Mammography Phototimeter Consistency Testing Slabs

Model 014A

USER GUIDE

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MAMMOGRAPHY PHOTOTIMER CONSISTENCY TESTING SLABS

The American Cancer Society and American College of Radiology guidelines for the screening of asymptomatic women have made over 50 million women candidates for mammography. In view of the staggering numbers involved, it is critically important that simple but reliable methods be developed to assess system performance and to assure consistent production of diagnostically useful images.

CONTENTS

PHANTOM USE

WHAT TO DO FIRST:

1. For testing slabs, make a series of exposures at different thicknesses by combining the slabs available. Make sure when stacking the slabs that they all have the same glandularity. For example make an exposure at 2, 3, 4, 4.5, and 5 cm.

   For an artifact evaluation phantom, make one exposure.

2. Mark each exposure so you can identify the film.

3. Measure each film's background density using an optical densitometer. Be sure to take your measurements in the same position on each film.

4. Record your results and compare variances in optical densities.

5. The optical density measurements should be relatively the same for each image taken.

RECORD KEEPING

Record Test Results:

Image#	Thickness	OD	Variance from the mean
1	2 cm		
2	3 cm		
3	3.5 cm		
4	4 cm		
5	4.5 cm		
6	5 cm		
7	6 cm		

mean OD =

**Variance should not exceed 0.1 OD

MATERIALS

Tissue equivalent resin molding techniques are used. The system of resins used have been developed over the past 20 years to permit mimicking of any body tissue at different diagnostic X-Ray energy levels. The elemental composition of CIRS simulating tissue as compared to Hammerstein's analysis [11] of human tissue is shown in *Table 1*. Also shown in *Table 1 and Figures 1, 2, and 3* are comparisons of linear attenuation coefficients for actual breast tissue and CIRS simulated tissue.

The materials used have been formulated for optimum response in the film screen mammographic range of X-Ray exposure (24 to 34 kVp), but will generally provide similar results at higher (xeromammographic) exposure ranges.

The CIRS resin materials mimic the photon attenuation coefficients of a range of breast tissues. The average elemental composition of the human breast being mimicked is based on the individual elemental compositions of adipose and glandular tissues as reported by Hammerstein. [11] See *Table 1 and 2* for comparative data.

CLEANING

Cleaning may be accomplished by using mild soap and water solutions. Avoid contact with corrosive substances and with radiographic contrast media. Wash thoroughly if such contact occurs.

HANDLING AND STORAGE

Your phantom is manufactured from epoxy resin. Various other chemicals and fillers have been added to the resin using a proprietary tissue simulation technology. As with most other epoxy plastics, your phantoms may discolor over time. This process can be accelerated by direct exposure to sunlight or extreme temperatures. Epoxy is quite durable, but can still be damaged if it is dropped on a hard surface so handle with care! Most phantoms can be easily repaired. If damaged, contact CIRS.

Epoxy plastics are flexible in nature and will creep (warp/bow/deform) under constant stress over time, even under its own weight. Creeping is not as common in smaller slabs. The slab will self correct and recover its original shape if placed back in its original geometry. An easy way to maintain slab flatness and minimize creep is to store the slabs, clean and free of debris on or in between flat surfaces. If slabs are to be shipped, special care should be given to packaging or the use of a specially fitted carry case which will protect flatness.

1. White, D.R., R.J. Martin, and R. Darlison, Epoxy resin based tissue substitutes, British Journal of Radiology, 5, 814-821, 1977.

2. Materials are formulated to maximize simulation properties at 20 KEV for the mammographic range, 80keV for the diagnostic range and 0.5MeV and above for the therapeutic range.

SPECIFICATIONS

STANDARD DIMENSIONS - TABLE 1

Standard Glandularity	Model	Quantity	Length	Width	Thickness
BR 12	014A	3	12.5 cm	10 cm	2 cm
		2	12.5 cm	10 cm	1 cm
		1	12.5 cm	10 cm	0.5 cm

For custom ordered slabs with embedded detail plates, it is important to note that, unless otherwise requested, the background material will vary while the embedded targets will remain the same. Masses are composed of 75% Glandular/ 25% Adipose Breast-Equivalent material. The detectability of the mass will vary with the changing background composition to the point that even the largest mass may not be detectable (i.e. 5% contrast with the 70/30 background and the 75/25 mass).

ELEMENTAL COMPOSITION OF CIRS BR12[1] FORMULA

C: 0.704 O: 0.169 H: 0.096 N: 0.019 Ca: 0.009 Cl: 0.002

Density = 0.97

CALCULATED ATTENUATION VALUES[2]:

keV = 10	MU = 3.550
keV = 15	MU = 1.183
keV = 20	MU = 0.610
keV = 30	MU = 0.315
keV = 40	MU = 0.239
keV = 50	MU = 0.209
keV = 60	MU = 0.193
keV = 80	MU = 0.174
keV = 100	MU = 0.163

SPECIFY GLANDULAR EQUIVALENCY WHEN ORDERING OTHER THAN STANDARD

% Gland	% Adipose
0/100	
30/70	
(BR 12) 47/53	
50/50	
70/30	
100/0	

TOTAL ATTENUATION COMPARISON FOR VARIOUS PHANTOM DENSITIES AND SIZES (TABLE 2)

TISSUE	Acrylic	Acrylic	BR-12	50/50	30/70	50/50	30/70	50/50	20/80	50/50	50/50
THICKNESS (cm)	4.4	4.55	4.5	4.0	4.5	4.5	5.0	5.0	6.0	4.2	4.5
MFGR	ACR	Mfgr #2	CIRS	CIRS	CIRS	CIRS	CIRS	CIRS	CIRS	CIRS Slab	MTM 100
FAT LAYER	n/a	n/a	n/a	yes	yes	yes	yes	yes	yes	n/a	yes
KEV											
10	15.5565	17.0861	15.966	13.7728	14.3436	15.6034	15.9943	17.4341	18.4018	15.3772	15.6034
15	5.1325	5.6061	5.3214	4.5971	4.7993	5.2068	5.3508	5.8165	6.1676	5.1216	5.2068
20	2.6875	2.9129	2.7471	2.3826	2.5136	2.6962	2.8012	3.0098	3.2472	2.6344	2.6962
30	1.4487	1.5496	1.4186	1.2429	1.3391	1.4038	1.4908	1.5648	1.7488	1.3521	1.4038
40	1.1322	1.2024	1.0777	0.9502	1.0368	1.0720	1.1536	1.1938	1.3628	1.0232	1.0720
50	1.0027	1.0612	0.9404	0.8318	0.9136	0.9379	1.0162	1.0439	1.2047	0.8909	0.9379

This chart compares the composite attenuation for various phantom size/ density combinations. The linear attenuation coefficient for each type of material (wax, acrylic, gland, etc.) applied to the thickness of the material in each phantom design permits calculation of the coefficient of total attenuation for each design.

ACTUAL BREAST TISSUES

(per Hammerstein) The formula $\frac{I}{I_0} = e^{-ux}$ is applicable.

TISSUE	50/50	50/50	30/70	20/80	50/50	50/50
THICKNESS (cm)	4.5	5.0	5.0	6.0	4.2	4.0
MFGR	Actual	Actual	Actual	Actual	Actual	Actual
FAT LAYER	yes	yes	yes	yes	no	yes
KEV						
10	16.1631	18.0691	16.4315	18.8438	16.0104	14.2571
15	5.2618	5.8788	5.3966	6.2186	5.1833	4.6447
20	2.6962	3.0098	2.8015	3.2506	2.6341	2.3826
30	1.3976	1.5577	1.4864	1.7456	1.3447	1.2375
40	1.0691	1.1905	1.1519	1.3616	1.0196	0.9477
50	0.9370	1.0429	1.016	1.2049	0.8897	0.8311

LINEAR ATTENUATION COEFFICIENTS ACTUAL VS SIMULATED (TABLE 3)

	100% Adipose		*70% Glandular*		*30% Glandular*		*100% Glandular*		*50% Glandular*	
KEV	ACTUAL	SIMULATED	ACTUAL	SIMULATED	ACTUAL	SIMULATED	ACTUAL	SIMULATED	ACTUAL	SIMULATED
10	2.8211	2.7891	4.2396	4.0294	3.4026	3.3013	4.9195	4.6330	3.8120	3.6612
15	0.9424	0.9388	1.3600	1.3364	1.1136	1.1030	1.5602	1.5300	1.2341	1.2194
20	0.5011	0.5009	0.6815	0.6805	0.5751	0.5751	0.7680	0.7681	0.6272	0.6272
30	0.2770	0.2772	0.3388	0.3407	0.3023	0.3034	0.3684	0.3719	0.3202	0.3219
40	0.2194	0.2194	0.2528	0.2537	0.2331	0.2336	0.2688	0.2708	0.2428	0.2436
50	0.1956	0.1954	0.2188	0.2191	0.2051	0.2052	0.2220	0.2309	0.2118	0.2121
60	0.1824	0.1821	0.2010	0.2009	0.1900	0.1899	0.2099	0.2103	0.1954	0.1954
80	0.1668	0.1665	0.1813	0.1909	0.1727	0.1725	0.1883	0.1883	0.1770	0.1767
100	0.1566	0.1563	0.1693	0.1688	0.1618	0.1615	0.1754	0.1753	0.1655	0.1652

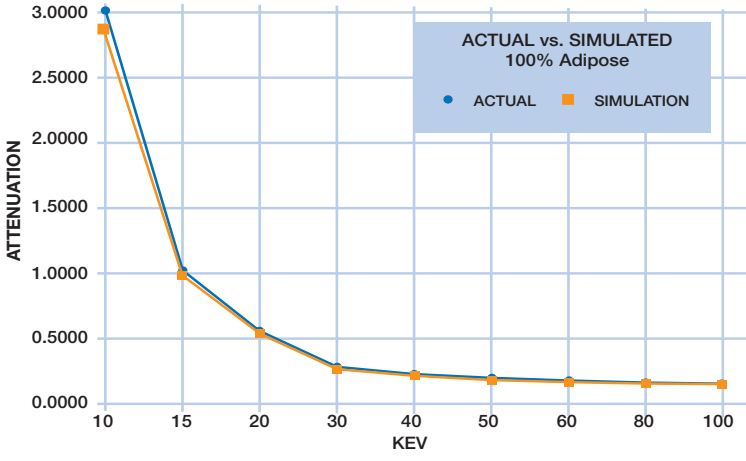

Figure 1

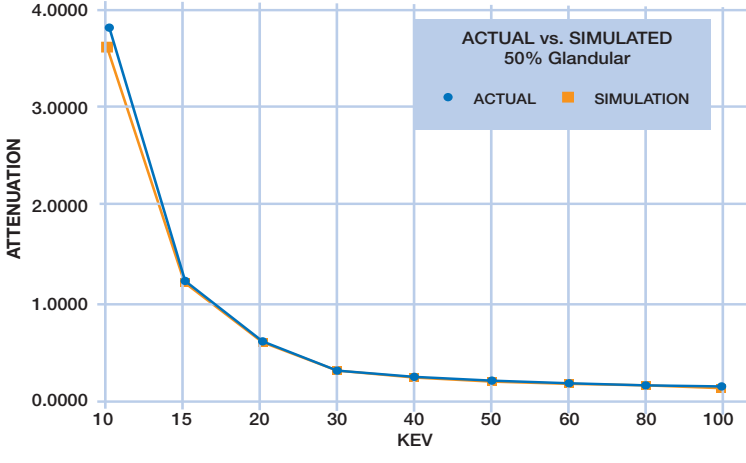

Figure 2

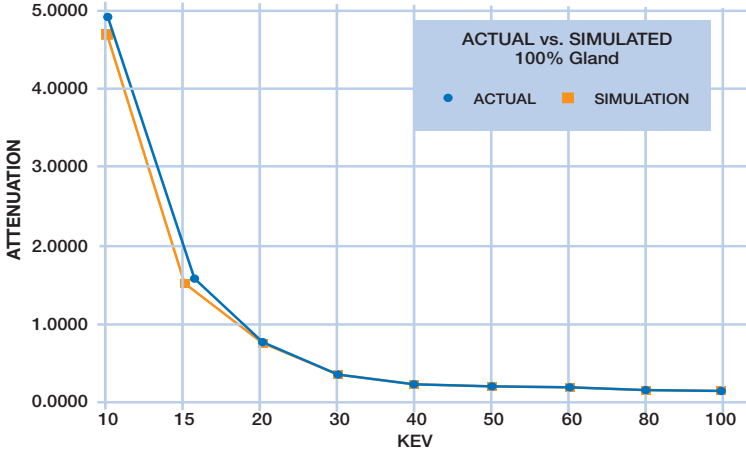

Figure 3

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WARRANTY

All standard CIRS products and accessories are warranted by CIRS against defects in material and workmanship for a period as specified below. During the warranty period, the manufacturer will repair or, at its option, replace, at no charge, a product containing such defect provided it is returned, transportation prepaid, to the manufacturer. Products repaired in warranty will be returned transportation prepaid.

There are no warranties, expressed or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description on the face hereof. This expressed warranty excludes coverage of, and does not provide relief for, incidental or consequential damages of any kind or nature, including but not limited to loss of use, loss of sales or inconvenience. The exclusive remedy of the purchaser is limited to repair, recalibration, or replacement of the product at manufacturer's option.

This warranty does not apply if the product, as determined by the manufacturer, is defective because of normal wear, accident, misuse, or modification.

NON-WARRANTY SERVICE

If repairs or replacement not covered by this warranty are required, a repair estimate will be submitted for approval before proceeding with said repair or replacement.

RETURNS

If you are not satisfied with your purchase for any reason, please contact your local distributor prior to returning the product. Visit https://www.cirsinc.com/distributors/ to find your local distributor. If you purchased your product direct through CIRS, call Customer Service at 800-617-1177, email rma@cirsinc.com, or fax an RMA request form to 757-857-0523. CIRS staff will attempt to remedy the issue via phone or email as soon as possible. If unable to correct the problem, a return material authorization (RMA) number will be issued. Non-standard or "customized" products may not be returned for refund or exchange unless such product is deemed by CIRS not to comply with documented order specifications. You must return the product to CIRS within 30 calendar days of the issuance of the RMA. All returns should be packed in the original cases and or packaging and must include any accessories, manuals and documentation that shipped with the product. The RMA number must be clearly indicated on the outside of each returned package. CIRS recommends that you use a carrier that offers shipment tracking for all returns and insure the full value of your package so that you are completely protected if the shipment is lost or damaged in transit. If you choose not to use a carrier that offers tracking or insure the product, you will be responsible for any loss or damage to the product during shipping. CIRS will not be responsible for lost or damaged return shipments. Return freight and insurance is to be pre-paid.

WITH RMA NUMBER, ITEMS MAY BE RETURNED TO:

CIRS
Receiving
900 Asbury Ave,
Norfolk, Virginia, 23513 USA

PRODUCT	WARRANTY PERIOD
Model 014A Mammography Phototimer Consistency Testing Slabs	60 Months

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