

T h e P h a n t o m L a b o r a t o r y

## Liqui-Phil™ General Manual

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### WARNING

Do not allow filled phantoms to be exposed to heat or freezing.

This product is not compatible with some chemicals. Review chemicals to be used in the phantom for compatibility with CAB and polycarbonate materials prior to use.

It is advised not to expose this product to open flame or high temperature (over 38° Celsius or 100° Fahrenheit) heating elements.

### 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  
The Phantom Laboratory Incorporated  
2727 State Route 29  
Greenwich, NY 12834

Or By Mail  
PO Box 511  
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 MERCHANT ABILITY AND FITNESS FOR PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED.

8/19/10



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## **Introduction**

The Phantom Laboratory designs and manufactures its own phantoms as well as custom and OEM phantoms. These phantoms are used for numerous research activities where scientists need to hold liquid solutions. Because each application is different, and each medical facility has its own unique set of requirements, The Phantom Laboratory does not set forth operational protocols, nor do we make specific recommendations on the frequency and expected results of evaluations. Review the local governing regulations, the needs of your radiologists and physicists, and your system manufacturer's recommendations when developing your measurement protocols. In order to prevent damage to your phantom, review the chemical compatibility chart that begins on page 6 in order to determine which chemicals can be used in these phantoms.

If you have questions about 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  
Email: [info@phantomlab.com](mailto:info@phantomlab.com)

## Care and Maintenance

The Liqui-Phil™ Phantom shell is fabricated from 0.125-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. Both of these materials are susceptible to solvents, therefore we recommend the use of mild soap and water when cleaning. Please note that water temperatures above 100° Fahrenheit should not be used as it will cause the plastic material to become deformed, thus destroying the phantom.

The Liqui-Phil™ Phantom is designed to be filled with water. Please refer to the Chemical Compatibility Chart on pages 6-11 of this manual prior to use. Some chemicals will destroy the Phantom's shell and, if used, will render the warranty invalid.

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 a mild detergent and water. Before storing the phantom, empty all water from it. To prevent mold build-up, the phantom should be stored empty, clean, and dry with the port plugs removed.

Cellulose acetate butyrate will yellow when exposed to ultraviolet light. This discoloration will not affect the phantom's performance.

The Liqui-Phil™ Phantom may contain o-rings. To ensure easy function and a tight seal, always lubricate o-rings with petroleum jelly or silicon lubricant periodically during use and after each cleaning.

## Chemical Compatibility Chart

Reagent Chemicals	Time Exposed	Percent Increase		Observed Condition of Plastic
		Weight	Thickness	
<b>Acids</b>				
Acetic, 5%	1 year	3.6	2.1	Slightly softened
Acetic, 10%	2 months	5.2	2.4	Slightly softened
•Acetic, 30%	2 months	13.6	8.6	Softened and swollen
Boric, 5%	2 days	1.3	0.0	Unchanged
Chromic, 6%	8 days (38°C, 100°F)	2.0	0.1	Slightly stained
Citric, 10%	4 months (60°C, 140°F)	1.6	0.8	Slightly softened
Citric, 10%	1 year	1.4	0.6	Unchanged
•Citric, 60%	4 months (60°C, 140°F)	—	—	Surface attacked
Fluosilicic, 10%	2 months	4.5	1.2	Unchanged
Fluosilicic, 28%	2 months	4.7	3.6	Unchanged
Formic, 3%	20 days	—	—	Unchanged
Hydrochloric, 10%	1 year	0.9	0.5	Surface slightly attacked
•Hydrofluoric, 10%	1 month	10.3	5.5	Slightly swollen and softened
•Hydrofluoric, 48%		—	—	Dissolved
Lactic, 50%	2 days	1.6	0.5	Unchanged
•Nitric, 10%	8 months	—	—	Decomposed
Oleic	1 year	2.3	1.5	Unchanged
Phosphoric, 30%	2 months	1.3	0.8	Unchanged
Phosphoric, 50%	2 months	1.6	0.8	Unchanged
•Phosphoric, 75%	2 months	—	—	Partially decomposed
Pyrogalllic, 4%	1 week	2.6	1.1	Stained yellow
Stearic	1 week	—	—	Unchanged
Sulfuric, 3%	1 year	1.6	1.0	Slightly discolored
Sulfuric, 10%	1 year	1.5	0.7	Slightly discolored
•Sulfuric, 20%	1 year	0.9	0.3	Slightly softened, surface
attacked •Sulfuric, 30%	1 year	0.4	0.3	Surface attacked
•Sulfuric, 94%		—	—	Disintegrated
Tannic, 10%	4 months (38°C, 100°F)	2.8	1.2	Unchanged
Trichloroacetic, 1%	1 month	3.3	0.5	Unchanged
•Trichloroacetic, 5%	1 month	9.3	3.1	Softened
<b>Alcohols, Monohydric</b>				
n-Amyl	2 days	3.1	3.0	Unchanged
•tert-Amyl	2 days	14.0	11.3	Softened, tacky
•n-Butyl	2 days	6.5	7.2	Swollen
•sec-Butyl	2 days	7.2	10.7	Swollen
•tert-Butyl	2 days	3.6	3.3	Slightly softened
•Diacetone		—	—	Dissolved
•Ethyl (denatured)	2 days	23.0	24.7	Softened
•Ethyl, 50%	1 week	13.4	11.6	Softened
•2-Ethylhexyl	1 week	—	—	Swollen
<b>Hydrocarbons</b>				
Gas, Natural, aromatic-free	1 year	—	—	Shown slight decrease in tensile strength and increase in impact strength
Gas, Natural, 5% aromatic content	23 days	—	—	Shown slight decrease in tensile strength and increase in impact strength

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

## Chemical Compatibility Chart continued

Reagent Chemicals	Time Exposed	Percent Increase		Observed Condition of Plastic
		Weight	Thickness	
•Isoamyl	2 days	2.0	2.1	Very slightly softened
•Isopropyl	2 days	23.4	25.1	Softened, tacky
•Methyl		—	—	Dissolved
Methyl, 5%	1 year	2.0	1.2	Slightly softened
•n-Propyl	2 days	15.0	4.4	Slightly softened
•Tetrahydrofurfuryl		—	—	Dissolved
Alcohols, Dihydric and Trihydric				
•Diethylene Glycol	2 months	8.2	6.1	Softened
2-Ethyl Hexanediol-1,3	2 days (38°C, 100°F)	—	—	Unchanged
Ethylene Glycol	1 year	4.2	2.1	Unchanged
Glycerin	1 year	0.0	0.4	Unchanged
Propylene Glycol	2 days	0.4	0.0	Unchanged
•Triethylene Glycol	2 months	8.6	6.7	Softened
Bases				
•Ammonium Hydroxide, 10%	2 months	21.9	12.9	Softened
Calcium Hydroxide, saturated solution				
	1 week	0.7	0.7	Unchanged
Sodium Hydroxide, 1%	1 year	1.0	0.6	Unchanged
•Sodium Hydroxide, 10%	8 months	3.2	2.2	Brittle
Trimethylbenzyl Ammonium Hydroxide, 5%	17 days	1.1	0.0	Unchanged
Esters				
•n-Butyl Acetate		—	—	Dissolved
•sec-Butyl Acetate		—	—	Dissolved
Di-2-Ethylhexyl Adipate	1 year	0.9	0.3	Unchanged
Di-2-Ethylhexyl Phthalate	1 month (50°C, 122°F)			Small gain
•Ethyl Acetate		—	—	Dissolved
•Ethyl Lactate		—	—	Dissolved
•Ethyl Propionate		—	—	Dissolved
•Ethylene Glycol Monoethyl Ether Acetate		—	—	Dissolved
•Ethylene Glycol Monomethyl Ether Acetate		—	—	Dissolved
•Isoamyl Acetate		—	—	Dissolved
•Isobutyl Acetate		—	—	Dissolved
•Isopropyl Acetate		—	—	Dissolved
•Methyl Acetate		—	—	Dissolved
•n-Propyl Acetate		—	—	Dissolved
Ethers				
•Dichloro Diethyl Ether		—	—	Dissolved
•Diethyl Ether	2 days	46.0	50.0	Considerably swollen
Di-Isopropyl Ether	2 days	0.8	1.1	Unchanged
Ether-Alcohols				
•Ethylene Glycol Monoethyl Ether		—	—	Dissolved
•Ethylene Glycol Monomethyl Ether		—	—	Dissolved
•Toluene	2 days	39.3	54.9	Softened
•Xylene	1 week	41.5	33.2	Softened
Hydrocarbons, Halogenated				
•Carbon Tetrachloride	2 days	14.8	6.8	Surface slightly softened
•Chlorobenzene		—	—	Dissolved
•Chlorobromomethane		—	—	Dissolved
•Chloroform		—	—	Dissolved
•o-Dichlorobenzene	3 days	—	—	Softened and swollen
•p-Dichlorobenzene	3 days	11.1	11.7	Swollen

## Chemical Compatibility Chart continued

Reagent	Time Exposed	Percent Increase		Observed Condition
Chemicals		Weight	Thickness	of Plastic
•Ethylene Chloride		—	—	Dissolved
•Methylene Chloride		—	—	Dissolved
•Propylene Chloride		—	—	Dissolved
•s-Tetrabromoethane	3 days	—	—	Softened, swollen, and tacky
•Tetrachloroethane		—	—	Dissolved
•Tetrachloroethylene	12 days	—	—	Badly swollen
•Trichloroethylene	1 day	—	—	Badly swollen
<b>Ketones</b>				
•Acetone		—	—	Dissolved
•Cyclohexanone		—	—	Dissolved
•Di-Isopropyl Ketone		—	—	Dissolved
•Methyl Ethyl Ketone		—	—	Dissolved
•Methyl n-Butyl Ketone		—	—	Dissolved
•Methyl Isobutyl Ketone		—	—	Dissolved
•Phorone		—	—	Dissolved
<b>Salts</b>				
Aluminum Acetate, Basic, 33% water slurry				
	2 months	1.8	0.6	Unchanged
Aluminum Chloride, 10%	2 months	1.5	0.7	Unchanged Aluminum
Chloride, saturated solution				
	2 months	0.1	0.0	Unchanged
Aluminum Sulfate, solid	3 months	1.7	1.1	Unchanged
Ammonium Bifluoride, saturated solution				
	1 month	2.3	—	Slightly bleached
Ammonium Chloride, saturated solution				
	1 month	2.1	0.8	Unchanged Ammonium
Nitrate, solid	1 week	0.2	0.2	Unchanged Ammonium
Nitrate, 10%	1 week	1.7	0.8	Unchanged Ammonium
Sulfate, solid	1 year	0.1	0.6	Unchanged
Ammonium Sulfate, 10%	1 year	1.3	0.5	Unchanged
Calcium Chloride, 2.5%	1 year	1.5	0.9	Unchanged
Calcium Chloride, 40%	2 months	0.4	0.0	Unchanged
Calcium Hypochlorite, 6%	1 year	6.0	-3.8	Softened and cracked
Calcium Hypochlorite, 30%	13 days	0.8	0.0	Unchanged
Calcium Phosphate, Monobasic, solid				
	1 year	1.7	0.5	Unchanged
Calcium Phosphate, Dibasic, solid				
	1 year	-0.6	0.6	Unchanged
Calcium Phosphate, Tribasic, solid				
	1 year	-0.6	0.6	Unchanged
Heptane	1 year	1.6	2.5	Unchanged
Hexane	1 week	—	—	Unchanged
Propane, gas	2 months	0.3	0.6	Unchanged
Propane, liquid	2 months	1.4	4.6	Unchanged
Calcium Sulfate (Gypsum), solid				
	1 year	-0.1	0.6	Unchanged
Copper Sulfate (Cupric), 10%	2 months	1.7	0.6	Unchanged
Copper Sulfate, saturated solution				
	2 months	1.7	0.9	Unchanged
Cuprous Chloride, solid	1 week	1.5	—	Unchanged
Ferric Ammonium Sulfate, solid				
	1 week (38°C, 100°F,	0.3	—	Unchanged
80% RH) Ferric Chloride, 5%	2 months	2.0	0.8	Unchanged
Ferric Chloride, 20%	2 months	1.7	1.0	Unchanged
Ferric Chloride, 40%	2 months	1.3	0.4	Unchanged

## Chemical Compatibility Chart continued

Reagent	Time Exposed	Percent Increase Weight Thickness	Observed Condition of Plastic
Ferric Chloride, saturated solution	1 month	0.9 0.3	Unchanged
Lithium Bromide, solid	1 week	-0.7 0.0	Unchanged
Lithium Bromide, 50%	1 week	0.0 0.0	Unchanged Magnesium
Carbonate, 2.5%	2 days	1.6 1.0	Unchanged
Potassium Aluminum Sulfate (alum), 21%	4 months (38°C, 100°F)	1.9 0.8	Unchanged
Potassium Bromide, 3%	3 days (38°C, 100°F)	1.3 -	Unchanged
Potassium Chloride, solid	1 year	0.1 0.5	Unchanged
Potassium Chloride, 10%	1 year	1.7 0.4	Unchanged Potassium
Chrome Alum, 10%	3 days (38°C, 100°F)	1.3 -	Unchanged
Potassium Cyanide, 10%	2 months	1.4 0.3	Slightly discolored (brown)
Potassium Cyanide, saturated solution	2 months	0.5 0.0	Slightly discolored (brown)
Potassium Ferricyanide, 10%	4 days	- -	Unchanged
Potassium Sulfate, solid	1 year	0.1 0.6	Unchanged
Potassium Sulfate, 10%	1 year	1.4 0.4	Unchanged
Silver Nitrate, 2.5%	2 days	1.5 0.0	Unchanged
Sodium Acetate, 3%	3 days (38°C, 100°F)	1.3 -	Unchanged
Sodium Aluminum Sulfate, solid	1 week	1.6 0.4	Unchanged
Sodium Bicarbonate, 2.5%	2 days	1.7 0.5	Unchanged
Sodium Bisulfate, solid	1 week (38°C, 100°F, 80% RH)	0.1 -	Unchanged
Sodium Bisulfate, 1%	3 days (38°C, 100°F)	1.3 -	Unchanged
Sodium Bisulfite, 20%	1 week	2.1 0.8	Unchanged
Sodium Borate, 2.5%	2 days	1.5 0.5	Unchanged
Sodium Carbonate, solid	1 week (38°C, 100°F, 80% RH)	3.9 -	Unchanged
Sodium Carbonate, 2.5%	1 year	1.3 0.9	Unchanged Sodium
Carbonate, 6%	3 days (38°C, 100°F)	1.2 -	Unchanged
Sodium Carbonate, 10%	1 year	- -	Unchanged
Sodium Chloride, 2.5%	1 year	- -	Unchanged
Sodium Chloride, 10%	1 year	1.3 0.5	Unchanged
Sodium Chloride, saturated solution	2 months	0.8 0.3	Unchanged
Sodium Chloride, saturated solution	2 months (60°C, 140°F)	0.9 0.9	Unchanged
Sodium Chromate, saturated solution	1 week	0.6 0.2	Unchanged
Sodium Cyanide, 10%	2 months	1.0 0.3	Unchanged
Sodium Cyanide, saturated solution	2 months	-0.2 -0.4	Unchanged
Sodium Ferrocyanide, solid	1 week	0.8 -	Unchanged
Sodium Fluoride, 4%	1 month	2.5 -	Unchanged
Sodium Hypochlorite, 30%	13 days	1.1 -2.1	Unchanged
Sodium Nitrate, solid	2 months	0.1 0.1	Unchanged
Sodium Nitrate, 10%	1 year	1.2 0.4	Unchanged
Sodium Nitrate, saturated solution	2 months	0.9 0.4	Unchanged
Sodium Silicate, solid	2 months	0.3 0.2	Unchanged
Sodium Silicate, saturated solution	2 months	1.2 0.1	Unchanged

## Chemical Compatibility Chart continued

Reagent	Time Exposed	Percent Increase		Observed Condition
		Weight	Thickness	of Plastic
Sodium Sulfite, 10%	1 week	2.1	0.9	Unchanged
Sodium Thiosulfate, 20%	13 days	1.1	0.0	Unchanged
Sodium Thiosulfate, 24%	3 days (38°C, 100°F)	1.2	—	Unchanged
Tetra (2-Ethylbutyl) Silicate	1 month (50°C, 122°F)	0.7	- 0.1	Unchanged
Trimethyl Benzyl Ammonium Chloride, 5%	17 days	1.1	0.1	Unchanged
Zinc Chloride (hydrous salt)	1 week	0.5	0.0	Unchanged
Zinc Chloride, saturated solution	1 week	1.4	0.8	Slightly etched
Zinc Oxide, solid	1 week	—	—	Unchanged
Miscellaneous Chemicals and Gases				
Ammoniated Mercury	1 week (60°C, 140°F)	—	—	Unchanged
•Aniline		—	—	Dissolved
•Benzaldehyde		—	—	Dissolved
•Butadiene-1,3, liquid	6 months	19.3	26.4	Swollen and softened
Butadiene-1,3, gas	1 month	2.7	2.3	Unchanged
•Carbon Disulfide	1 week	25.8	1.6	Softened and swollen
•Carbon Disulfide, saturated atmosphere	2 days	17.4	11.8	Warped
•Chlorine, dry	1 week	8.8	2.2	Crazed and brittle
•Chlorine, moist	1 week	7.8	0.1	Crazed and brittle
•Chlorine, saturated solution	1 week	—	—	Considerably softened and swollen
•1,4-Dioxane		—	—	Dissolved
Ethylene Oxide, gas	10 minutes (41°C, 105°F)	—	—	Unchanged
•Ethylene Oxide, gas	1 day	20.9	25.6	Swollen and softened
Formaldehyde, 4%	10 min per day	0.2	—	Unchanged for 5 days
•Formaldehyde, 35%	2 months	13.0	6.7	Swollen and softened
•Furfural		—	—	Dissolved
Hydrogen Peroxide, 3%	1 year	1.7	1.1	Unchanged
Hydrogen Peroxide, 5%	2 days	1.4	1.3	Unchanged
Hydrogen Sulfide, dry	2 months	2.3	0.8	Unchanged
Hydrogen Sulfide, moist	2 months	3.0	1.7	Unchanged
Hydrogen Sulfide, saturated solution	2 months	5.9	2.3	Unchanged
Hydroquinone, 20 g per gallon	1 week	2.4	1.0	Slightly stained yellow
•Methyl Methacrylate Monomer		—	—	Dissolved
•Nitrobenzene		—	—	Dissolved
Ozone, 0.05-0.15 ppm	45 days (outdoors)	—	—	Unchanged
Ozone, 0.7 ppm	45 days (49°C, 120°F)	—	—	Yellowed
•Phenol	1 week	—	—	Decomposed
•Styrene Monomer		—	—	Dissolved
Sulfur, solid	1 week	—	—	Unchanged
•Sulfur Dioxide, dry	2 months	19.4	8.6	Swollen, slightly warped
•Sulfur Dioxide, moist	2 months	31.9	10.2	Considerably swollen and warped
•Sulfur Dioxide, saturated	2 months	23.2	18.1	Swollen and warped

**Chemical Compatibility Chart continued**

<b>Reagent</b>	<b>Time Exposed</b>	<b>Percent Increase</b>		<b>Observed Condition</b>
		<b>Weight</b>	<b>Thickness</b>	<b>of Plastic</b>
•Sulfur Dioxide in Hydrocarbons		—	—	<b>Dissolved</b>
•Sulfur Dioxide and Hydrocarbon Vapor				
	<b>2 months</b>	<b>19.2</b>	<b>11.5</b>	<b>Swollen</b>
•Titanium Tetrachloride	<b>3 days</b>	—	—	<b>Very brittle</b>
Trinitrotoluene (TNT), water slurry				
	<b>4 weeks</b>	—	—	<b>Stained</b>

## **Optional Accessories**

Your phantom may include some of the following accessories:

### **Tumor Rotation Ball**

Some of the Liqui-Phil™ Phantoms that we manufacture have rotation ball tumor supports. For proper functioning, it is important that the internal o-ring within the rotation ball is lightly lubricated with petroleum jelly or silicon lubricant. The tumor and organ support rods will fit through the rotation balls and allow for varied positioning. The rotation ball lock nut holds the tumor into place and also seals the phantom in order to prevent leaking.

To insert tumors into the organs or phantom, remove the port plug and assemble the tumor through the rotation ball port and tumor into the organ. Not all tumor sizes will fit into all organs. When organs or tumors are not required in a study, the port can be sealed by rotating the rotation ball so the internal hole is perpendicular to the port hole.

### **Optional Tumor Vessels**

The tumor vessels come in many different shapes, sizes, and materials. It is recommended that a test be performed prior to filling with solutions. This should be done by applying a small amount of the desired solution onto the outside of the tumor vessel and observing the material for any changes in appearance. If unsure of the solution's affect on the plastic, it is recommended that the tumor vessels be emptied and cleaned after each use.

