Caution
Federal law restricts this device to sale by or on the order of a physician, or with the descriptive designation of any other practitioner licensed by the law of the State in which he/she practices to use or order the use of the device.

This product is intended for use by medical physicists with training in radiation therapy. A medical physicist must design and supervise the actual tests performed with this phantom. This manual does not provide information regarding applications of the product only information regarding the product functions.

WARNING
This product has an FH3-4 mm/min flame rating and is considered to be flammable. It is advised not to expose this product to open flame or high temperature (over 125° Celsius or 250° Fahrenheit) heating elements.
RSVP Phantom™ Pelvis Manual

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Indications for Use

The RSVP Phantom™ Pelvis is designed for use in a variety of radiation therapy applications including, final quality verification of therapy dose delivery and for comparing the delivered dose profiles for different treatment plans. It is also used for periodic quality assurance evaluations and acceptance testing and to perform re-evaluations after equipment or software upgrades.

Introduction

The Phantom Laboratory, Incorporated and physicist Charles W. Coffey, II, Ph.D. have developed the RSVP Phantom™ Pelvis to provide localization and dose verification for IMRT systems.

A variety of techniques may be used to measure the radiation dose delivered to the tumor vessel. Quantitative dose measurements may also be obtained by using commercially available probes and ionization chambers.

Because each medical facility has its own unique set of requirements, we do not make specific recommendations on the frequency and expected results of evaluations. When developing your measurement protocols, review the local governing regulations, the needs of your radiologists, oncologists, physicists, and your system manufacturer’s recommendations.

If you have questions about the operation of the RSVP Phantom™ Pelvis or the optional equipment that is available for the phantom, please contact The Phantom Laboratory at the following address:

The Phantom Laboratory, Incorporated
PO Box 511, Salem NY 12865 USA
Phone: 800-525-1190 or 518-692-1190
Fax: 518-692-3329
Figure 1

Cross section view of the RSVP Phantom™ Pelvis
1. Tumor support rod
2. Lock bolt
3. Rotation ball
4. Rotation ball lock nut
5. Cover plate
6. Tumor vessel
Care of the Phantom

The shell of the RSVP Pelvis Phantom™ is formed from 0.25-inch-thick cellulose acetate butyrate (CAB), a transparent plastic chosen for its strength and low water absorption. The shell is mounted on durable polycarbonate end plates. A cover plate and an assembly, that allows the tumor port to be rotated, is attached to the top.

The RSVP Phantom™ is designed to be filled with water. Please refer to the Chemical Compatibility Chart on pages 8-13 of this manual prior to use. You should never allow a filled phantom to freeze. If water is left in the phantom for an extended period of time, bacteria and other microorganisms may begin to grow and cause the water to become cloudy. If clouding occurs, the phantom should be emptied and washed with water and a mild detergent. Before storing, empty all water from, the phantom.

The tumor rotation ball assembly is located on the top of the phantom. The ball assembly may be extracted from the phantom by simply removing its lock nut and then lifting the ball out of the assembly. The O-ring that lies under the rotation ball should sit evenly on the lip surrounding the opening that leads into the main body of the phantom. The application of a small amount of petroleum jelly to the O-ring will help insure that the rotation ball forms a tight seal on the ring. Be careful not to apply too much jelly to the O-ring, because excessive lubrication may cause the ring to slip out of position when the lock nut is tightened. Always remember to loosen the rotation ball lock nut before rotating the tumor ball. If the rotation ball is turned when the nut is tight, the O-ring will be twisted out of position, thereby preventing a proper seal.
Tumor Removal

To remove the tumor vessel, remove the rotation ball lock nut. Once this is accomplished, the rotation ball, tumor support rod, and tumor vessel can be lifted out of the phantom as a complete assembly, as shown in Figure 2.

Figure 2

1. Tumor vessel  
2. Tumor support rod  
3. Lock bolt  
4. Rotation ball
# Chemical Compatibility Chart

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Chemicals</th>
<th>Percent Increase</th>
<th>Observed Condition of Plastic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acetic, 5%</strong></td>
<td>1 year</td>
<td>3.6</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Acetic, 10%</strong></td>
<td>2 months</td>
<td>5.2</td>
<td>2.4</td>
</tr>
<tr>
<td>•<strong>Acetic, 30%</strong></td>
<td>2 months</td>
<td>13.6</td>
<td>8.6</td>
</tr>
<tr>
<td><strong>Boric, 5%</strong></td>
<td>2 days</td>
<td>1.3</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Chromic, 6%</strong></td>
<td>8 days (38°C, 100°F)</td>
<td>2.0</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Citric, 10%</strong></td>
<td>4 months (60°C, 140°F)</td>
<td>1.6</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Citric, 10%</strong></td>
<td>1 year</td>
<td>1.4</td>
<td>0.6</td>
</tr>
<tr>
<td>•<strong>Citric, 60%</strong></td>
<td>4 months (60°C, 140°F)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Fluosilicic, 10%</strong></td>
<td>2 months</td>
<td>4.5</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Fluosilicic, 28%</strong></td>
<td>2 months</td>
<td>4.7</td>
<td>3.6</td>
</tr>
<tr>
<td><strong>Formic, 3%</strong></td>
<td>20 days</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Hydrochloric, 10%</strong></td>
<td>1 year</td>
<td>0.9</td>
<td>0.5</td>
</tr>
<tr>
<td>•<strong>Hydrofluoric, 10%</strong></td>
<td>1 month</td>
<td>10.3</td>
<td>5.5</td>
</tr>
<tr>
<td>•<strong>Hydrofluoric, 48%</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Lactic, 50%</strong></td>
<td>2 days</td>
<td>1.6</td>
<td>0.5</td>
</tr>
<tr>
<td>•<strong>Nitric, 10%</strong></td>
<td>8 months</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Oleic</strong></td>
<td>1 year</td>
<td>2.3</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Phosphoric, 30%</strong></td>
<td>2 months</td>
<td>1.3</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Phosphoric, 50%</strong></td>
<td>2 months</td>
<td>1.6</td>
<td>0.8</td>
</tr>
<tr>
<td>•<strong>Phosphoric, 75%</strong></td>
<td>2 months</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Pyrogallic, 4%</strong></td>
<td>1 week</td>
<td>2.6</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Searic</strong></td>
<td>1 week</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Sulfuric, 3%</strong></td>
<td>1 year</td>
<td>1.6</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Sulfuric, 10%</strong></td>
<td>1 year</td>
<td>1.5</td>
<td>0.7</td>
</tr>
<tr>
<td>•<strong>Sulfuric, 20%</strong></td>
<td>1 year</td>
<td>0.9</td>
<td>0.3</td>
</tr>
<tr>
<td>•<strong>Sulfuric, 30%</strong></td>
<td>1 year</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>•<strong>Sulfuric, 94%</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Tannic, 10%</strong></td>
<td>4 months (38°C, 100°F)</td>
<td>2.8</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Trichloroacetic, 1%</strong></td>
<td>1 month</td>
<td>3.3</td>
<td>0.5</td>
</tr>
<tr>
<td>•<strong>Trichloroacetic, 5%</strong></td>
<td>1 month</td>
<td>9.3</td>
<td>3.1</td>
</tr>
<tr>
<td><strong>Alcohols, Monohydric</strong></td>
<td>2 days</td>
<td>3.1</td>
<td>3.0</td>
</tr>
<tr>
<td>•<strong>n-Amyl</strong></td>
<td>2 days</td>
<td>14.0</td>
<td>11.3</td>
</tr>
<tr>
<td>•<strong>n-Butyl</strong></td>
<td>2 days</td>
<td>6.5</td>
<td>7.2</td>
</tr>
<tr>
<td>•<strong>sec-Butyl</strong></td>
<td>2 days</td>
<td>7.2</td>
<td>10.7</td>
</tr>
<tr>
<td>•<strong>tert-Butyl</strong></td>
<td>2 days</td>
<td>3.6</td>
<td>3.3</td>
</tr>
<tr>
<td>•<strong>Diacetone</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>•<strong>Ethyl (denatured)</strong></td>
<td>2 days</td>
<td>23.0</td>
<td>24.7</td>
</tr>
<tr>
<td>•<strong>Ethyl, 50%</strong></td>
<td>1 week</td>
<td>13.4</td>
<td>11.6</td>
</tr>
<tr>
<td>•<strong>2-Ethylhexyl</strong></td>
<td>1 week</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Hydrocarbons</strong></td>
<td>1 year</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Gas, Natural, aromatic-free</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Gas, Natural, 5% aromatic content</strong></td>
<td>23 days</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

• Indicates that material is generally unsatisfactory for use in contact with Tenite butyrate under the conditions of this test.
Chemical Compatibility Chart continued

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Time Exposed</th>
<th>Percent Increase</th>
<th>Observed Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td></td>
<td>Weight Thickness</td>
<td>of Plastic</td>
</tr>
<tr>
<td>• Isoamyl</td>
<td>2 days</td>
<td>2.0</td>
<td>2.1</td>
</tr>
<tr>
<td>• Isopropyl</td>
<td>2 days</td>
<td>23.4</td>
<td>25.1</td>
</tr>
<tr>
<td>• Methyl</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Methyl, 5%</td>
<td>1 year</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td>• n-Propyl</td>
<td>2 days</td>
<td>15.0</td>
<td>4.4</td>
</tr>
<tr>
<td>• Tetrahydrofurfuryl</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Alcohols, Dihydric and Trihydric</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Diethylene Glycol</td>
<td>2 months</td>
<td>8.2</td>
<td>6.1</td>
</tr>
<tr>
<td>2-Ethyl Hexanediol-1,3</td>
<td>2 days (38°C, 100°F)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>1 year</td>
<td>4.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Glycerin</td>
<td>1 year</td>
<td>0.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Propylene Glycol</td>
<td>2 days</td>
<td>0.4</td>
<td>0.0</td>
</tr>
<tr>
<td>• Triethylene Glycol</td>
<td>2 months</td>
<td>8.6</td>
<td>6.7</td>
</tr>
<tr>
<td>Bases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ammonium Hydroxide, 10%</td>
<td>2 months</td>
<td>21.9</td>
<td>12.9</td>
</tr>
<tr>
<td>Calcium Hydroxide, saturated solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Hydroxide, 1%</td>
<td>1 year</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Sodium Hydroxide, 10%</td>
<td>8 months</td>
<td>3.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Trimethylbenzyl Ammonium Hydroxide, 5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Esters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• n-Butyl Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• sec-Butyl Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Di-2-Ethylhexyl Adipate</td>
<td>1 year</td>
<td>0.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Di-2-Ethylhexyl Phthalate</td>
<td>1 month (50°C, 122°F)</td>
<td>Small gain</td>
<td></td>
</tr>
<tr>
<td>• Ethyl Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Ethyl Lactate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Ethyl Propionate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Ethylene Glycol Monoethyl Ether Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Ethylene Glycol Monomethyl Ether Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Isoamyl Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Isobutyl Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Isopropyl Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Methyl Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• n-Propyl Acetate</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Ethers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Dichloro Diethyl Ether</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Diethyl Ether</td>
<td>2 days</td>
<td>46.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Di-Isopropyl Ether</td>
<td>2 days</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Ether-Alcohols</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ethylene Glycol Monoethyl Ether</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Ethylene Glycol Monomethyl Ether</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Toluene</td>
<td>2 days</td>
<td>39.3</td>
<td>54.9</td>
</tr>
<tr>
<td>• Xylene</td>
<td>1 week</td>
<td>41.5</td>
<td>33.2</td>
</tr>
<tr>
<td>Hydrocarbons, Halogenated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Carbon Tetrachloride</td>
<td>2 days</td>
<td>14.8</td>
<td>6.8</td>
</tr>
<tr>
<td>• Chlorobenzene</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Chlorobromomethane</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Chloroform</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• o-Dichlorobenzene</td>
<td>3 days</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• p-Dichlorobenzene</td>
<td>3 days</td>
<td>11.1</td>
<td>11.7</td>
</tr>
<tr>
<td>Reagent</td>
<td>Time Exposed</td>
<td>Percent Increase</td>
<td>Observed Condition</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td><strong>Chemicals</strong></td>
<td></td>
<td>Weight Thickness</td>
<td>of Plastic</td>
</tr>
<tr>
<td>Ethylene Chloride</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Methylene Chloride</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Propylene Chloride</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>s-Tetrabromoethane</td>
<td>3 days</td>
<td>—</td>
<td>Softened, swollen, and tacky</td>
</tr>
<tr>
<td>Tetrachloroethane</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>12 days</td>
<td>—</td>
<td>Badly swollen</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>1 day</td>
<td>—</td>
<td>Badly swollen</td>
</tr>
<tr>
<td><strong>Ketones</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Cyclohexanone</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Di-Isopropyl Ketone</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Methyl Ethyl Ketone</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Methyl n-Butyl Ketone</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Methyl Isobutyl Ketone</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Phorone</td>
<td>— —</td>
<td>—</td>
<td>Dissolved</td>
</tr>
<tr>
<td><strong>Salts</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum Acetate, Basic, 33% water slurry</td>
<td>2 months</td>
<td>1.8 0.6</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Aluminum Chloride, 10% 2 months</td>
<td>1.5 0.7</td>
<td>Unchanged Aluminum Chloride, saturated solution</td>
<td></td>
</tr>
<tr>
<td>Aluminum Sulfate, solid 3 months</td>
<td>1.7 1.1</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Ammonium Bifluoride, saturated solution</td>
<td>1 month</td>
<td>2.3 —</td>
<td>Slightly bleached</td>
</tr>
<tr>
<td>Ammonium Chloride, saturated solution</td>
<td>1 month</td>
<td>2.1 0.8</td>
<td>Unchanged Ammonium Nitrate, solid 1 year</td>
</tr>
<tr>
<td>Aluminum Sulfate, 10% 1 year</td>
<td>1.3 0.5</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Calcium Chloride, 2.5% 1 year</td>
<td>1.5 0.9</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Calcium Chloride, 40% 2 months</td>
<td>0.4 0.0</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Calcium Hypochlorite, 6% 1 year</td>
<td>6.0 -3.8</td>
<td>Softened and cracked</td>
<td></td>
</tr>
<tr>
<td>Calcium Hypochlorite, 30% 13 days</td>
<td>0.8 0.0</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Calcium Phosphate, Monobasic, solid</td>
<td>1 year</td>
<td>1.7 0.5</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Calcium Phosphate, Dibasic, solid</td>
<td>1 year</td>
<td>-0.6 0.6</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Calcium Phosphate, Tribasic, solid</td>
<td>1 year</td>
<td>-0.6 0.6</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Heptane</td>
<td>1 year</td>
<td>1.6 2.5</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Hexane</td>
<td>1 week</td>
<td>— —</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Propane, gas</td>
<td>2 months</td>
<td>0.3 0.6</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Propane, liquid</td>
<td>2 months</td>
<td>1.4 4.6</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Calcium Sulfate (Gypsum), solid</td>
<td>1 year</td>
<td>-0.1 0.6</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Copper Sulfate (Cupric), 10% 2 months</td>
<td>1.7 0.6</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Copper Sulfate, saturated solution</td>
<td>2 months</td>
<td>1.7 0.9</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Cuprous Chloride, solid 1 week</td>
<td>1.5 —</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Ferric Ammonium Sulfate, solid</td>
<td>1 week (38°C, 100°F, 80% RH)</td>
<td>0.3 —</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Ferric Chloride, 5% 2 months</td>
<td>2.0 0.8</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Ferric Chloride, 20% 2 months</td>
<td>1.7 1.0</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Ferric Chloride, 40% 2 months</td>
<td>1.3 0.4</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Reagent</td>
<td>Percent Increase</td>
<td>Observed Condition of Plastic</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------------------</td>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>Ferric Chloride, saturated solution</td>
<td>0.9</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Lithium Bromide, solid 1 week</td>
<td>-0.7</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Lithium Bromide, 50% 1 week 2.5%</td>
<td>0.0</td>
<td>Unchanged Magnesium Carbonate,</td>
<td></td>
</tr>
<tr>
<td>2 days</td>
<td>1.6</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Potassium Aluminum Sulfate (alum), 21% 4 months (38°C, 100°F)</td>
<td>1.9</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Potassium Bromide, 3% 3 days (38°C, 100°F)</td>
<td>1.3</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Potassium Chloride, solid 1 year</td>
<td>0.1</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Potassium Chloride, 10% 1 year</td>
<td>1.7</td>
<td>Unchanged Potassium Chrome</td>
<td></td>
</tr>
<tr>
<td>Alum, 10% 3 days (38°C, 100°F)</td>
<td>1.3</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Potassium Cyanide, 10% 2 months</td>
<td>1.4</td>
<td>Slightly discolored (brown)</td>
<td></td>
</tr>
<tr>
<td>Potassium Cyanide, saturated solution</td>
<td>2 months 0.5</td>
<td>Slightly discolored (brown)</td>
<td></td>
</tr>
<tr>
<td>Potassium Ferricyanide, 10% 4 days</td>
<td>—</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Potassium Sulfate, solid 1 year</td>
<td>0.1</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Potassium Sulfate, 10% 1 year</td>
<td>1.4</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Silver Nitrate, 2.5% 2 days</td>
<td>1.5</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Acetate, 3% 3 days (38°C, 100°F)</td>
<td>1.3</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Aluminum Sulfate, solid 1 week</td>
<td>1.6</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Bicarbonate, 2.5% 2 days</td>
<td>1.7</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Bisulfate, solid 1 week</td>
<td>0.1</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Bisulfate, 1% 3 days (38°C, 100°F)</td>
<td>1.3</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Bisulfite, 20% 1 week</td>
<td>2.1</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Sodium Borate, 2.5% 2 days</td>
<td>1.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Sodium Carbonate, solid 1 week</td>
<td>3.9</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Carbonate, 6% 3 days (38°C, 100°F)</td>
<td>0.1</td>
<td>Unchanged Magnesium Carbonate,</td>
<td></td>
</tr>
<tr>
<td>Sodium Carbonate, 2.5% 1 year</td>
<td>1.3</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>1 week (38°C, 100°F)</td>
<td>0.1</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Chloride, 10% 1 year</td>
<td>—</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Chloride, 2.5% 1 year</td>
<td>—</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Chloride, 10% 1 year</td>
<td>1.8</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Chloride, saturated solution</td>
<td>2 months 0.4</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Chloride, saturated solution</td>
<td>2 months (60°C, 140°F) 0.9</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Chromate, saturated solution</td>
<td>1 week 0.6</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Cyanide, 10% 2 months</td>
<td>1.0</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Cyanide, saturated solution</td>
<td>2 months 0.2</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Ferrocyanide, solid 1 week</td>
<td>0.8</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Fluoride, 4% 1 month</td>
<td>2.5</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Hypochlorite, 30% 13 days</td>
<td>1.1</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Sodium Nitrate, solid 2 months</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Sodium Nitrate, 10% 1 year</td>
<td>1.2</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Sodium Nitrate, saturated solution</td>
<td>2 months 0.9</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Sodium Silicate, solid 2 months</td>
<td>0.3</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Sodium Silicate, saturated solution</td>
<td>2 months 1.2</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>
### Chemical Compatibility Chart continued

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Time Exposed</th>
<th>Percent Increase</th>
<th>Weight</th>
<th>Thickness</th>
<th>Observed Condition of Plastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Sulfite, 10%</td>
<td>1 week</td>
<td>2.1</td>
<td>0.9</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Thiosulfate, 20%</td>
<td>13 days</td>
<td>1.1</td>
<td>0.0</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Sodium Thiosulfate, 24%</td>
<td>3 days (38°C, 100°F)</td>
<td>1.2</td>
<td></td>
<td>—</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Tetra (2-Ethylbutyl) Silicate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 month (50°C, 122°F)</td>
<td>-0.7</td>
<td>-0.1</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Trimethyl Benzyl Ammonium Chloride, 5%</td>
<td>17 days</td>
<td>1.1</td>
<td>0.1</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Zinc Chloride (hydrous salt) 1 week 0.5</td>
<td>0.5</td>
<td></td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Zinc Chloride, saturated solution 1 week</td>
<td>1.4</td>
<td></td>
<td>0.8</td>
<td>Slightly etched</td>
<td></td>
</tr>
<tr>
<td>Zinc Oxide, solid 1 week</td>
<td></td>
<td></td>
<td>—</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous Chemicals and Gases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammoniated Mercury 1 week (60°C, 140°F)</td>
<td></td>
<td></td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>• Aniline</td>
<td></td>
<td></td>
<td></td>
<td>Dissolved</td>
<td></td>
</tr>
<tr>
<td>• Benzaldehyde</td>
<td></td>
<td></td>
<td></td>
<td>Dissolved</td>
<td></td>
</tr>
<tr>
<td>• Butadiene-1,3, liquid 6 months</td>
<td>19.3</td>
<td>26.4</td>
<td></td>
<td>Swollen and softened</td>
<td></td>
</tr>
<tr>
<td>Butadiene-1,3, gas 1 month</td>
<td>1.5</td>
<td>2.3</td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>• Carbon Disulfide 1 week</td>
<td>25.8</td>
<td>1.6</td>
<td></td>
<td>Softened and swollen</td>
<td></td>
</tr>
<tr>
<td>• Carbon Disulfide, saturated atmosphere</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 days</td>
<td>17.4</td>
<td>11.8</td>
<td>Warped</td>
<td></td>
</tr>
<tr>
<td>• Chlorine, dry 1 week</td>
<td>8.8</td>
<td>2.2</td>
<td></td>
<td>Crazed and brittle</td>
<td></td>
</tr>
<tr>
<td>• Chlorine, moist 1 week</td>
<td>7.8</td>
<td>0.1</td>
<td></td>
<td>Crazed and brittle</td>
<td></td>
</tr>
<tr>
<td>• Chlorine, saturated solution 1 week — —</td>
<td>—</td>
<td></td>
<td></td>
<td>Considerably softened and swollen</td>
<td></td>
</tr>
<tr>
<td>• 1,4-Dioxane</td>
<td></td>
<td></td>
<td></td>
<td>Dissolved</td>
<td></td>
</tr>
<tr>
<td>Ethylene Oxide, gas 10 minutes (41°C, 105°F)</td>
<td></td>
<td></td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>• Ethylene Oxide, gas 1 day</td>
<td>20.9</td>
<td>25.6</td>
<td></td>
<td>Swollen and softened</td>
<td></td>
</tr>
<tr>
<td>Formaldehyde, 4% 10 min per day</td>
<td>0.2</td>
<td></td>
<td></td>
<td>Unchanged for 5 days</td>
<td></td>
</tr>
<tr>
<td>• Formaldehyde, 35% 2 months</td>
<td>13.0</td>
<td>6.7</td>
<td></td>
<td>Swollen and softened</td>
<td></td>
</tr>
<tr>
<td>• Furfural</td>
<td></td>
<td></td>
<td></td>
<td>Dissolved</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Peroxide, 3% 1 year</td>
<td>1.7</td>
<td>1.1</td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Peroxide, 5% 2 days</td>
<td>1.4</td>
<td>1.3</td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Sulfide, dry 2 months</td>
<td>2.3</td>
<td>0.8</td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Sulfide, moist 2 months</td>
<td>3.0</td>
<td>1.7</td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Sulfide, saturated solution 2 months</td>
<td>5.9</td>
<td>2.3</td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Hydroquinone, 20 g per gallon 1 week</td>
<td>2.4</td>
<td>1.0</td>
<td></td>
<td>Slightly stained yellow</td>
<td></td>
</tr>
<tr>
<td>• Methyl Methacrylate Monomer</td>
<td></td>
<td></td>
<td></td>
<td>Dissolved</td>
<td></td>
</tr>
<tr>
<td>• Nitrobenzene</td>
<td></td>
<td></td>
<td></td>
<td>Dissolved</td>
<td></td>
</tr>
<tr>
<td>Ozone, 0.05-0.15 ppm 45 days (outdoors) — —</td>
<td></td>
<td></td>
<td></td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Ozone, 0.7 ppm 45 days (49°C, 120°F) — —</td>
<td></td>
<td></td>
<td></td>
<td>Yellowed</td>
<td></td>
</tr>
<tr>
<td>• Phenol</td>
<td>1 week</td>
<td>—</td>
<td>—</td>
<td>Decomposed</td>
<td></td>
</tr>
<tr>
<td>• Styrene Monomer</td>
<td></td>
<td></td>
<td>—</td>
<td>Dissolved</td>
<td></td>
</tr>
<tr>
<td>Sulfur, solid 1 week</td>
<td></td>
<td></td>
<td>—</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>• Sulfur Dioxide, dry 2 months</td>
<td>19.4</td>
<td>8.6</td>
<td></td>
<td>Swollen, slightly warped</td>
<td></td>
</tr>
<tr>
<td>• Sulfur Dioxide, moist 2 months</td>
<td>31.9</td>
<td>10.2</td>
<td></td>
<td>Considerably swollen and warped</td>
<td></td>
</tr>
<tr>
<td>• Sulfur Dioxide, saturated 2 months</td>
<td>23.2</td>
<td>18.1</td>
<td></td>
<td>Swollen and warped</td>
<td></td>
</tr>
</tbody>
</table>
## Chemical Compatibility Chart continued

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Percent Increase</th>
<th>Observed Condition of Plastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur Dioxide in Hydrocarbons</td>
<td>-</td>
<td>Dissolved</td>
</tr>
<tr>
<td>Sulfur Dioxide and Hydrocarbon Vapor</td>
<td>2 months</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19.2</td>
<td>Swollen</td>
</tr>
<tr>
<td></td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>Titanium Tetrachloride 3 days</td>
<td>-</td>
<td>Very brittle</td>
</tr>
<tr>
<td>Trinitrotoluene (TNT), water slurry</td>
<td>4 weeks</td>
<td>Stained</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
**Tumor Positioning and Filling the Phantom**

The following steps are used to place the rotation ball, position rod and tumor vessel into the phantom. First, loosen the lock bolts on the position rod to insert it through the rotation ball until the rod extends the desired distance, then tighten the lock bolts. Next, position the rotation ball assembly and tumor vessel (or dosimeter) within the phantom. Check to see if the tumor vessel or chamber is in the proper position.

Once you have completed the necessary adjustments to the ball, rod, and tumor vessel, remove the intact assembly from the phantom and fill the phantom with water. Next, insert the assembly back into the phantom and fit the rotation ball lock nut loosely onto the phantom. Rotate the ball until the tumor vessel (or dosimeter) is in the desired position, and tighten the rotation ball lock nut.

Place the pelvis on its back to check for leaks. Small leaks can generally be stopped by tightening the rotation ball lock nut and position rod lock bolt. If you are unable to stop leakage from the rotation ball port, it may be necessary to disassemble the port and check the O-rings to ensure that they are properly seated and lubricated.
Filling the Tumor Vessel

As shown in Figure 3, the tumor vessel has a small port at the base of the position rod connector. Therefore, you must remove the position rod before adding or removing materials through the port. To fill the tumor vessel with a low-viscosity liquid, you may use a syringe to inject the fluid directly through the port into the tumor vessel. Once the vessel is full, simply rethread the position rod into the connector to close the port.

Filling tumor vessel with low viscosity liquids
As shown in Figure 3, the tumor vessel has a small port at the base of the position rod connector. Therefore, you must remove the position rod before adding or removing materials through the port. To fill the tumor vessel with a low-viscosity liquid, you may use a syringe to inject the fluid directly through the port into the tumor vessel. Once the vessel is full, simply rethread the position rod into the connector to close the port.

Filling the tumor vessels with high viscosity materials
A different procedure is used for filling the tumor vessel with high-viscosity materials that cannot be injected through the port. In such cases, it is necessary to unthread the two halves of the tumor vessel and then place the desired material in each half. While the half of the tumor vessel with male threads should be filled completely with material, the female threaded half should be filled only to the beginning of the first thread nearest the rounded end. The two halves of the tumor vessel may then be threaded together. Please note that you may set a tumor-simulation mark by inserting an object such as a catheter section into the gel before threading the two halves together.
Dosimetry Gels

The tumor vessel is molded out of Barex plastic. This plastic is oxygen impermeable. This vessel can be used with a variety of gels. If you prefer not to make your own gel, vessels can be filled by MGS Research Inc. in Guilford CT. 203-453-8679

Preparing the Ferrous Agarose Gel

You may use the following seven-step “recipe” to prepare 50ml of ferrous agarose gel:

WARNING: Beware of any impurities, for example dirt, etc. Impurities will cause the gel to change color prior to irradiation.

(1) Bring 45ml of triply de-ionized water to a boil.

(2) Measure 1 gram of agar.

(3) Add the agar to the boiling water and heat the mixture while stirring continuously for 4 to 5 minutes.

(4) Remove the mixture from heat and continue stirring for 3 to 4 minutes.

(5) While the agar mixture is being stirred (step 4), combine 5ml of a ferrous ammonium sulfate solution and 5ml of xylenol orange solution. Directions for preparing these solutions are provided below.

(6) Once the stirring in Step 4 is completed, add the ferrous ammonium sulfate xylenol orange solution to the agar mixture and stir for an additional 8 to 10 minutes.

(7) Pour the resulting gel into the two halves of the tumor vessel.

Original Chemicals Needed:
- 2 x 10^{-4} M Ferrous Ions (Fe^{++})
- 1.5 x 10^{-4} M Xylenol Orange
- 5 x 10^{-2} N Sulfuric Acid (H_{2}SO_{4})
- 1.0% Agar

Preparing Stock Solutions:

Xylenol Orange
(1) Measure 0.124 grams of xylenol orange.
(2) Add 100ml of triply de-ionized H_{2}O.

Ferrous Ammonium Sulfate
(1) Measure .0784 grams of Fe^{++}.
(2) Add 25ml of H_{2}SO_{4} (5x 10^{-2} Normal).
(3) Add 75ml of triply de-ionized water.

Chemical Supply Source:
Fisher Scientific Headquarters, 711 Forbes Avenue, Pittsburgh, PA 15219
412-562-8300
- Ferrous Ammonium Sulfate crystal [Fe(NH_{4})_{2} (SO_{4})_{2} \Sigma 6H_{2}O] (Cat.# I77-500)
- Xylenol Orange Tetrasodium Salt (Cat.# X15-5)

Sigma Chemical Co., St. Louis, MO
314-771-5750
- Purified Agar (Stock# A-7049)
- Ferrous Ammonium Sulfate [Fe(NH_{4})_{2} (SO_{4})_{2} \Sigma 6H_{2}O]
- Xylenol Orange (Stock# X-3500 Tetrasodium Salt)
Radiation Chambers and Probes

The rotation ball will hold 1/2” diameter tubing. Water sealed chambers mounted on 1/2” diameter tubes with adequate length and end clearance may be used in this phantom. In some cases custom modifications can be made to allow other sizes.

WARRANTY

THE PHANTOM LABORATORY INCORPORATED (“Seller”) warrants that this product shall remain in good working order and free of all material defects for a period of one (1) year following the date of purchase. If, prior to the expiration of the one (1) year warranty period, the product becomes defective, Buyer shall return the product to the Seller at:

By Truck  By Mail
The Phantom Laboratory, Incorporated The Phantom Laboratory, Incorporated
2727 State Route 29 PO Box 511
Greenwich, NY 12834 Salem, NY 12865-0511

Seller shall, at Seller’s sole option, repair or replace the defective product. The Warranty does not cover damage to the product resulting from accident or misuse.

IF THE PRODUCT IS NOT IN GOOD WORKING ORDER AS WARRANTED, THE SOLE AND EXCLUSIVE REMEDY SHALL BE REPAIR OR REPLACEMENT, AT SELLER’S OPTION. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT. THIS LIMITATION APPLIES TO DAMAGES OF ANY KIND, INCLUDING, BUT NOT LIMITED TO, DIRECT OR INDIRECT DAMAGES, LOST PROFITS, OR OTHER SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER FOR BREACH OF CONTRACT, TORT OR OTHERWISE, OR WHETHER ARISING OUT OF THE USE OF OR INABILITY TO USE THE PRODUCT. ALL OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED.
Bibliography

Radiation-Sensitive Gels


Film Dosimetry


Quality Assurance