	1.508	-3.2

Table 3. Radcal Model 2025 compared with the reference.

The next step was to compare PMX-III dosimeter and the MX solid state detector with a dosimeter with ion-chamber. The Radcal model 1015 was selected. The first measurement was made in free air, see Figure 2.

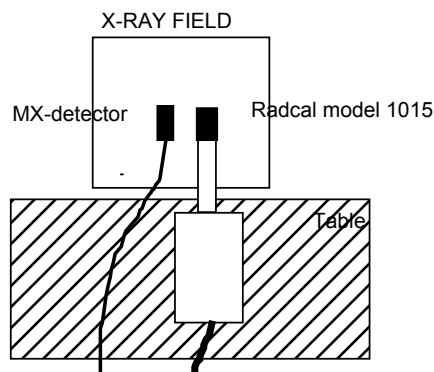


Figure 2.

The measurements show that the PMX-III dosimeter measures very well compared to the Radcal model 1015, maximum difference is -3.2%, see table 4. If no correction is made for the energy dependence of the MX-detector, the maximum difference is -11.7 %.

The readings from the PMX-III were corrected for the energy dependence according to the calibration record. Note that this correction is automatically made if the software oRTIgo is used.

kV	mA	ms	PMX/MX mR	PMX/MXcorr mR	Radcal 1015 mR	Difference %
60	100	100	56.2	55.7	57.0	-2.3
80	100	100	90.4	94.0	94.6	-0.6
100	100	100	121.4	128.7	131.4	-2.1
120	100	100	145.2	162.6	164.5	-1.2
FLUORO	mA		R/min	R/min	R/min	
80	2	-	0.938	0.957	0.984	-2.7
100	2	-	1.366	1.448	1.496	-3.2

Table 4. PMX-III with the MX-detector compared to Radcal model 1015

One important difference between an ion-chamber and the MX-detector is that the MX-detector is not sensitive to back scatter. This makes it possible to place the MX-detector directly on top of a table without introducing a measuring error. This is not the case for an ion chamber.

To test this the Radcal model 1015 ion chamber and the MX-detector was placed on "table" made of different materials:

- Lead
- Wood
- Plexi-glass

Figure 3 shows the measuring setup. The source-detector distance is unchanged, i.e. 100 cm.

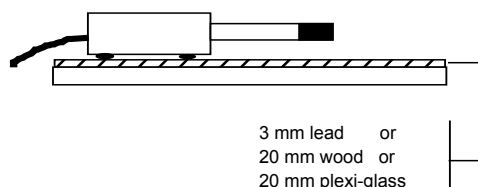
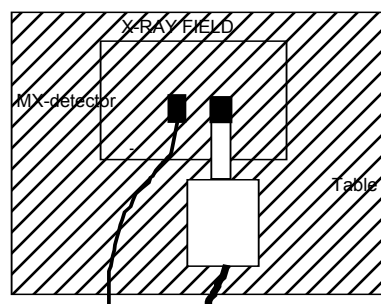


Table 5, 6 and 7 shows the result.

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This change of reading was not observed with PMX-III and the MX-detector because the MX-detector is protected from back scatter by a lead shield.

A significant change in the readings from the Radcal model 1015 ion-chamber was noticed when the ion-chamber was placed directly on the table, i.e. not in free air.

kV	mA	ms	PMX/MX mR	PMX/MXcorr mR	Radcal 1015 mR	Difference %
60	100	100	61.2	60.6	74.1	-18.2
80	100	100	99.0	101.0	122.6	-17.6
100	100	100	127.9	135.6	164.8	-17.7
120	100	100	155.8	174.5	209	-16.5
FLUORO	mA		R/min	R/min	R/min	
80	2	-	1.00	1.02	1.251	-18.5
100	2	-	1.456	1.543	1.885	-18.1

Table 5. The ion-chamber and the MX-detector were placed on top of a table with 3 mm of lead.

kV	mA	ms	PMX/MX mR	PMX/MXcorr mR	Radcal 1015 mR	Difference %
60	100	100	64.3	63.6	74.6	-14.7
80	100	100	100.7	102.8	120.5	-14.7
100	100	100	130.3	138.1	162.6	-15.1
120	100	100	155.6	174.3	202	-13.7
FLUORO	mA		R/min	R/min	R/min	
80	2	-	1.028	1.049	1.230	-14.7
100	2	-	1.449	1.536	1.800	-14.7

Table 6. The ion-chamber and the MX-detector were placed on top of a table with 20 mm of wood.

kV	mA	ms	PMX/MX mR	PMX/MXcorr mR	Radcal 1015 mR	Difference %
60	100	100	61.5	60.9	72.9	-16.5
80	100	100	97.5	99.5	119.4	-16.7
100	100	100	133.1	141.0	169.5	-16.8
120	100	100	158.0	177.6	210	-15.4
FLUORO	mA		R/min	R/min	R/min	
80	2	-	1.035	1.056	1.28	-17.5
100	2	-	1.442	1.529	1.83	-16.4

Table 7. The ion-chamber and the MX-detector were placed on top of a table with 20 mm of plexi-glass.

Conclusion

These measurements show that the PMX-III dosimeter with the MX solid state detector can replace a dosimeter with ion-chamber. The PMX-III and MX-detector measured within $\pm 4\%$ compared with four different dosimeters with ion-chamber. The most common argument against the solid state detector is that the energy dependence is greater than that for an ion chamber. This is sometimes true, but it will not cause any problem in practice. The correction is easy to make by using the calibration chart supplied. If the software oRTIgo is used the correction is made automatically.

The solid state detectors are not designed to be as general as ion chambers. They are designed to be suitable for QC and service applications. Taking into account all benefits of the solid state detector:

- Not sensitive to back scattering effect
- No bias voltage needed
- Small size, very sensitive compared to the volume
- Durable
- No TP-correction
- Less expensive than an ion-chamber

The MX-detector is a good replacement for an ion-chamber in a lot of different applications especially for QC and service work. In addition to this, the PMX-III instrument is small and compact. The included dosimeter is easy to use since it has:

- Auto-range
- Automatic drift compensation, i.e. a measured value will remain stable in the display when the exposure ends
- Auto reset before each new measurement
- Automatic detector identification; the PMX-III instrument automatically senses type connected detector. The calibration factor, measuring unit for dose and rate, energy correction data, serial number and more are stored in the ADI module.

However, there are some things to be aware of when comparing the MX-detector with an ion chamber:

1. Measure in free air when using the ion-chamber since it is sensitive to back scatter. The MX-detector will not be influenced by back scatter.
2. Set the control for air pressure compensation when using the Radcal model 1015 with an ion chamber. If the used dosimeter does not have correction for temperature and air pressure, make this correction manually.

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