Cylindrical Ion Chambers
Victoreen Model 550 Series

Introduction
Model 550 Series Cylindrical Ionization Chambers are fully guarded thimble-type probes for use in a variety of applications. Equilibrium caps are available for each probe, extending their energy range up to 12 MeV. Sensitive volumes have been selected such that the nominal coulomb-to-roentgen calibration factors are convenient powers of ten. The cables may be terminated by triax BNC connectors for compatibility with Model 530, Model 35040 electrometers, or coax UHF connectors for compatibility with the older model electrometers.

Applications
The family of Cylindrical Ionization Chambers is designed to meet a wide range of radiation measurement and dosimetry applications required for diagnostic x-ray and radiation therapy in medical facilities. The 550 Series Ion Chambers offers volumes of 330, 33, 3.3, 0.33 cm³ for scatter, dose and rate measurements and accommodate energies from 21 keV to 12 MeV when used with equilibrium caps.

The selection guide on the next page will assist the user in selecting the appropriate chamber for rates from 0.03 to 2300 R/s and for sensitivities from 100 to 0.1 nA/R/s.

Specifications
Available model(s)

<table>
<thead>
<tr>
<th>Applications</th>
<th>550-3</th>
<th>550-4</th>
<th>550-5</th>
<th>550-6A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (cm³)</td>
<td>330</td>
<td>33</td>
<td>3.3</td>
<td>0.33</td>
</tr>
<tr>
<td>Energy Response</td>
<td>± 6%, 21 keV to 520 keV</td>
<td>± 3%, 42 keV to 520 keV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity (nA/R/s)</td>
<td>100</td>
<td>10</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Ion Collection Efficiency (Pulse)</td>
<td>0.3 mR @ 60Hz</td>
<td>2 mR @ 400Hz</td>
<td>6 mR @ 1.3 kHz</td>
<td>80 mR @ 17kHz</td>
</tr>
</tbody>
</table>

Equilibrium caps - model numbers and specific energies

<table>
<thead>
<tr>
<th>137Cs, 60Co</th>
<th>2 MeV</th>
<th>550-3-26</th>
<th>550-4-26</th>
<th>550-5-26</th>
<th>550-6-25</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 MeV</td>
<td>550-3-27</td>
<td>550-4-27</td>
<td>550-5-27</td>
<td>550-5-26*</td>
<td></td>
</tr>
<tr>
<td>6 MeV</td>
<td>550-3-28</td>
<td>550-4-28</td>
<td>550-5-28</td>
<td>550-5-27*</td>
<td></td>
</tr>
<tr>
<td>8 MeV</td>
<td>550-3-29</td>
<td>550-4-29</td>
<td>550-5-29</td>
<td>550-5-28*</td>
<td></td>
</tr>
<tr>
<td>10 MeV</td>
<td>550-3-30</td>
<td>550-4-30</td>
<td>550-5-30</td>
<td>550-5-29*</td>
<td></td>
</tr>
<tr>
<td>12 MeV</td>
<td>550-3-31</td>
<td>550-4-31</td>
<td>550-5-31</td>
<td>550-5-30*</td>
<td></td>
</tr>
</tbody>
</table>

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4606, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.
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550-ds rev 4 11 mar 03
Farmer-Type Radiation Therapy
Waterproof Ionization Chamber
Victoreen® Model 580-006-WP

Introduction
The Model 580-006-WP Radiation Therapy Ionization Chamber is modeled after the traditional 0.6 cm³ Farmer-type chamber used for absolute dosimetry measurements of medical linear accelerators and ⁶⁰Co machines. Each chamber includes an energy response for M-80, M-100, M-250, and ⁶⁰Co for both linear accelerator and brachytherapy applications as illustrated in the table below. Also supplied with each chamber is a PMMA ⁶⁰Co buildup cap, a convenient low noise one meter cable with triaxial BNC connector and a Victoreen custom carrying case.

Applications
This chamber is equivalent to a 0.6 cm³ acrylic walled chamber with the following published values of \( k_Q \) for accelerator photon beams as a function of %dd(10)\( x \) for cylindrical ion chambers commonly used for clinical reference dosimetry.

<table>
<thead>
<tr>
<th>%dd(10)_x</th>
<th>k_Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>58.0</td>
<td>1.000</td>
</tr>
<tr>
<td>63.0</td>
<td>0.996</td>
</tr>
<tr>
<td>66.0</td>
<td>0.992</td>
</tr>
<tr>
<td>71.0</td>
<td>0.984</td>
</tr>
<tr>
<td>81.0</td>
<td>0.967</td>
</tr>
<tr>
<td>93.0</td>
<td>0.945</td>
</tr>
</tbody>
</table>

(See AAPM’s TG-51 Protocol for Clinical Reference Dosimetry of High Energy Photon and Electron Beams, Table I, PTW N30001 0.6 cc Farmer.)

Features
• Completely waterproof, does not require protective sleeve
• Pure aluminum electrode 1 mm in diameter, 20.0 mm long
• Fully guarded up to the collection volume
• Vented to air
• Compatible with existing phantoms

Typical Energy Dependence

<table>
<thead>
<tr>
<th>NIST technique</th>
<th>kVp</th>
<th>Added filler Al (mm)</th>
<th>Cu (mm)</th>
<th>HVL (mm Al)</th>
<th>Energy (keV)</th>
<th>Typical calibration factor (Gy/C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-80</td>
<td>80</td>
<td>2.6</td>
<td>0.0</td>
<td>2.97</td>
<td>30</td>
<td>4.96E+07</td>
</tr>
<tr>
<td>M-100</td>
<td>100</td>
<td>5.0</td>
<td>0.0</td>
<td>5.02</td>
<td>40</td>
<td>4.92E+07</td>
</tr>
<tr>
<td>M-250</td>
<td>250</td>
<td>5.0</td>
<td>3.2</td>
<td>18.5</td>
<td>90</td>
<td>4.83E+07</td>
</tr>
<tr>
<td>( ^{60} )Co</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1250</td>
<td>4.99E+07*</td>
</tr>
</tbody>
</table>

* With supplied build-up cap.
Specifications

Volume 0.61 cm³
Sensitivity 2.0 x 10⁻⁸ CGy⁻¹
Leakage < 4 x 10⁻¹⁵ A
Optimum polarizing voltage + 300 VDC
Maximum polarizing voltage 500 VDC
Minimum exposure 0.04 Gy
Ion collection time
  300 V: 0.14 ms
  400 V: 0.11 ms
  500 V: 0.09 ms
Wall material PMMA (C₅H₈O₂)n acrylic with graphite layer
Wall density 1.19 g/cm³ (PMMA), 1.78 g/cm³ (C)
Wall thickness 0.203 mm (PMMA), 0.279 mm (C)
Wall area material density 73.8 mg/cm²
Electrode Pure aluminum, 1 mm Ø, 20.0 mm long
Cable 1.6 m with triaxial BNC connector
Cable leakage < 10⁻¹² CGy⁻¹ cm⁻¹
Temperature range +10° to +40°C
Relative humidity 20 to 75%
Buildup cap PMMA for¹³⁷Cs - ⁶⁰Co
Weight 4.4 oz (125 gm)
Case Custom foam lined
Vent tubing material Polyethylene-lined ethyl vinyl acetate tubing

Saturation behavior

<table>
<thead>
<tr>
<th>Polarizing voltage</th>
<th>99% saturation</th>
<th>99.5% saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 V</td>
<td>6.0 Gys⁻¹</td>
<td>3.0 Gys⁻¹</td>
</tr>
<tr>
<td>400 V</td>
<td>10.7 Gys⁻¹</td>
<td>5.3 Gys⁻¹</td>
</tr>
<tr>
<td>500 V</td>
<td>16.6 Gys⁻¹</td>
<td>8.3 Gys⁻¹</td>
</tr>
</tbody>
</table>

Optional accessories

Check Source, ¹⁰⁹Sr, 33 MBq (892 µCi) (Model 30-657)
Extension Cable, 33 ft (10 m), Triax BNC plug to BNC jack (Model 86133)
Acrylic Buildup Caps (M11x1 Thread): available upon request
Waterproof Kit (Model 580-006-1)

Available model(s)

580-006-WP Farmer-Type Radiation Therapy Waterproof Ionization Chamber

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.
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580-006-wp-ds  rev S  26 mar 03
Farmer-Type Ionization Chamber, 0.6 cm³, Waterproof Model 30-351

The waterproof 0.6 cm³ ionization chamber (Model 30-351) is designed for absolute dosimetry in radiation therapy. Since the chamber is waterproof, it may be used in water phantoms and does not require a protective sleeve. It is rugged in construction and has a PMMA/graphite thimble and an aluminum electrode. This chamber includes a 3.3 ft (1 m) cable, BNC Triax connector, and a PMMA buildup cap.

Specifications

- **Volume**: 0.6 cm³
- **Response**: $2 \times 10^{-8}$ C/Gy
- **Leakage**: $\pm 4 \times 10^{-15}$ A
- **Polarizing voltage**: Maximum 500 V
- **Cable length**: 3.3 ft (1 m)
- **Cable leakage**: $10^{-15}$ C/(Gy • cm)
- **Wall material**: PMMA (C₅H₈O₂), Graphite (C)
- **Wall density**: 1.19 gm/cm³ (PMMA), 1.85 gm/cm³ (C)
- **Wall thickness**: 0.335 mm PMMA, 0.09 mm C
- **Area density**: 56.5 mg/cm²
- **Electrode**: Aluminum, 1.1 mm Ø, 21.2 mm long
- **Nominal useful range**: 30 keV to 50 MeV
- **Range of temperature**: 10° to 40°C
- **Range of relative humidity**: 10% to 80%

### Ion collection time

- **300 V**: 0.18 ms
- **400 V**: 0.14 ms
- **500 V**: 0.11 ms

### Saturation behavior

<table>
<thead>
<tr>
<th>Saturation behavior</th>
<th>Polarizing voltage</th>
<th>99.0% saturation</th>
<th>99.5% saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum dose rate at continuous irradiation</td>
<td>300 V</td>
<td>5.70 Gy/s</td>
<td>2.80 Gy/s</td>
</tr>
<tr>
<td></td>
<td>400 V</td>
<td>10.00 Gy/s</td>
<td>5.00 Gy/s</td>
</tr>
<tr>
<td></td>
<td>500 V</td>
<td>16.00 Gy/s</td>
<td>7.80 Gy/s</td>
</tr>
<tr>
<td>Maximum dose rate per irradiation pulse</td>
<td>300 V</td>
<td>0.69 mGy</td>
<td>0.34 mGy</td>
</tr>
<tr>
<td></td>
<td>400 V</td>
<td>0.91 mGy</td>
<td>0.46 mGy</td>
</tr>
<tr>
<td></td>
<td>500 V</td>
<td>1.14 mGy</td>
<td>0.57 mGy</td>
</tr>
</tbody>
</table>

See next page for more specifications.
Optional accessories

Check Source, $^{90}$Sr, 33 MBq (892 µCi) (Model 30-657)

Available model(s)

30-351 Farmer-Type Ionization Chamber, 0.6 cm$^3$, Waterproof, includes BNC Triax connector and PMMA buildup cap

Other types of triaxial cable connectors available

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.

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30-351-ds rev 1 11 mar 03
Semiflex™ Ionization Chamber, 0.125 cm³, Waterproof  
Model 30-344

The 0.125 cm³ ionization chamber type (Model 30-344) is designed for measurements in the useful beam of high energy photon and electron fields. The chamber is waterproof and is used mainly for relative measurements in a water phantom or in an air scanner. The measuring volume is approximately spherical resulting in a flat energy response over an angle of 160º and a uniform spatial resolution, in all three axes, during measurements in a phantom. The chamber includes a 4.3 ft (1.3 m) cable, BNC Triax connector, PMMA buildup cap, and a short (36 mm) rigid stem for easy mounting.

Specifications

<table>
<thead>
<tr>
<th>Volume</th>
<th>0.125 cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>$4 \times 10^{-9}$ C/Gy</td>
</tr>
<tr>
<td>Leakage</td>
<td>$4 \times 10^{-15}$ A</td>
</tr>
<tr>
<td>Polarizing voltage</td>
<td>Maximum 500 V</td>
</tr>
<tr>
<td>Cable length</td>
<td>4.3 ft (1.3 m)</td>
</tr>
<tr>
<td>Cable leakage</td>
<td>$10^{-12}$ C/(Gy cm)</td>
</tr>
<tr>
<td>Wall material</td>
<td>PMMA (C₅H₈O₂), Graphite (C)</td>
</tr>
<tr>
<td>Wall density</td>
<td>1.19 gm/cm³ (PMMA), 0.82 gm/cm³ (C)</td>
</tr>
<tr>
<td>Wall thickness</td>
<td>0.55 mm PMMA, 0.15 mm C</td>
</tr>
<tr>
<td>Area density</td>
<td>78 mg/cm²</td>
</tr>
<tr>
<td>Electrode</td>
<td>Aluminum, 1.0 mm Ø, 5.0 mm long</td>
</tr>
<tr>
<td>Nominal useful range</td>
<td>30 keV to 50 MeV</td>
</tr>
<tr>
<td>Range of temperature</td>
<td>10º to 40ºC</td>
</tr>
<tr>
<td>Range of relative humidity</td>
<td>10% to 80%</td>
</tr>
</tbody>
</table>

| Ion collection time |
|---|---|---|
| 300 V | 0.14 ms |
| 400 V | 0.10 ms |
| 500 V | 0.08 ms |

| Saturation behavior |
|---|---|---|---|
| Polarizing voltage | 99.0% saturation | 99.5% saturation |
| 300 V | 5.6 Gy/s | 2.8 Gy/s |
| 400 V | 10.0 Gy/s | 5.0 Gy/s |
| 500 V | 15.0 Gy/s | 7.5 Gy/s |

Maximum dose rate at continuous irradiation

<table>
<thead>
<tr>
<th>Saturation behavior</th>
<th>Polarizing voltage</th>
<th>99.0% saturation</th>
<th>99.5% saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 V</td>
<td>0.7 mGy</td>
<td>0.4 mGy</td>
<td></td>
</tr>
<tr>
<td>400 V</td>
<td>1.0 mGy</td>
<td>0.5 mGy</td>
<td></td>
</tr>
<tr>
<td>500 V</td>
<td>1.2 mGy</td>
<td>0.6 mGy</td>
<td></td>
</tr>
</tbody>
</table>

Maximum dose rate per irradiation pulse

See next page for more specifications.
Specifications (continued)

Optional accessories

Check Source, $^{90}$Sr, 33 MBq (892 µCi) (Model 30-657)

Available model(s)

30-344 Semiflex Ionization Chamber, 0.125 cm$^3$. Waterproof, includes BNC Triax connector, PMMA buildup cap, and 36 mm rigid stem for mounting

Other types of triaxial cable connectors available

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.

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Semiflex™ Ionization Chamber, 0.3 cm³, Waterproof
Model 30-316

Suitable for use in water phantoms or solid state phantoms
- Measuring volume is fully vented via the connector
- Fully guarded up to measuring volume
- Touchable parts free of high voltage
- Extension cables up to 100 meters in length are available
- Type tested by PTB Braunschweig

The 0.3 cm³ ionization chamber (Model 30-316) is designed for measurements in the useful beam of high energy photon and electron fields. The chamber is waterproof and is used mainly for relative measurements in a water phantom or in an air scanner. The measuring volume is open to the surrounding air via the 4.3 ft (1.3 m) cable and BNC Triax connector. This chamber has a short rigid stem for easy mounting, includes a PMMA buildup cap, and is type tested by PTB Braunschweig.

Specifications

<table>
<thead>
<tr>
<th>Volume</th>
<th>0.3 cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>1 • 10⁻⁸ C/Gy</td>
</tr>
<tr>
<td>Leakage</td>
<td>± 4 • 10⁻¹⁵ A</td>
</tr>
<tr>
<td>Polarizing voltage</td>
<td>Maximum 500 V</td>
</tr>
<tr>
<td>Cable length</td>
<td>4.3 ft (1.3 m)</td>
</tr>
<tr>
<td>Cable leakage</td>
<td>10⁻¹² C/(Gy • cm)</td>
</tr>
<tr>
<td>Wall material</td>
<td>PMMA (C₅H₈O₂)</td>
</tr>
<tr>
<td>Wall density</td>
<td>1.19 gm/cm² (PMMA)</td>
</tr>
<tr>
<td>Wall thickness</td>
<td>0.7 mm PMMA</td>
</tr>
<tr>
<td>Area density</td>
<td>83.3 mg/cm²</td>
</tr>
<tr>
<td>Electrode</td>
<td>Aluminum, graphite coated, 1.0 mm Ø, 14.25 mm long</td>
</tr>
<tr>
<td>Nominal useful range</td>
<td>30 keV to 50 MeV</td>
</tr>
<tr>
<td>Range of temperature</td>
<td>10° to 40°C</td>
</tr>
<tr>
<td>Range of relative humidity</td>
<td>20% to 75%</td>
</tr>
</tbody>
</table>

Ion collection time

- 300 V: 0.10 ms
- 400 V: 0.08 ms
- 500 V: 0.06 ms

Saturation behavior

<table>
<thead>
<tr>
<th>Saturation behavior</th>
<th>Polarizing voltage</th>
<th>99.0% saturation</th>
<th>99.5% saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous irradiation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 V</td>
<td>17.0 Gy/s</td>
<td>8.5 Gy/s</td>
<td></td>
</tr>
<tr>
<td>400 V</td>
<td>30.0 Gy/s</td>
<td>15.0 Gy/s</td>
<td></td>
</tr>
<tr>
<td>500 V</td>
<td>45.0 Gy/s</td>
<td>23.0 Gy/s</td>
<td></td>
</tr>
<tr>
<td>Pulse irradiation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 V</td>
<td>1.0 mGy</td>
<td>0.4 mGy</td>
<td></td>
</tr>
<tr>
<td>400 V</td>
<td>1.3 mGy</td>
<td>0.5 mGy</td>
<td></td>
</tr>
<tr>
<td>500 V</td>
<td>1.7 mGy</td>
<td>0.7 mGy</td>
<td></td>
</tr>
</tbody>
</table>

See next page for more specifications.
### Specifications (continued)

#### Directional dependence

<table>
<thead>
<tr>
<th>Energy</th>
<th>0º</th>
<th>12º</th>
<th>18º</th>
<th>24º</th>
<th>30º</th>
<th>60º</th>
<th>90º</th>
<th>120º</th>
<th>150º</th>
<th>162º</th>
<th>174º</th>
<th>180º</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 kV</td>
<td>44.1</td>
<td>65.6</td>
<td>69.2</td>
<td>68.5</td>
<td>92.5</td>
<td>99.7</td>
<td>100.0</td>
<td>99.6</td>
<td>96.1</td>
<td>93.0</td>
<td>88.7</td>
<td>70.0</td>
</tr>
<tr>
<td>140 kV</td>
<td>68.7</td>
<td>82.9</td>
<td>92.2</td>
<td>95.0</td>
<td>97.4</td>
<td>99.7</td>
<td>100.0</td>
<td>99.4</td>
<td>97.7</td>
<td>96.5</td>
<td>94.5</td>
<td>91.0</td>
</tr>
<tr>
<td>280 kV</td>
<td>79.9</td>
<td>87.1</td>
<td>93.1</td>
<td>95.5</td>
<td>97.5</td>
<td>99.5</td>
<td>100.0</td>
<td>99.7</td>
<td>98.5</td>
<td>97.4</td>
<td>96.1</td>
<td>94.9</td>
</tr>
<tr>
<td>Co-60</td>
<td>83.2</td>
<td>91.1</td>
<td>94.6</td>
<td>96.0</td>
<td>97.1</td>
<td>99.4</td>
<td>100.0</td>
<td>99.4</td>
<td>97.5</td>
<td>96.8</td>
<td>96.0</td>
<td>94.6</td>
</tr>
</tbody>
</table>

#### Energy dependence

- **Absorbed dose to water**
- **Ar kerma**

<table>
<thead>
<tr>
<th>Photon Energy, kV</th>
<th>60</th>
<th>95</th>
<th>145</th>
<th>Co-60</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 kV</td>
<td>97.2</td>
<td>104.9</td>
<td>105.9</td>
<td>103.8</td>
</tr>
<tr>
<td>140 kV</td>
<td>110.9</td>
<td>108.0</td>
<td>106.9</td>
<td>105.1</td>
</tr>
<tr>
<td>280 kV</td>
<td>111.3</td>
<td>107.1</td>
<td>105.0</td>
<td>104.2</td>
</tr>
<tr>
<td>Co-60</td>
<td>104.0</td>
<td>106.4</td>
<td>104.6</td>
<td>103.5</td>
</tr>
</tbody>
</table>

#### Optional accessories

- **Check Source**, $^{90}$Sr, 33 MBq (892 µCi) (Model 30-657)

- **Available model(s)**
  - 30-316 Semiflex Ionization Chamber, 0.3 cm³, Waterproof, includes BNC Triax connector, PMMA buildup cap, and rigid stem for mounting

- **Other types of triaxial cable connectors available**

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA. Specifications are subject to change without notice.

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PinPoint™ Ionization Chamber, 0.015 cm³, Waterproof
Model 30-350

The 0.015 cm³ PinPoint ionization chamber is specifically designed for stereotactic field measurements. PinPoint is a waterproof cylindrical ion chamber ideally suited to perform relative measurements in water phantoms or solid-state phantoms when superior spatial resolution is required. The chamber is fully guarded up to its measuring volume and open to the surrounding air via its 4.3 ft (1.3 m) cable and BNC Triax connector. PinPoint has a short rigid stem for mounting and includes a PMMA buildup cap.

Specifications

Volume 0.015 cm³
Response 4 • 10⁻¹⁰ C/Gy
Leakage ± 4 • 10⁻¹⁵ A
Polarizing voltage Maximum 400 V
Cable length 4.3 ft (1.3 m)
Cable leakage 10⁻¹² C/(Gy • cm)
Wall material PMMA (C₅H₈O₂), Graphite (C)
Wall density 1.19 gm/cm² (PMMA), 0.82 gm/cm² (C)
Wall thickness 0.56 mm PMMA, 0.15 mm C
Area density 79 mg/cm²
Electrode Steel, 0.18 mm Ø, 4.5 mm long
Nominal useful range “Co to 50 mV
Range of temperature 10° to 40°C
Range of relative humidity 10% to 80%

Ion collection time
100 V: 80 µs
200 V: 40 µs
300 V: 20 µs

Saturation behavior

<table>
<thead>
<tr>
<th>Saturation behavior</th>
<th>Polarizing voltage</th>
<th>99.0% saturation</th>
<th>99.5% saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum dose rate at continuous irradiation</td>
<td>100 V</td>
<td>145 Gy/s</td>
<td>74 Gy/s</td>
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<tr>
<td></td>
<td>200 V</td>
<td>585 Gy/s</td>
<td>290 Gy/s</td>
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<td></td>
<td>400 V</td>
<td>2,340 Gy/s</td>
<td>1,160 Gy/s</td>
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<tr>
<td>Maximum dose rate per irradiation pulse</td>
<td>100 V</td>
<td>1.3 mGy</td>
<td>0.6 mGy</td>
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<tr>
<td></td>
<td>200 V</td>
<td>2.6 mGy</td>
<td>1.3 mGy</td>
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<tr>
<td></td>
<td>400 V</td>
<td>5.0 mGy</td>
<td>2.5 mGy</td>
</tr>
</tbody>
</table>

See next page for more specifications.
Available model(s)

30-350 PinPoint Ionization Chamber, 0.015 cm$^3$, Waterproof, includes BNC Triax connector, PMMA buildup cap, and 33 mm rigid stem for mounting

Other types of triaxial cable connectors available

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.

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Roos™ Electron Ionization Chamber, 0.35 cm³, Waterproof
Model 30-332

The Roos chamber, a development from Dr. Roos of PTB-Braunschweig, is used as a standard chamber for electron dosimetry. This chamber has a very wide guard ring to exclude any perturbation effect, even at low electron energies. The polarity effect is negligible. Energy dependence is only influenced by the stopping power correction, a type dependent correction is not necessary. The chamber is waterproof and vented through the connection cable. Roos includes a 3.5 ft (1.08 m) cable and BNC Triax connector.

Specifications

Volume 0.35 cm³
Response 1 • 10⁻⁸ C/Gy
Leakage ± 4 • 10⁻¹⁵ A
Polarizing voltage 100 V recommended, maximum 400 V
Cable length 3.5 ft (1.08 m)
Cable leakage 3.5 • 10⁻¹³ C/(Gy • cm)
Wall material Acrylic (C₅H₈O₂)
Wall density 1.19 gm/cm³
Wall thickness 1.0 mm
Area density 119 mg/cm²
Electrode Acrylic, graphite coated, 15 mm Ø
Guard ring 4 mm wide
Nominal useful range 2 to 25 MeV
Range of temperature 10° to 40°C
Range of relative humidity 10% to 80%

Ion collection time
100 V: 0.37 ms
200 V: 0.13 ms
300 V: 0.07 ms

Saturation behavior

<table>
<thead>
<tr>
<th>Saturation behavior</th>
<th>Polarizing voltage</th>
<th>99.0% saturation</th>
<th>99.5% saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum dose rate at continuous irradiation</td>
<td>100 V</td>
<td>2.6 Gy/s</td>
<td>1.3 Gy/s</td>
</tr>
<tr>
<td>200 V</td>
<td>11.0 Gy/s</td>
<td>5.2 Gy/s</td>
<td></td>
</tr>
<tr>
<td>400 V</td>
<td>42.0 Gy/s</td>
<td>21.0 Gy/s</td>
<td></td>
</tr>
<tr>
<td>Maximum dose rate per irradiation pulse</td>
<td>100 V</td>
<td>0.5 mGy</td>
<td>0.2 mGy</td>
</tr>
<tr>
<td>200 V</td>
<td>0.9 mGy</td>
<td>0.5 mGy</td>
<td></td>
</tr>
<tr>
<td>400 V</td>
<td>1.9 mGy</td>
<td>0.9 mGy</td>
<td></td>
</tr>
</tbody>
</table>

See next page for more specifications.
Optional accessories

Check Source, ⁹⁰Sr, 20 MBq (541 μCi) (Model 30-658)

Available model(s)

30-332 Roos Electron Ionization Chamber, 0.35 cm³, Waterproof, includes BNC Triax connector

Other types of triaxial cable connectors available

Specifications (continued)

Diagram

The deviation of the response following tilting of the chamber by up to 10° at 6 and 20 MeV, at the dose maximum in water, is less than 0.1%.

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.

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30-332-ds rev 1 11 mar 03
Markus™ Electron Ionization Chamber, 0.055 cm³, Waterproof Model 30-329

The Markus chamber is the very first chamber specifically designed for electron dosimetry. The chamber may be used for measurements in water phantoms or solid state phantoms. A PMMA waterproofing cap, 0.87 mm thick (equivalent to 1 mm of water), and an annulus, for solid state phantom measurements, are included. The chamber’s small measuring volume makes it ideal for electron measurements when very high spatial resolution is required. The diaphragm front allows measurements in the buildup region of electron fields to a depth of virtually zero. Markus includes a 3.4 ft (1.05 m) cable and BNC Triax connector.

Specifications

- **Volume**: 0.055 cm³
- **Response**: 2 • 10⁻⁹ C/Gy
- **Leakage**: ± 2 • 10⁻¹⁶ A
- **Polarizing voltage**: 300 V recommended, 400 V maximum
- **Cable length**: 3.4 ft (1.05 m)
- **Cable leakage**: 3.5 • 10⁻¹² C/(Gy • cm)
- **Wall material**: Polyethylene CH₂
- **Membrane thickness**: 0.03 mm
- **Area thickness**: 2.5 mg/cm²
- **Electrode**: Acrylic, graphite coated, 5.3 mm Ø
- **Nominal useful range**: 2 to 45 MeV
- **Range of temperature**: 10° to 40°C
- **Range of relative humidity**: 10% to 80%

**Ion collection time**

- **150 V**: 0.20 ms
- **300 V**: 0.09 ms
- **400 V**: 0.07 ms

**Saturation behavior**

<table>
<thead>
<tr>
<th>Saturation behavior</th>
<th>Polarizing voltage</th>
<th>99.0% saturation</th>
<th>99.5% saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum dose rate at continuous irradiation</td>
<td>150 V</td>
<td>5.9 Gy/s</td>
<td>2.9 Gy/s</td>
</tr>
<tr>
<td></td>
<td>300 V</td>
<td>24.0 Gy/s</td>
<td>12.0 Gy/s</td>
</tr>
<tr>
<td></td>
<td>400 V</td>
<td>42.0 Gy/s</td>
<td>21.0 Gy/s</td>
</tr>
<tr>
<td>Maximum dose rate per irradiation pulse</td>
<td>150 V</td>
<td>0.7 mGy</td>
<td>0.4 mGy</td>
</tr>
<tr>
<td></td>
<td>300 V</td>
<td>1.4 mGy</td>
<td>0.7 mGy</td>
</tr>
<tr>
<td></td>
<td>400 V</td>
<td>1.9 mGy</td>
<td>0.9 mGy</td>
</tr>
</tbody>
</table>

See next page for more specifications.
Specifications (continued)

Optional accessories

Check Source, $^{90}\text{Sr}$, 20 MBq (541 µCi) (Model 30-658)

Available model(s)

30-329 Markus Electron Ionization Chamber, 0.055 cm$^3$, Waterproof, includes BNC Triax connector and PMMA build-up cap

Other types of triaxial cable connectors available

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.

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30-329-ds rev 1 11 mar 03
Advanced Markus™ Electron Ionization Chamber, 0.02 cm³, Waterproof
Model 30-331

- Vented sensitive volume of 0.02 cm³
- Same dimensions as the Markus chamber
- Suitable for relative and absolute electron dosimetry
- Very thin entrance window
- The chamber is waterproof when used with protective cap

The 0.02 cc Advanced Markus Chamber is our newest development in plane-parallel electron ion chambers. This chamber combines the advantages of both Roos™ and Markus chamber types into one truly exceptional plane-parallel electron chamber. Developed for relative and absolute electron dosimetry in water or solid type phantoms, the advanced design of this chamber makes it possible to perform absolute electron dosimetry without perturbation effects.

This chamber is designed in strict accordance with the recommendations of IEC 60731 and it is waterproof. Since the outer shape is identical to that of the Markus chamber, all existing Markus chamber phantom plates and adapters can be used with the Advanced Markus chamber. The small sensitive volume makes this chamber ideal for dose distribution measurements in a water phantom, giving a good spatial resolution. An improved design of the guard ring reduces the influence of scattered radiation from the housing, and makes it possible to perform absolute electron dosimetry without perturbation effects. The chamber features a flat energy response within the nominal useful range from 2 to 45 MeV. The membrane material is polyethylene of 0.03 mm thickness. The Advanced Markus chamber comes with a protective acrylic cover 0.87 mm thick (1 mm water equivalence) for use in water. In addition, the chamber includes a 3.4 ft (1.05 m) cable and BNC Triax connector. Air density correction is required for each measurement. A radioactive check device is available as an option.

**Note:** The Advanced Markus chamber was developed in cooperation with Prof. Rosenow, Göttingen University, Germany IEC 60731: “Medical electrical equipment - Dosimeters with ionization chambers as used in radiotherapy.”
Specifications

**Type of product**  Vented plane-parallel chamber type 34045 with guard ring

**Application**  Dose and dose rate measurements in high-energy electron beams

**Measuring quantities and units**  Absorbed dose to water (Gy); absorbed dose rate to water (Gy/min)

**Radiation quality**  Electrons 2 to 45 MeV

**Response**  670 pC/Gy

**Sensitive volume**  0.02 cm³

**Directional dependence**  The deviation of the response following tilting of the chamber by up to 10° is smaller than 0.1%

**Entrance window**  Polyethylene \((\text{CH}_2)^{\text{CH}}\) foil with 0.03 mm thickness

**Electrode**  Acrylic (PMMA), graphite coated 5 mm Ø

**Area density**  2.5 mg/cm²

**Reference point**  Center of entrance foil

**Chamber voltage**  Maximum 400 V

**Leakage current**  ± 4 fA

**Cable leakage**  Less than or equal to 1 PC/(Gy • cm)

**Ion collection time**

- 150 V: 44 µs
- 300 V: 22 µs
- 400 V: 17 µs

**Range of temperature**  10° to 40°C, 50° to 104°F

**Range of relative humidity**  10 to 80%, max 20 g/m³

**Range of air pressure**  700 to 1060 hPa

**Temperature equilibrium**  2 to 3 min/K

**Pressure equilibrium**  Less than or equal to 10 s

**Optional accessories**

- **Check Source**, 90 Sr, 20 MBq (541 µCi) (Model 30-658)

**Available model(s)**

- 30-331  Advanced Markus Electron Ionization Chamber, 0.02 cm³, Waterproof, includes BNC Triax connector and PMMA buildup cap

**Other types of triaxial cable connectors available**

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**Extension Cable Reel for Ionization Chambers**

**Model 30-355**

- Prevents tangled, loose, or misplaced triaxial-connector cables
- A must for every therapy department

This handy reel makes locating, using, and storing cable easy. Just reel-off the exact length of cable needed, and connect it to your equipment. After use, wind the cable back into its covered reel. No more tangled, loose, dirty, or lost cable.

The Extension Cable Reel holds 40 feet of cable. It has a triaxial male connector at the extendable end, and a female triaxial receptacle on the reel housing.

**Specifications**

**Dimensions**  7 (w) x 3.25 (d) x 8.25 in (h) (17.78 x 8.26 x 20.95 cm)

**Weight**  2 lb (0.90 kg)

**Available model(s)**

- 30-355  Extension Cable Reel for Ionization Chambers
Radioactive Check Source, 
$^{90}$Sr, 33 MBq (892 µCi)
Model 30-657

**Introduction**
The Radioactive Check Source, Model 30-657, provides the Medical Physicist with an easy way to check the constancy of response of compact thimble type ionization chambers. The device contains 33.3 MBq of $^{90}$Sr, in a fully shielded container, and is equivalent to ISO Class C43323. Holders for reproducible chamber positioning during check measurements are available for a variety of ion chambers.

**Applications**
Use of the Radioactive Check Source, Model 30-657, is recommended for high precision dosimetry and is required by IEC 60731 - Dosimeters with ionization chambers as used in radiotherapy, 1977. A check measurement performed before each dose measurement will assure the ionization chamber is responding properly. Since the radioactive source is in the shape of a tube, the chamber volume is irradiated from all directions.

Check readings must be corrected for the 28.7 year half-life time of the $^{90}$Sr source. However, under constant environmental conditions (temperature, pressure, air humidity) the current produced in an ionization chamber is reproducible with an uncertainty of ± 1%.

Holders to assure correct positioning and repositioning accuracy for the 0.6 cm$^3$ Farmer-type chambers (Models 580-006-WP and 30-351), 0.125 cm$^3$ Semiflex™ chamber (Models 30-344), 0.3 cm$^3$ Semiflex™ chamber (Models 30-316), and 0.015 cm$^3$ PinPoint™ chamber (Model 30-350) are available. If this device is used with other types of chambers, proper positioning becomes the responsibility of the user.

The Radioactive Check Source, Model 30-657, is equipped with an attached thermometer. When making check measurements care must be taken to obtain temperature equilibrium between the ionization chamber, check device, and the surrounding environment. After use, the protective cover should be replaced and secured. With the protective cover in place the dose rate from the source is reduced to less than 1 µSv/h at 10 cm. Leaving an ionization chamber in the check device when not in use is not recommended since this can damage the ion chamber.

**Note:** A radioactive materials license for $^{90}$Sr is required for purchase.

**Specifications**

- **Radioactive content** 33.3 MBq (892 µCi)
- **Half-value time** 28.7 years

**Optional accessories**

- **Holder for 0.6 cm$^3$ Farmer-Type (Models 580-006-WP and 30-351) Ion Chambers** Model 30-657-1000
- **Holder for 0.125 and 0.3 cm$^3$ Semiflex (Models 30-344 and 30-316) Ion Chambers** Model 30-657-2000
- **Holder for 0.015 cm$^3$ PinPoint (Model 30-350) Ion Chamber** Model 30-657-3000

**Available model(s)**

- 30-657 Radioactive Check Source, $^{90}$Sr, 33 MBq (892 µCi). A radioactive materials license is required

For additional information, please contact Radiation Management Services business of Cardinal Health at 440.248.9300, fax 440.349.2307, or e-mail rmsinfo@cardinal.com; located at 6045 Cochran Rd., Cleveland, Ohio 44139-3303, USA.

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Radioactive Check Source, 
$^{90}\text{Sr}$, 20 MBq (541 µCi)
Model 30-658

**Introduction**

The Radioactive Check Source, Model 30-658, provides the Medical Physicist with an easy way to check the constancy of response of flat plane-parallel type ionization chambers. The device contains 20 MBq of $^{90}\text{Sr}$ in a fully shielded container, and is equivalent to ISO Class C64444. Holders for reproducible chamber positioning during check measurements are available for the Markus, Advanced Markus, and Roos ion chambers.

**Applications**

Use of the Radioactive Check Source, Model 30-658, is recommended for high precision dosimetry and is required by IEC 60731 - Dosimeters with ionization chambers as used in radiotherapy, 1977. A check measurement performed before each dose measurement will assure the ionization chamber is responding properly. Since the radioactive source is cylindrical, the entrance window of the flat plane-parallel is placed near the source by means of the appropriate holding device.

Check readings must be corrected for the 28.7 year half-life time of the $^{90}\text{Sr}$ source. However, under constant environmental conditions (temperature, pressure, air humidity) the current produced in an ionization chamber is reproducible with an uncertainty of ± 1%.

Holders to assure correct positioning and repositioning accuracy for the 0.055 cm³ Markus chamber (Model 30-329), 0.02 cm³ Advanced Markus chamber (Model 30-331), and 0.35 cm³ Roos chamber (Model 30-332) are available. If this device is used with other types of chambers, proper positioning becomes the responsibility of the user.

When making check measurements with the Radioactive Check Source, Model 30-658, care must be taken to obtain temperature equilibrium between the ionization chamber, check device, and the surrounding environment. After use, the protective cover should be replaced and secured. With the protective cover in place the dose rate from the source is reduced to less than 1 µSv/h at 10 cm. Leaving an ionization chamber in the check device when not in use is not recommended since this can damage the ion chamber.

**Specifications**

- **Radioactive content** 20 MBq (541 µCi)
- **Half-value time** 28.7 years
- **Optional accessories**
  - Holder for 0.055 cm³ Markus (Model 30-329) and 0.02 cm³ Advanced Markus (Model 30-331) Electron Ion Chambers Model 30-658-1000
  - Holder for 0.35 cm³ Roos (Model 30-332) Electron Ion Chamber Model 30-658-2000

**Available model(s)**

30-658 Radioactive Check Source, $^{90}\text{Sr}$, 20 MBq (541 µCi).
A radioactive materials license is required

**Note:** A radioactive materials license for $^{90}\text{Sr}$ is required for purchase.

For additional information, please contact Radiation Management Services business of Cardinal Health at 440.248.9300, fax 440.349.2307, or e-mail rmsinfo@cardinal.com; located at 6045 Cochran Rd., Cleveland, Ohio 44139-3303, USA.

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