Radcal Corporation

Model 2026C Radiation Monitor Controller

Manual

Radcal part # MNL/2026C
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Warranty for the Model 2026C Radiation Monitor Controller

Radcal Corporation warrants that, in the event that any defects in material or workmanship should develop within one year of the date of shipment, the company assumes full responsibility for servicing equipment of its manufacture without charge upon return of the equipment to Radcal, with shipping costs prepaid by the customer. Costs to return-ship to customers will be paid by Radcal if the repairs are warranty-applicable.

Radcal shall not be held liable for damages or delays caused by defects beyond making repairs or furnishing replacement parts, nor shall Radcal be liable for any defective material replaced without Radcal's consent during the period of this warranty. Radcal reserves the right to perform warranty services at its own factory.

This warranty specifically excludes batteries.

Non-Warranty Repairs

The calibration of this instrument was correct within specified limits when the instrument left our factory. Radcal cannot be responsible for injury or damage resulting from improper use or calibration errors which develop subsequent to our shipment of the instrument.

If Radcal determines that a fault has been caused by misuse, abnormal operating conditions, or repairs by unauthorized personnel during the warranty period, repairs and shipping costs will be billed at normal rates.

If the equipment is found to be in proper working condition, Radcal will return-ship the equipment at customer expense.

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Introduction

This manual introduces you to Radcal Corporation's Model 2026C Radiation Monitor Controller. It provides you with the information necessary to set up, test and use the 2026C. Appendices to the manual provide specifications for its use with various sensor assemblies, and other useful information. Instructions for set-up and use are provided in an easy-to-use, step-by-step format.

The 2026C system complies with the CE marking requirements of the European Union. The model 2026C system with 20X6 sensors is functionally identical to the 2026 with 20X5 sensors.

Features

The 2026C extends the capabilities of the 20X6 converter/ion chamber assemblies by providing direct readout in radiation units for each sensor type, automatic sensor identification, automatic temperature compensation and an electronic chamber bias supply.

Operation is controlled by three push-buttons: *Rate, Dose,* and *Off.*

A *Test* button simulates an ion chamber signal.

A 16-character LCD display provides messages and measurements.

Readout is calibrated in Grays or Roentgens. Selection of the units can be made in the field. (The 2026C is **not** compatile with SI-calibated 20X5 sensor assemblies.

A comprehensive self-test is performed each time power is applied.

6 AA cells provide 200 hours of operation; they are easily replaced by the user.

The 2026C reads out correctly for the selected sensor. Do not scale readings for the 20X6-.6, -.18, -6M, -60, and -1800 cc sensors.

Chamber bias voltage in the 2026C comes from an electronic power supply.

The 2026 provides automatic temperature compensation by correcting all measurements to 22 °C.

Barometric pressure corrections should be made unless you have the Barometric Pressure option in your instrument.

The controller shuts off after 10 minutes of inactivity to extend battery lifetime.

Specifications

Compatible sensor assemblies:

All 20X6 series and

20X5-0.18	20X5-0.6	20X5-3
20X5-3CT	20X6-6	20X5-6M
20X5-60	20X5-60E	20X5-180
20X5-1800		

Display:

16-digit, dot-matrix, liquid-crystal.

Controls:

Rate, Dose, Test and *Off* push-buttons.

Bias voltage:

Low-noise electronic bias supply, +275 V nominal.

Power:

6 externally accessible AA cells.
200 hours operating time.

Measurement modes:

Dose Integrate and Dose Rate. See tables for performance specifications for the various sensors.

Performance:

Accuracy:	4% of reading, 1 digit, 2 times resolution
Repeatability:	1% of reading, 1 digit, 2 times resolution
Energy response:	See sensor specifications.
Maximum dose rate:	See sensor specifications.

Automatic temperature compensation:

The accuracy of the correction is equivalent to measuring the difference in temperature between ambient and the reference

temperature, 22 °C, with an accuracy of 0.5 °C plus 10% of the difference. (At 45 °C, the correction factor is 1.08; the compensation will apply a factor of 1.07 to 1.09.)

Automatic pressure compensation (optional):
The accuracy of the correction is equivalent to measuring the difference in pressure between ambient and the reference pressure, 101.3kPa, with an accuracy of 0.4 kPa plus 2% of the difference. (At 600 kPa, the correction factor is 1.69; the compensation will apply a factor of 1.66 to 1.72.)

Automatic sensor identification with user override.

Measurement in Gy or R (selected with an internal jumper).

Automatic power-off after 10 minutes of inactivity (extends battery lifetime).

Self-test includes display test, display of battery voqJage and test of bias supply-sensor integrity.

Compliance:

- Meets Generic Immunity Standard EN 50082-2 requirements for radiated susceptibility, conducted susceptibility, electrostatic discharge, and electrical fast transients.
- Meets EN 55011 requirements for radiated emissions of electromagnetic energy for Class A devices.

Environment:

Operating:	5 °C to 45 °C
	< 95% RH, without condensation
Storage:	-40 °C to +65 °C

Sensor Performance - Roentgens

Sensor	Rate				Dose			
	Minimum	Resolution	Maximum	Noise	Minimum	Resolution	Maximum	Leakage
20X6-0.18	0.02 R/min	0.01 R/min	10 kR/min	40 mR/min	1 mR	1 mR	2.4 MR	0.5 mR/sec
20X6-0.6	0.01 R/min	0.01 R/min	10 kR/min	20 mR/min	0.3 mR	0.3 mR	1.4 MR	0.3 mR/sec
20X6-3	1 mR/min	1 mR/min	1 kR/min	2 mR/min	0.03 mR	0.03 mR	144 kR	20 μR/sec
20X6-3CT	1 mR/min	1 mR/min	1 kR/min	2 mR/min	0.03 mR	0.03 mR	144 kR	20 μR/sec
20X6-6	1 mR/min	1 mR/min	1 kR/min	2 mR/min	0.03 mR	0.03 mR	144 kR	20 μR/sec
20X6-6M	1 mR/min	1 mR/min	1 kR/min	2 mR/min	0.03 mR	0.03 mR	144 kR	15 μR/sec
20X6-60,60E	0.1 mR/min	0.1 mR/min	100 R/min	0.2 mR/min	3 μR	3 μR	14 kR	2 μR/sec
20X6-180	1 mR/hr	1 mR/hr	1 kR/hr	2 mR/hr	1 μR	1 μR	2.4 kR	0.4 μR/sec
20X6-1800	0.1 mR/hr	0.1 mR/hr	65 R/hr	0.2 mR/hr	0.1 μR	0.1 μR	240 R	40 nR/sec

Sensor Performance - Grays

Sensor	Rate				Dose			
	Minimum	Resolution	Maximum	Noise	Minimum	Resolution	Maximum	Leakage
20X6-0.18	3 μGy/sec	1 μGy/sec	1.5 Gy/sec	4 μGy/sec	5 μGy	5 μGy	21 kGy	3 μGy/sec
20X6-0.6	2 μGy/sec	1 μGy/sec	1.5 Gy/sec	2 μGy/sec	3 μGy	3 μGy	12 kGy	2 μGy/sec
20X6-3	0.2 μGy/sec	0.1 μGy/sec	150 mGy/sec	0.4 μGy/sec	0.3 μGy	0.3 μGy	1.2 kGy	0.2 μGy/sec
20X6-3CT	0.2 μGy/sec	0.1 μGy/sec	150 mGy/sec	0.4 μGy/sec	0.3 μGy	0.3 μGy	1.2 kGy	0.2 μGy/sec
20X6-6	0.2 μGy/sec	0.1 μGy/sec	150 mGy/sec	0.4 μGy/sec	0.3 μGy	0.3 μGy	1.2 kGy	0.2 μGy/sec
20X6-6M	0.2 μGy/sec	0.1 μGy/sec	150 mGy/sec	0.2 μGy/sec	0.3 μGy	0.3 μGy	1.2 kGy	0.2 μGy/sec
20X6-60,60E	0.02 μGy/sec	0.01 μGy/sec	15 mGy/sec	0.02 μGy/sec	0.03 μGy	0.03 μGy	120 Gy	15 nGy/sec
20X6-180	0.01 mGy/hr	0.01 mGy/hr	8.8 Gy/hr	20 μGy/hr	5 nGy	5 nGy	21 Gy	4 nGy/sec
20X6-1800	1 μGy/hr	1 μGy/hr	570 mGy/hr	2 μGy/hr	0.5 nGy	0.5 nGy	2.1 Gy	0.4 nGy/sec

Getting Started

This tells you how to assemble, operate and test the 2026C. No radiation is required for this procedure; the *Test* button simulates a radiation signal. You will need one of the 20X6 sensor assemblies listed above; the 20X6-6 is used in this example.

Assembly

To install the batteries, remove the battery cover and slide out the battery holder. Insert the AA cells according to the polarity markings on the holder. Put the holder back into the 2026C housing and snap the access cover back into place. Connect the cable from the 2026C to the sensor. This connection may be made directly, or through a 20C6-7 extension cable.

Turn-on

Press *Rate.* The 2026C will switch on and perform a self test, displaying information about the progress of the self test as it proceeds.

The tests and corresponding the display messages are:

Display test:
Confirm that all 16 character blocks on the display operate.

Read Only Memory test:

Prom ok

Version number:

Version X.XX

...where X.XX is the firmware version number.

Serial number:

Serial 26-0000

...where the 0000 is replaced with the controller serial number.

Power supply and battery test:

Battery OK v.vv V

...where v.vv is replaced with the battery voltage.

Converter test:

Converter OK

Pressure test (if the pressure option is installed):

Pressure ppp.p kPa

...where ppp.p is replaced with the measured pressure, or:

Ref to 101.3 kPa

...if the option is not installed.

Temperature test:

Temperature ttC

...where tt is replaced with the measured temperature.

Bias-Chamber-Converter integrity:

Chbr - Conv Ok

Following the self test, the 2026C identifies the sensor and displays **Chmbr 6cc.** This display remains for 10 seconds or until

you press *Dose* or *Rate*. Following sensor identification, the message **Bias Stabilizing** appears until the bias voltage reaches 90% of the nominal value. This usually takes about 10 seconds.

After the voltage reaches the 90% point, the system enters the Rate or Dose mode depending on which push-button was last pressed. The system is likely to be indicating that radiation is present, although that is not the case. The reading is due to turning on the electronic bias supply. It can take several minutes for these turn-on effects to die away.

Operational Test

For the operational test, we assume that you are using a 20X6-6 sensor, that the 2026C is set to read out in Roentgen units, and the sensor is not exposed to radiation. For other sensors the readings will vary inversely with the volume and directly with the time units. If the 2026C is set to read out in Grays, the readings will need to converted. (Divide R by 113 to get the equivalent Gy value.)

The 2026C display blanks when *Dose* or *Rate* is pressed. The operating mode changes, and the results are displayed as the button is released. The 2026C measures Dose or Rate, and can Measure or Hold readings in each. You switch between Hold and Measure by pressing the button corresponding to the mode you are in; to switch to the other mode, press the appropriate button. An arrow appears at the left of the display when the 2026C is making a measurement. The arrow blinks when the display is updated.

Press *Rate*. If the 2026C was off, allow it to complete the self test, identify the sensor, and allow the **Bias Stabilizing** message to be replaced by a measurement. If the display shows **Hld** at the left end, press *Rate* a second time.

With no radiation present, the displayed rate should fall to less than 2 mR/min within 5 minutes after turning power on. Self test con-

firmed that the ion chamber, bias supply and signal processing circuits worked. Thus, by observing a proper zero reading, the basic functioning of your system is confirmed. The arrow at the left of the display is on while a measurement is made, and blinks as the display is updated.

Press and hold the *Test* push-button. For the 20X6-6 sensor, the display should be **50.0 R/min** (any reading between 25 and 100 R/min is acceptable). Except for the first reading, the rate should vary less than 0.5 R/min during any 30-second interval. Press *Rate.* When the display changes to **Hld 50.0 R/min**, release *Test.* The arrow is no longer present. Note the value.

Press *Dose* (press it a second time if **Hld** appears at the left of the display). The arrow should come on, and in about a second it should blink and a numeric value (typically **0.00mR**) should appear. Then press and hold *Test* for six seconds. The display should be **5.0R**, or one-tenth the value you noted in the rate test, because you turned on *Test* for one-tenth of a minute. Press *Dose* and the display will change to **Hld 5.0 R.**

This concludes the operational test.

Description

The 2026C is a microprocessor-based control unit and power supply for use with 20X6 sensor assemblies.

The 2026C's microprocessor-based controls and display permit direct readout for all eight sensor assemblies, in either Roentgen or Gray units.

Power is obtained from six AA cells. The chamber bias is provided by an electronic bias supply.

Comprehensive self-test functions are provided, including a battery-voltage monitor and test of the Bias-supply - Ion chamber - Converter integrity.

The 2026C provides automatic recognition of ion chamber/converter assemblies by observing the signals produced as the chamber bias voltage is turned on.

Self Test

Self test checks the major elements of the 2026C hardware. If a problem is encountered, a description of the problem is displayed and the system waits for you to press *Dose* or *Rate* to acknowledge the problem, after which the test (usually) continues. In cases where the instrument could give seriously incorrect readings, the system will shut down or restart when you press the button.

The Display test checks the LCD and associated electronics by turning on each of the 16 7 by 9 dot character arrays and the associated underline cursor, and then turning them off. Be sure that there are no missing elements. Each character should be a solid array of rectangular elements except for the second line up from the bottom that separates the underline cursor from the character matrix. There is a single row of off elements between each character array.

The PROM test verifies the data stored in the Read Only Memory. **PROM ok** signals success. This test sums the PROM values to check that the programs and data are unchanged. If an error occurs, a 4-character code replaces the **ok** for use in analyzing the problem.

The message **Version 1.01** is the version number of the firmware installed in the Controller.

The message **Serial 26-0000**, where the 0000 is replaced with the controller serial number, is displayed. Use the serial number and the firmware version if you need to contact Radcal about your controller.

The next test verifies operation of the 2026C power supply and displays the battery voltage. The **Battery ok v.vv v.** test verifies that the power-supply is operating correctly in addition to checking the battery voltage. The message **Repl. Batt. v.vv v.** displays when the battery voltage falls below 5.25 volts; you must press *Dose* or *Rate* to continue self test. **Power error** is displayed when the internal voltages are out of regulation. The system will shut off after displaying this message for 20 seconds; it will restart if you press a push-button while the display is present.

The next test verifies that the current-to-frequency converter (the "converter" part of the sensor) is working properly. The converter is checked to be sure that the *Test* signal produces a minimum signal and that the converter is not overloaded. Leakage, noise and background radiation are not tested. **Converter ok** displays if the test is successful, **LED on fail, Conv Overload** and **Conv Negative** describe converter problems. See the troubleshooting section for information. **Conv Test Abort** will display if you interrupt the test by pressing *Rate* or *Dose*.

The measured temperature is displayed to test the temperature sensor. **Temperature23C** is displayed (the actual value is the measured control–unit temperature). You may check this against a

known ambient. +++ or --- is displayed if the temperature is out of the 5 to 45 °C operating range.

If the pressure transducer option is installed, **Press. 101.3 kPa** will be displayed. (The actual value is the measured atmospheric pressure.) **+++, ---** will be displayed if the pressure measurement read is outside the specified 60 to 105 kPa range.

The Bias-Chamber-Converter integrity test displays **Chmbr - Snsr ok** if the signal to the converter exceeds a minimum value. If no signal is measured, **NoChamberBias** is displayed. The message **Chbr Hi Leakage** is displayed if the signal is well above the maximum expected.

Sensor Identification

Sensor identification is based on the value of the signal produced by the sensor as the bias voltage is applied to the chamber. The value is compared to that expected for each of the eight sensors, and the first one that matches is selected as the proposed sensor. For example, if the value of the signal is within the range expected for a 60 cc sensor, the message **Chmbr 60cc** will be displayed. If the signal doesn't match any of the expected ones, the system defaults to the 3cc or 180cc sensor selections using identification codes wired into the converter. In this case, the display shows **Chmbr 3cc ?** or **Chmbr180cc?.** The **?** means that user action is required to proceed.

The selected sensor is displayed for 10 seconds. If you do nothing, that sensor will be selected. If you wish to change the sensor, press both *Rate* and *Dose* and hold them in for 0.5 seconds. This selects the next sensor from an internal list. Its description along with a **?** will be displayed; press *Rate* or *Dose* to select this sensor, or repeat pressing both buttons to select the next item in the list. Pressing the push-buttons eight times gets back to your starting point in the list. The 2026 remembers the override, and will automatically select the volume you chose the next time it encounters this signal pattern during turn-on.

When the sensor is selected by pressing *Rate* or *Dose* with the question mark showing, the "expected" value for the selected sensor is changed to match the value measured so the next time this sensor is encountered it will be correctly identified. At the same time, any other sensors whose "expected" values match this measured value are marked as invalid.

Operation

The 2026C is controlled by the *Rate, Dose* and *Off* push-buttons. Pressing *Rate, Dose* or both blanks the display. The new operating mode takes effect when the button is released. The both-push-buttons-pressed input used in the sensor-select logic decides that both push-buttons were pressed if they are pressed together for 0.5 seconds. If you release the push-buttons before this delay, the last push-button released will win and you'll end up measuring dose or rate rather than selecting another sensor. The push-button is effective when the push-button is released. *Off* activates the microcontroller reset pin, which shuts off the power supply.

The arrow at the left of the display shows that the 2026C is active. It is on while dose is being accumulated or while a *Rate* measurement is taking place. It blinks to show that the display is being updated.

A question mark at the right end of the display signals that the user should press either *Rate* or *Dose* to continue or resume operation.

Usually pressing *Rate* or *Dose* during a self test will end the display of that self-test result to speed up the test process. Pressing *Rate* or *Dose* while the Bias Stabilizing message is on the display starts a dose or rate measurement. You will likely get some very large readings if you do this; you have also bypassed the bias supply overload test.

Radcal recommends that you start operation of the 2026C in Rate mode. This shows you the measured rate as the bias supply turn-on

transient dies away, so you know when the system is stable enough to make the measurements that you require.

EAROM

The 2026C stores the "expected" values for the automatic sensor ID system in an Electrically Alterable Read Only Memory. You may reset these to the factory defaults by turning off the instrument, and then turning it on while holding the *Test* push-button. Following the battery test, the display will say **Hold Test to rst** for 5 seconds. The message will then change to **Rls Test to rst.** If you release the *Test* push-button within 5 seconds, the message **EAROM Reset** is displayed for 5 seconds and the self test resumes. If you release *Test* while **Hold Test to rst** is displayed, or if you leave *Test* pressed for more than 5 seconds while **Rls Test to rst** is displayed, the EAROM is not altered and **Not Reset** is displayed.

The EAROM also stores the controller serial number and calibration factors, including those for the temperature and pressure sensors. These are not altered by the **EAROM Reset** process.

Errors and Warnings

Above Snsr Rate

The ion chambers and the converter in the sensors become nonlinear above certain exposure rates. The 2026C monitors the exposure rate and displays **Above Snsr Rate** when that limit is exceeded. The limits are defined in the sensor tables.

Conv Overload

The converter output stops increasing (it does not, however, fold back) at about 20% above the maximum design current. This condition produces the message **Conv Overload,** replacing the **Above Snsr Rate** message.

Input too large, Input Zero

If the converter encounters an out of range signal during rate or dose measurements, the **Input too large, Input zero or -** messages are displayed. This can occur if the ion chamber is bumped during a measurement, or it can occur from electrical noise. It is unlikely to be caused by a radiation signal, because that causes the **Conv Overload** and **Above Snsr Rate** messages.

If these occur in Rate mode, the system will resume rate measurements when input error messages go away.

If input error messages occur in Dose mode, the 2026C goes to Dose Hold mode when the condition clears.

No Sensor

If you unplug the sensor while the system is operating, the 2026C recognizes this and displays the message **No Sensor.** This remains for 20 seconds, after which the system turns off. If a sensor is reconnected while the message is displayed, the 2026C restarts as if *Off* had been pressed.

Power Error

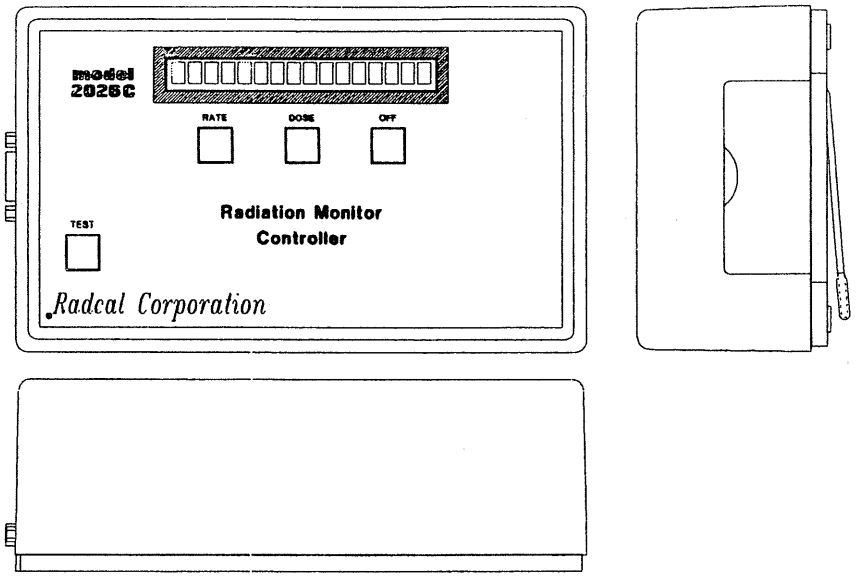
If the battery voltage falls to the point where the system accuracy is no longer within specifications, the message **Power Error** appears for 20 seconds, and then the system shuts off. Note that this is quite different from the 5.25-volt **Repl. Batt.** warning.

Repl. Batt.

During battery test, the message **Repl. Batt. v.vv v** will appear if the battery voltage is below 5.25 V. You should replace the 6 AA cell battery as soon as convenient. This is only a warning; the instrument is still operating within specifications.

Configuration

The overall configuration of the 2026C is shown in the drawing below.



Troubleshooting

This sections discusses what to do if an error message is displayed.

Power Error

Replace the AA batteries. The message means that the internal power supply is out of regulation, probably because the batteries are exhausted.

LED on Fail, Conv Overload and Conv Negative

The converter failed to respond to test signals. **LED on Fail** means that the *Test* function did not get the expected minimum

response; **Conv Overload** means that the converter was receiving a signal above the maximum the electronics can handle; and **Conv Negative** means that the converter did not respond at all to the Test signal. Retry the self test. This problem could be due to a faulty cable; try connecting the sensor directly to the 2026C. If you have one available, try a different sensor.

+++, ---

The temperature (or pressure, if it is installed) returned an out-of-range value. Pressing *Dose* or *Rate* will cause the system to default to using the reference values of 22C and 101.3kPa, without automatic compensation. If the parameter is actually outside of the operating range, the instrument accuracy is not known; however the display could also be due to a circuit fault. Repair and recalibration of these circuits requires specialized equipment available at Radcal and at Radcal authorized service centers.

No Chamber Bias

The converter failed to respond to application of bias voltage to the chamber. If the converter passed self test, it is likely that either the bias supply is not reaching the sensor, or that the ion chamber connection to the converter is open. Try connecting the sensor directly to the control unit to eliminate the possibility of a faulty cable. Try a different sensor to see if the problem is in the sensor. You cannot override this error.

Chbr Hi Leakage

The signal measured as the bias voltage turns on is above the maximum expected. This usually means there is a fault in the ion chamber. Repair of ion chambers must be done at Radcal. You cannot override this error.

Bias Voltage Low

If the bias voltage does not come into regulation within 20 seconds following the sensor ID process, the message **Bias Voltage Low** appears. This usually means that the bias supply is overloaded or has failed. Try connecting the sensor directly to the controller to see if the problem is in the interconnecting cable. Try a different sensor to see if the problem is in the senor. You cannot override this error.

EAROM Write Err, EAROM Read Err

These mean that the system is unable to write to or read from the EAROM, respectively. The system cannot be used. You cannot override this error.

Use of An External Power Supply

The 2026C imposes some special requirements on an external power supply.

The internal power supply does not provide ground isolation, so the positive terminal of the external power supply is connected to instrument ground.

The internal power supply was not designed to reject the 50 or 60 Hz ripple that is typically present in "Battery Eliminator" power supplies, so a regulated supply is required.

The external power supply must be able to supply about 1.5 A of pulse current to get the 2026C started; this is somewhat higher than available from commonly available battery eliminators.

If an external supply is to be used, it should provide a voltage between -6 and -9 VDC, regulated so noise and ripple are less than 0.1%, and capable of supplying 1.5 A peak current. It must also be isolated from power lines and the ground.

Appendix A - 20X6 sensor specifications

Specification tables, chamber energy dependence graphs, and chamber schematics begin on the next page.

20X6-0.18 Sensor

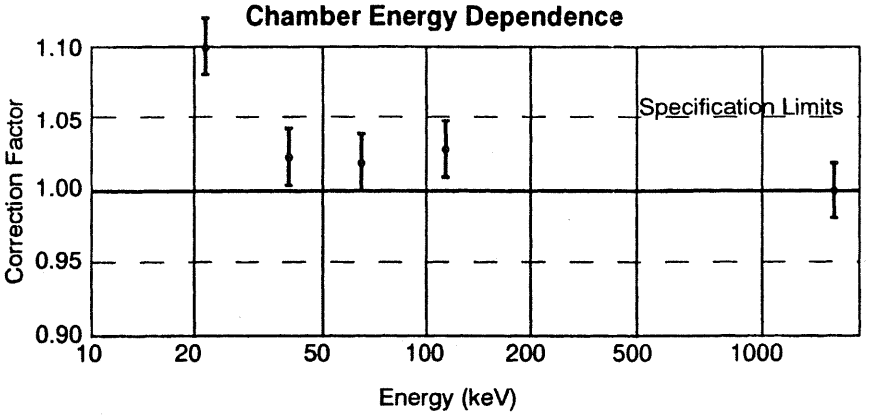
Measurement Performance

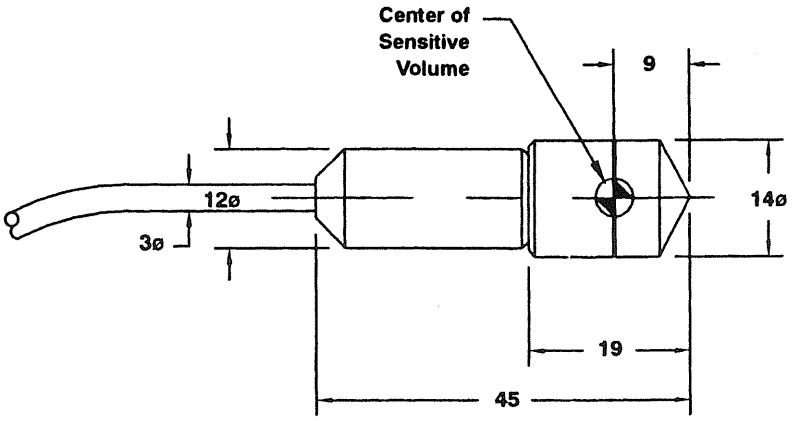
Rate		
Minimum	0.02 r/min	3 μGy/sec
Maximum	10 kR/min	1.5 Gy/sec
Resolution	0.01 R/min	1 μGy/sec
Noise	40 mR/min	4 μGy/sec
Dose		
Minimum	1 mR	5 μGy
Maximum	2.4 MR	21 kGy
Resolution	1 mR	5 μGy
Leakage	0.5 mR/sec	3 μGy/sec

Ion Chamber

Construction	Fully guarded; C552 air-equivalent walls and electrode; polyacetal exterior cap; 0.18 cm3 active volume; unsealed
Cable	3-meter, low-noise triax
Energy dependence	±5%, 45 keV to 1.33 MeV
Rate dependence	±2%, 10 R/h (100 mGy/h) to 650 kR/h (5.7 kGy/h) average
Calibration accuracy	±4% after temperature and pressure corrections using 60Co
Weight	0.30 kg

0.18 cc Ion Chamber





Dimensions in millimeters

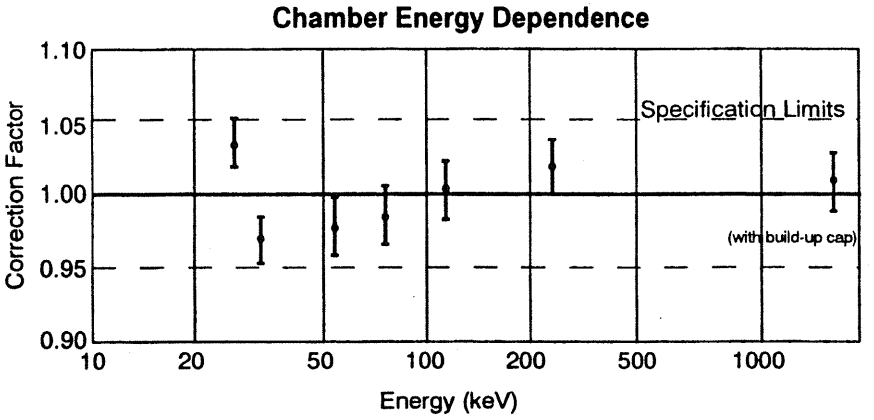
20X6-0.6 Sensor

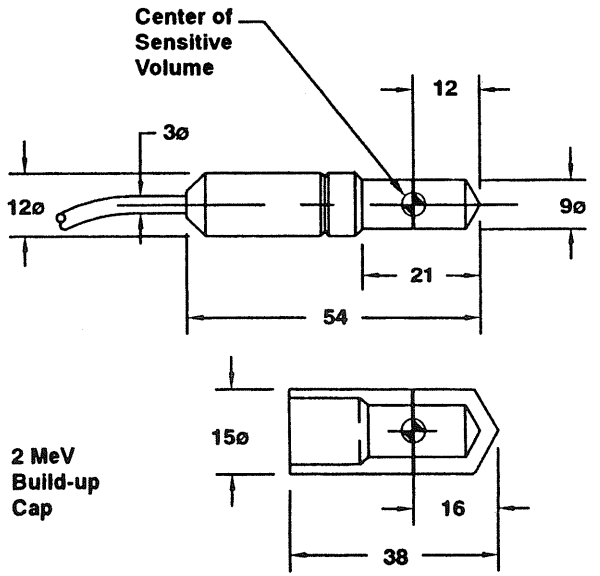
Measurement Performance

Rate			
	Minimum	0.01 R/min	2 μGy/sec
	Maximum	10 kR/min	1.5 Gy/sec
	Resolution	0.01 R/min	1 μGy/sec
	Noise	20 mR/min	2 μGy/sec
Dose			
	Minimum	0.3 mR	3 μGy
	Maximum	1.4 MR	12 kGy
	Resolution	0.3 mR	3 μGy
	Leakage	0.3 mR/sec	2 μGy/sec

Ion Chamber

Construction	Fully guarded; C552 air-equivalent walls and electrode; polyacetal exterior cap; 0.6 cm3 active volume; unsealed
Cable	12-meter, low-noise triax
Energy dependence	±5%, 40 keV to 1.33 MeV (with build-up cap)
Rate dependence	±2%, 0.6 R/min (6 mGy/min) to 6 kR/min (60 Gy/min) average
Calibration accuracy	±4% after temperature and pressure corrections using 60Co
Weight	0.48 kg





Dimensions in millimeters

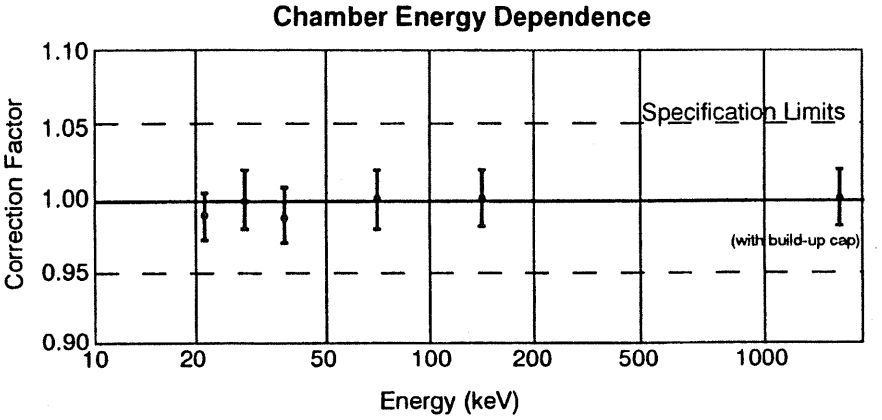
20X6-3 Sensor

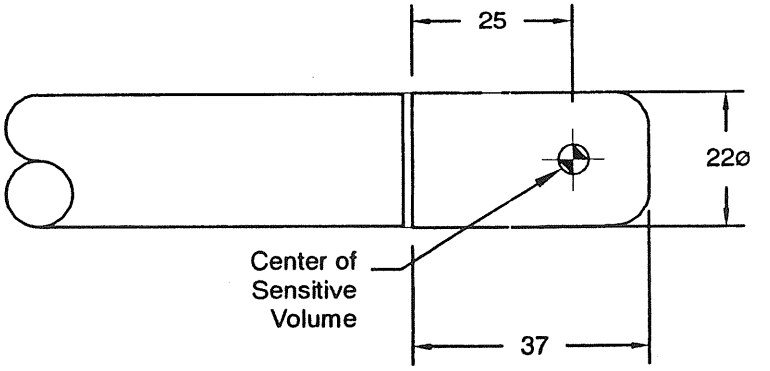
Measurement Performance

Rate		
Minimum	1 mR/min	0.2 µGy/sec
Maximum	1 kR/min	150 mGy/sec
Resolution	1 mR/min	0.1 µGy/sec
Noise	2 mR/min	0.4 µGy/sec
Dose		
Minimum	0.03 mR	0.3 µGy
Maximum	144 kR	1.2 KGy
Resolution	0.03 mR	0.3 µGy
Leakage	20 µR/sec	0.2 µGy/sec

Ion Chamber

Construction	Fully guarded; polycarbonate walls and electrode; conductive graphite interior coating; 3cm3 active volume; unsealed
Energy dependence	±5%, 20 keV TO 1.33MeV (With Build-up Cap)
Rate dependence	±5%, .02 R/Min (0.2 mGy/min) to 1000 R/min average and up to 500 R/s (5Gy/s) for 10 ms pulses
Calibration accuracy	±4% after temperature and pressure corrections at 150 kVp and 10.2 mm AL HVL
Weight	0.30 kg





Dimensions in millimeters

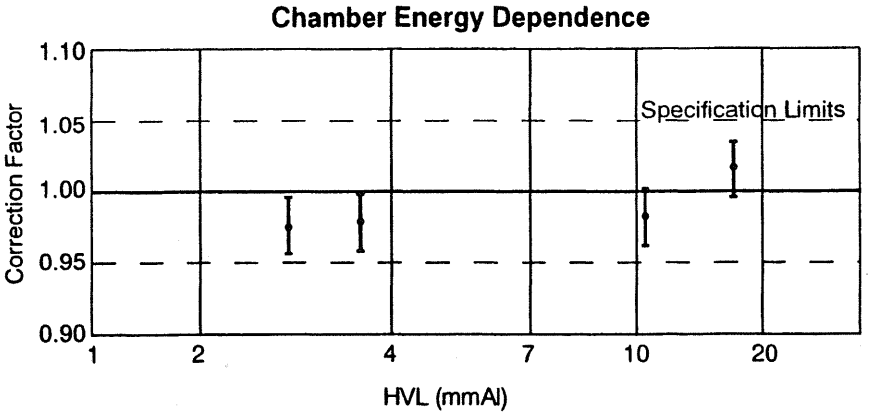
20X6-3CT Sensor

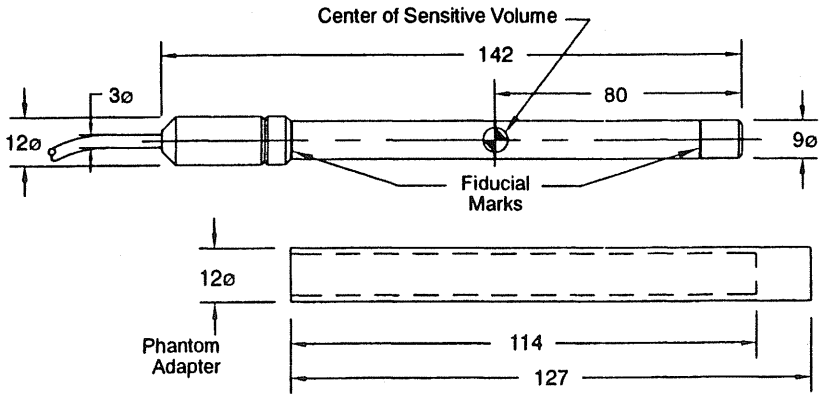
Measurement Performance

Rate		
Minimum	1 mR/min	0.2 μGy/sec
Maximum	1 kR/min	150 mGy/sec
Resolution	1 mR/min	0.1 μGy/sec
Noise	2 mR/min	0.4 μGy/sec
Dose		
Minimum	0.03 mR	0.3 μGy
Maximum	144 kR	1.2 KGy
Resolution	0.03 mR	0.3 μGy
Leakage	20 μR/sec	0.2 μGy/sec

Ion Chamber

Construction	Fully guarded; 9.1 mm dia.; active length 10 cm; polyacetal exterior cap; C552 air-equivalent walls and electrode; 3 cm3 active volume; unsealed
Uniformity of response	±5% to within 0.25 cm of chamber ends for constant volume slice
Cable	2-meter, low-noise triax
Energy dependence	±5%, 3mm Al to 20mm Al HVL
Rate dependence	±2%, 2 mR/s (0.2 μGy/s) to 40 R/s (300mGy/s) average
Calibration accuracy	±4% after temperature and pressure corrections at 150 kVp and 10.2 mm AL HVL
Weight	0.30 kg





Dimensions in millimeters

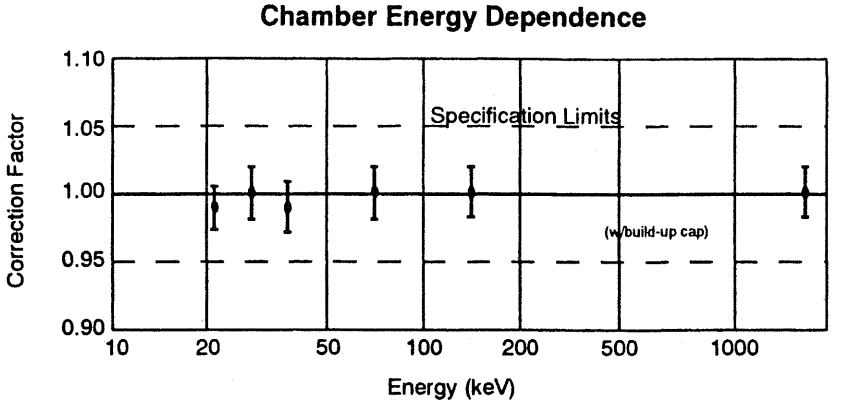
20X6-6 Sensor

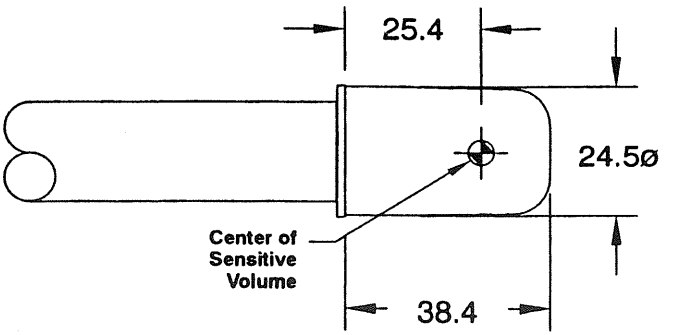
Measurement Performance

Rate		
Minimum	1 mR/min	0.2 μGy/sec
Maximum	1 kR/min	150 mGy/sec
Resolution	1 mR/min	0.1 μGy/sec
Noise	2 mR/min	0.4 μGy/sec
Dose		
Minimum	0.03 mR	0.3 μGy
Maximum	144 kR	1.2 KGy
Resolution	0.03 mR	0.3 μGy
Leakage	20 μR/sec	0.2 μGy/sec

Ion Chamber

Construction	Fully guarded; polycarbonate walls and electrode; conductive graphite interior coating; 6cm3 active volume; unsealed
Energy dependence	±5%, 20 keV TO 1.33MeV (With Build-up Cap)
Rate dependence	±5%, .02 R/Min (0.2 mGy/min) to 1000 R/min average and up to 500 R/s (5Gy/s) for 10 ms pulses
Calibration accuracy	±4% after temperature and pressure corrections at 150 kVp and 10.2 mm AL HVL
Weight	0.30 kg





Dimensions in millimeters

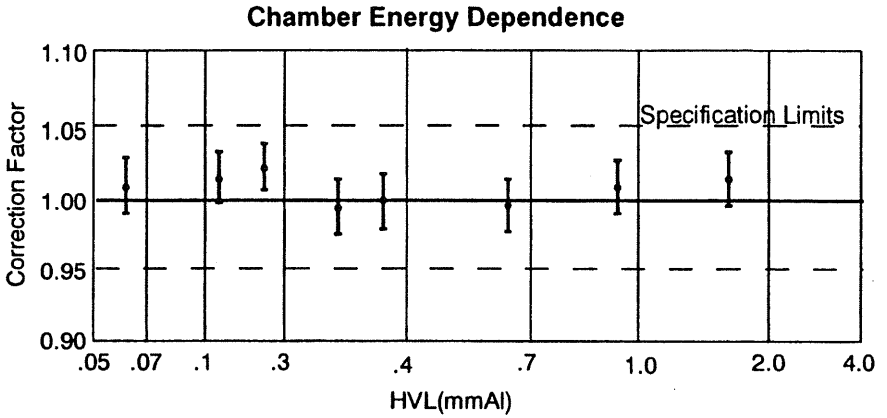
20X6-6M Sensor

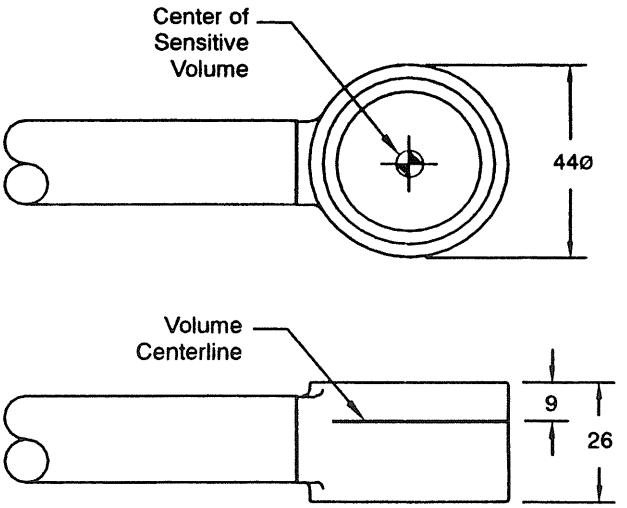
Measurement Performance

Rate		
Minimum	1 mR/min	0.2 µGy/sec
Maximum	1 kR/min	150 mGy/sec
Resolution	1 mR/min	0.1 µGy/sec
Noise	2 mR/min	0.2 µGy/sec
Dose		
Minimum	0.03 mR	0.3 µGy
Maximum	144 kR	1.2 KGy
Resolution	0.03 mR	0.3 µGy
Leakage	15 µR/sec	0.2 µGy/sec

Ion Chamber

Construction	Fully guarded; 0.7 mg/cm2 metallized polyester window; polyacetal exterior; 6cm3 active volume; unsealed
Energy dependence	±5%, 10 keV to 40 keV
Rate dependence	±5%, 0.02 R/min (0.2 mGy/min) to 600 R/min (6 Gy/min) average
Calibration accuracy	±4% after temperature and pressure corrections with lightly filtered x-rays at 20 kVp and 0.26 mm Al HVL
Orientation	Exposure to be centered on flat face.
Weight	0.32 kg





Dimensions in millimeters

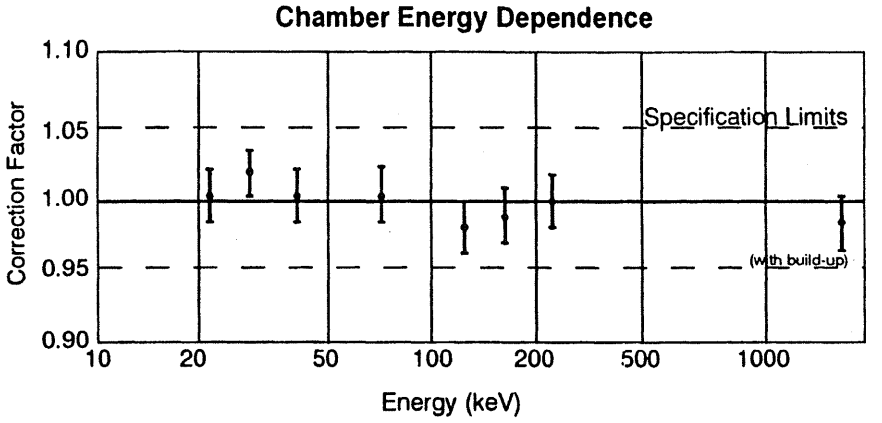
20X6-60 Sensor

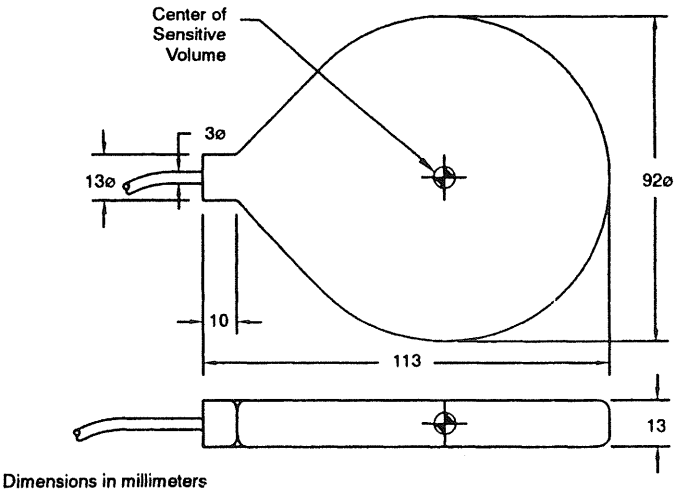
Measurement Performance

Rate		
Minimum	0.1 mR/min	0.02 µGy/sec
Maximum	100 R/min	15 mGy/sec
Resolution	0.1 mR/min	0.01 µGy/sec
Noise	0.2 mR/min	0.02 µGy/sec
Dose		
Minimum	3 µR	0.03 µGy
Maximum	14 kR	12 KGy
Resolution	3 µR	0.03 µGy
Leakage	2 µR/sec	15 nGy/sec

Ion Chamber

Construction	Fully guarded; polycarbonate walls; conductive graphite exterior coating; 60cm3 active volume; .030" wall; unsealed
Cable	3-meter, low-noise triax
Energy dependence	±5%, 20 keV to 1.33 MeV (with build-up material)
Rate dependence	±5%, 0.002 R/min (0.02 mGy/min) to 200 R/min (1.8 Gy/min) average
Calibration accuracy	±4% after temperature and pressure corrections at150 kVp and 10.2 mm Al HVL
Orientation	Exposure to be centered on flat face.
Weight	0.32 kg





Dimensions in millimeters

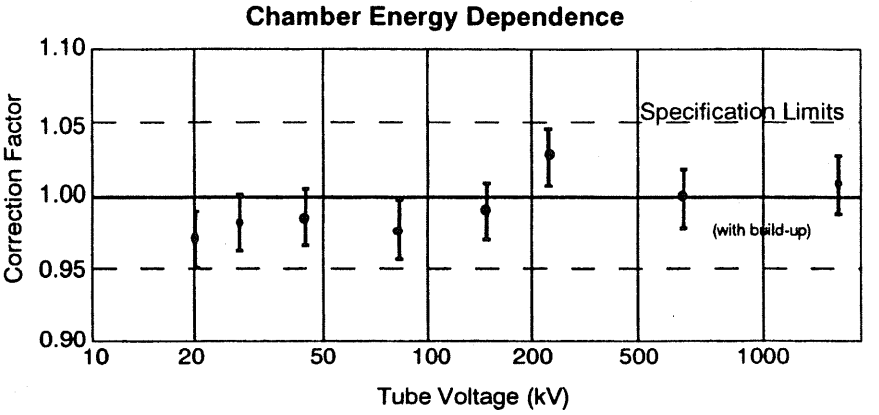
20X6-60E Sensor

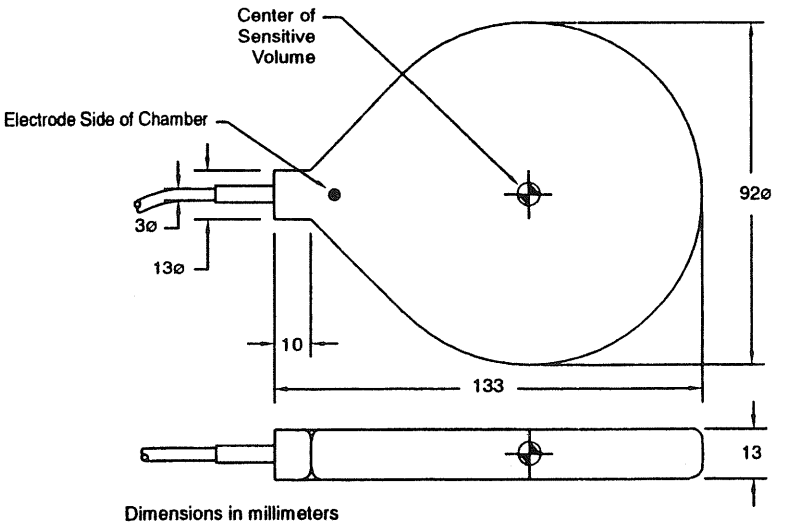
Measurement Performance

Rate		
Minimum	0.1 mR/min	0.02 µGy/sec
Maximum	100 R/min	15 mGy/sec
Resolution	0.1 mR/min	0.01 µGy/sec
Noise	0.2 mR/min	0.02 µGy/sec
Dose		
Minimum	3 µR	0.03 µGy
Maximum	14 kR	12 KGy
Resolution	3 µR	0.03 µGy
Leakage	2 µR/sec	15 nGy/sec

Ion Chamber

Construction	Fully guarded; polycarbonate walls; conductive graphite exterior coating; 60 cm3 active volume; .016" wall; unsealed
Cable	3-meter, low-noise triax
Energy dependence	±5%, 0.2MM Al HVL to 60Co (with build-up material)
Rate dependence	±5%, 0.002 R/min (0.02 mGy/min) to 200 R/min (1.8 Gy/min) average
Calibration accuracy	±4% after temperature and pressure corrections at 50 kVp and 0.88 mm Al HVL
Orientation	Exposure to be centered on flat face.
Weight	0.32 kg


Chamber Energy Dependence
Correction Factor
1.10
1.05
1.00
0.95
0.90
Specification Limits
(with build-up)
10
20
50
100
200
500
1000
Tube Voltage (kV)


Center of Sensitive Volume
Electrode Side of Chamber
3ø
13ø
10
133
92ø
13
Dimensions in millimeters

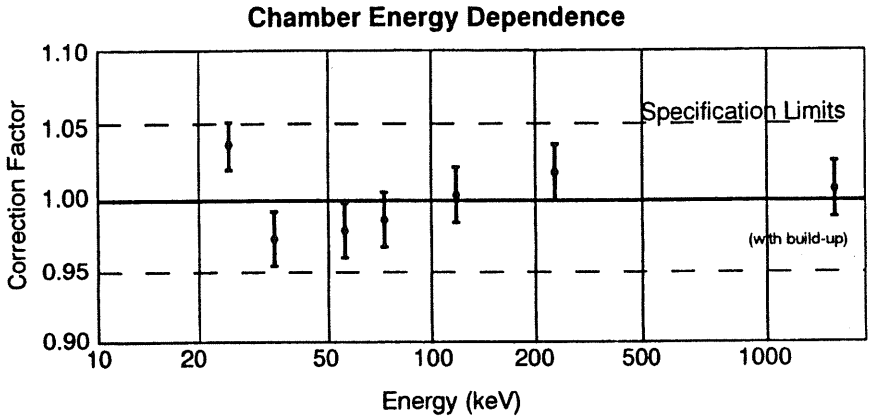
20X6-180 Sensor

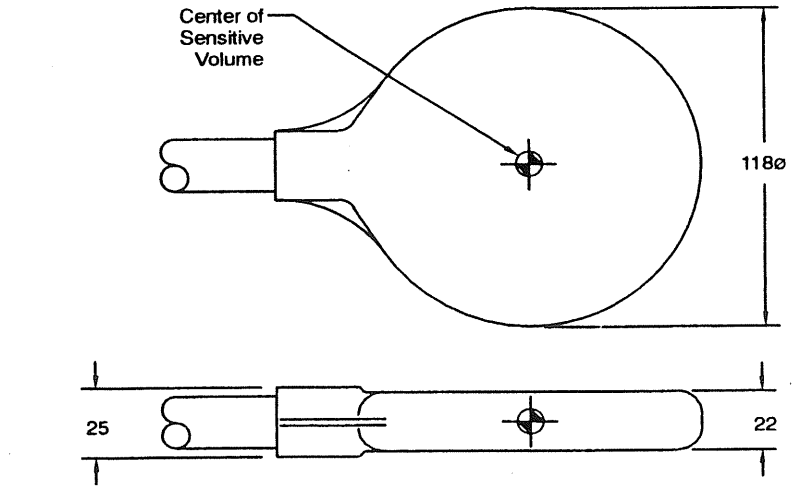
Measurement Performance

Rate		
Minimum	1 mR/hr	0.01 mGy/hr
Maximum	1 kR/hr	8.8 Gy/hr
Resolution	1 mR/hr	0.01 mGy/hr
Noise	2 mR/hr	20 µGy/hr
Dose		
Minimum	1 µR	5 nGy
Maximum	24 kR	2.1 kGy
Resolution	1 µR	5 nGy
Leakage	0.4 µR/sec	4 nGy/sec

Ion Chamber

Construction	Fully guarded; polycarbonate walls and electrode; conductive graphite exterior coating; 100 cm2 cross section; 180 cm3 active volume; unsealed
Energy dependence	±5%, 30 keV to 1.33 MeV (with build-up material)
Rate dependence	±5%, 0.02 R/h (0.2 mGy/h) to 2000 R/h (20 Gy/h) average
Calibration accuracy	±4% after temperature and pressure corrections at 150 kVp and 10.2 mm Al HVL
Orientation	Exposure to be centered on flat face.
Weight	0.35 kg





Dimensions in millimeters

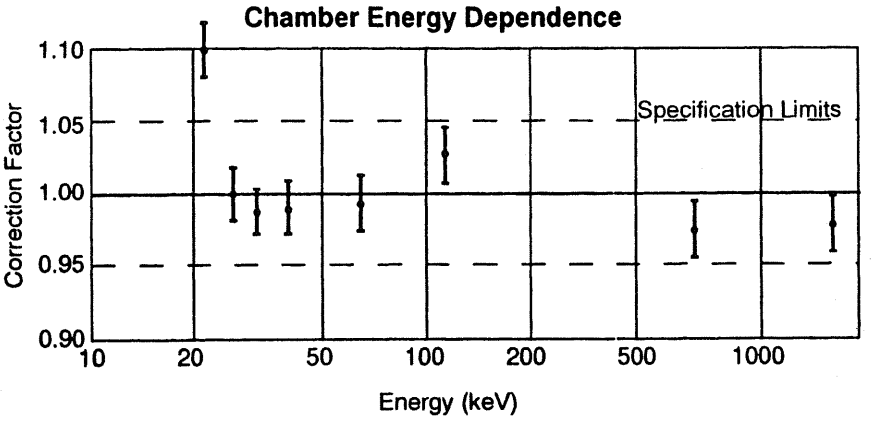
20X6-1800 Sensor

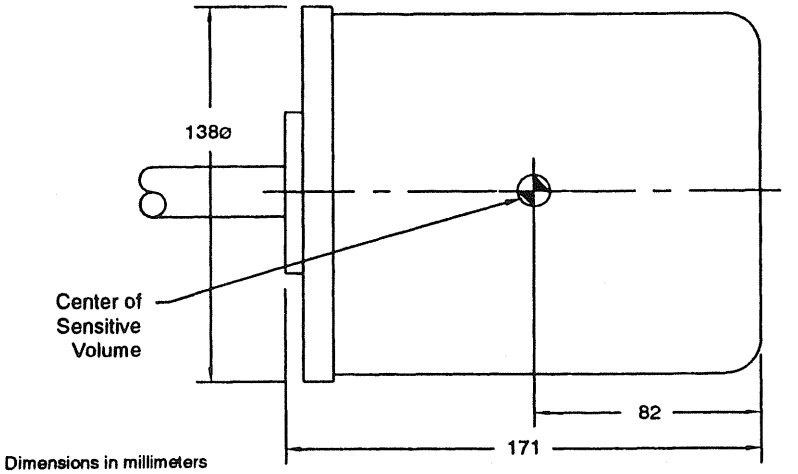
Measurement Performance

Rate		
Minimum	0.1 mR/hr	1 μGy/hr
Maximum	65 R/hr	570 mGy/hr
Resolution	0.1 mR/hr	1 μGy/hr
Noise	0.2 mR/hr	2 μGy/hr
Dose		
Minimum	0.1μR	0.5 nGy
Maximum	240 R	210 Gy
Resolution	0.1 μR	0.5 nGy
Leakage	40 nR/sec	0.4 nGy/sec

Ion Chamber

Construction	Fully guarded; polycarbonate walls and electrode; conductive graphite exterior coating; 1800 cm3 active volume; unsealed
Energy dependence	±5%, 33 keV to 1.33 MeV
Rate dependence	+0, -5%, 0.1 mR/h (0.01 μGy/h) to 20 R/h (200 mGy/h) and -10% to 65 R/h (650 mGy/h) average
Calibration accuracy	±4% after temperature and pressure corrections using moderately filtered x-rays at 150 kVp and 10.2 mm Al HVL
Weight	0.88 kg


Chamber Energy Dependence
Correction Factor
1.10
1.05
1.00
0.95
0.90
Specification Limits
10
20
50
100
200
500
1000
Energy (keV)

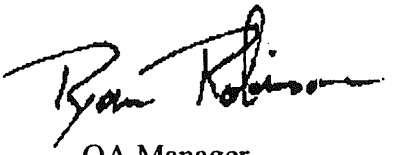

138ø
Center of
Sensitive
Volume
82
171
Dimensions in millimeters

Declaration of Conformity

According to IS)/IEC Guide 22 and EN 45014

The Radcal Corporatin declares, under our sole responsibility, that the 2026C X-Ray Monitor system conforms to the following Product Specifications.

EMC: CISPR 11, EN 55011, Class A
EN50082-1 IEC 801-2, 3kVCD, 8kVAD
EN50082-1 IEC 801-3, 3V/m
EN50082-1 IEC 801-4, 1.0kV(I/O)



QA Manager
Date: 1/16/97

Radcal Corporation
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Monrovia, CA 91016 U.S.A.