Stereotactic Breast Biopsy Quality Control Manual 1999

(A Supplement to the Mammography Quality Control Manual)

Physician's Section

Radiologic Technologist's Section

Medical Physicist's Section

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Quality Control Manual

(A Supplement to the Mammography Quality Control Manual)

Physician's Section

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1999

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American College of Radiology
Committee on Stereotactic Breast Biopsy Accreditation
Subcommittee of Stereotactic Breast Biopsy Quality Assurance

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PREFACE

The stereotactic Breast Biopsy Accreditation Program of the American College of Radiology was established to attest to the quality of the performance of these procedures at accredited facilities. Accreditation received through this program ensures patients, referring professionals, and others that stereotactic breast biopsies at accredited sites are only performed by well trained and competent personnel using safe and appropriately functioning equipment.

This manual has been designed to assist facilities in the testing and maintenance of their stereotactic units. The stereotactic quality control program of the American College of Radiology is based upon the demonstrated value of the quality control component of the Mammography Accreditation Program. Issues of accuracy of needle positioning and optimal functioning of digital imaging systems have also been included. The tests outlined in this manual will help to ensure that suboptimal functioning of stereotactic equipment will not compromise performance of these biopsy procedures or result in inappropriate radiation dose.

D. David Dershaw, M.D.
Chair, Committee on Stereotactic Breast Biopsy Accreditation

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Stereotactic Breast Biopsy Quality Control Manual 1999

Physician's Section

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INTRODUCTION

The widespread use of mammographic screening to decrease breast cancer mortality has lead to the discovery of many suspicious, nonpalpable lesions that may be malignant. Tissue sampling is necessary to determine whether these findings represent cancer, which is usually present in only 20-30% of detected lesions. Traditionally, tissue sampling has been done with surgical biopsy, often with preoperative localization under imaging control. Surgical biopsy is expensive and time consuming, however, and can result in breast scarring, breast deformity, and confusing findings on follow-up mammograms. The ability to sample these lesions percutaneously with needle biopsy decreases or eliminates these factors and thereby diminishes the cost of mammographic screening.

Because imaging-guided needle sampling of nonpalpable lesions is rapid and inexpensive, it has been increasingly utilized. Reports of poorly performed and inappropriate biopsies from nonprofessionals and concerns among physicians about the quality of some facilities performing these procedures resulted in the American College of Radiology (ACR) formulating a voluntary accreditation program for facilities offering percutaneous needle biopsy of the breast under stereotactic imaging control. This program was introduced in 1996. The highly successful ACR Mammography Accreditation Program, established in 1987, was used as its model. The program strives to assure that stereotactic breast biopsy procedures are being performed by appropriately trained personnel, that the equipment used functions properly, that the radiation dose during each exposure is within accepted limits, that a facility's complication rate is not excessive, and that women are appropriately followed up after the biopsy results are known.

The quality control and quality assurance responsibilities for the radiologic technologist and the medical physicist are outlined in the following two sections. The physician should understand that his or her responsibilities are all-inclusive and that he or she is ultimately responsible for the frequency, quality and documentation of the quality control and quality assurance tasks that are performed by other personnel. However, each member of the breast biopsy team should review the complete manual to understand the overall QC program goal and each member's responsibilities in achieving those goals.

The stated frequency for each quality control test is a minimum frequency. A test should be done more frequently when it is being introduced and whenever inconsistent results are found. In addition, it is important to adopt the attitude that quality assurance is a continuous, not episodic,

I. Introduction

process. An effective quality control program will not eliminate problems, but it will allow identification of problems before they seriously affect clinical results.

Each image obtained during each examination should be viewed by the physician and technologist with quality control in mind. Deviations from high-quality performance may occur quickly or gradually. The quality control program provides a frame of reference within which even gradual or subtle problems can be identified, isolated, and resolved. The QC program can help identify the causes of changes in image quality or in the accuracy of needle positioning.

DEFINITIONS OF QA AND QC

Quality assurance (QA) is a comprehensive concept that comprises all of the management practices instituted by the physician to ensure that:

1. every biopsy procedure is necessary and appropriate to the clinical problem at hand,
2. the images generated or biopsies performed contain information critical to the solution of that problem,
3. the recorded information is correctly interpreted and made available in a timely fashion to the patient's physician, and
4. the examination results in the lowest possible radiation exposure, cost, and inconvenience to the patient consistent with objective 2 (above).

The quality assurance program includes many facets: efficacy studies, continuing education, quality control, preventive maintenance and calibration of equipment. An essential part of the QA program is the quality assurance committee (QAC). This group is responsible for oversight of the program, setting the goals and direction, determining policies, and assessing the effectiveness of QA activities. The QAC should consist of one or more radiologists or physicians, a medical physicist, a supervisory stereotactic breast biopsy radiologic technologist, and other stereotactic breast biopsy department personnel involved in caring for biopsy patients. This may include a nurse, desk attendant, medical secretary, and others. It may also include medical and paramedical staff from outside the radiology department, such as a surgeon, referring physician, nurse educators, a nurse from a comprehensive breast clinic, etc. Anyone who helps provide care to the patient seeking breast cancer screening or diagnosis should be considered a member of the QAC since their efforts affect the quality of care and the satisfaction of the patient.

Quality control (QC) is an integral part of quality assurance. Quality control is a series of distinct technical procedures that ensure the production of a satisfactory product, e.g., a biopsy that targets and samples the appropriate lesion. Four steps are involved:

1. *Acceptance Testing.* Detection of defects in equipment that is newly installed or has undergone major repair.
2. *Establishment of Baseline Performance* of the equipment.
3. *Diagnosis of Changes* in equipment performance before they become apparent in clinical practice.
4. *Verification of Correction* of equipment performance problems.

Specifics of the QC program for stereotactic breast biopsy are provided by the American College of Radiology in this manual.

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PHYSICIAN RESPONSIBILITIES

The physician's specific responsibilities in stereotactic breast biopsy quality control are to:

1. Ensure that physicians, technologists, and medical physicists involved in these procedures have adequate training and continuing education in mammography and stereotactic breast biopsy.
2. Ensure that an effective quality control program exists for all stereotactic breast biopsy procedures performed at a facility. The physician should provide motivation, oversight, and direction to all aspects of the quality control program.
3. Select a single technologist to be the primary quality control technologist, performing the prescribed quality control tests.
4. Ensure that appropriate test equipment and materials are available to the technologists who perform QC tests.
5. Arrange staffing and scheduling so that adequate time is available to carry out the quality control tests and to record and interpret the results.
6. Provide ongoing positive and negative feedback to technologists about image quality, localization accuracy, and quality control procedures.
7. Select a medical physicist who will administer the QC program and perform the physicist's tests.
8. Review the technologist's test results at least every three months, or more frequently if consistency has not yet been achieved; review the physicist's test results annually, or more frequently when needed.
9. Ensure that records concerning employee qualifications, quality control, safety, radiation protection, and equipment service and calibration are properly maintained and updated in the stereotactic breast biopsy quality control procedures manual.

The physician's specific responsibilities in stereotactic breast biopsy quality assurance are to:

1. Ensure that the outcomes of procedures are documented and that appropriate patient follow-up care has been provided.
2. Document the number and causes of complications, including specific needles used during each procedure in which complications occur.
3. Record the number of, and reasons for, repeated biopsies.

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COMMENTS

1. Physicians performing stereotactic breast biopsies must assume the primary responsibility for the quality of these procedures and for the implementation of an effective quality assurance program at their facility. The staff's commitment to high quality will often mirror that of the physician-in-charge. The individuals performing quality control tests need to know that the physician understands the program and is interested in its results. The physician needs to review the test results and their trends periodically, providing direction when problems are detected.
2. The physician must make sure that adequate time is available for the quality control program. The necessary time must be incorporated into the daily schedule.
3. To ensure consistency in quality control test performance, a single technologist should be selected. It is not desirable, for example, to rotate this assignment among a group of technologists. Such a practice will introduce into the test results variability extraneous to the items being tested.
4. A medical physicist on-site or readily available should administer each facility's QC program, perform the tests designated as medical physicist quality control tests, and oversee the work of the quality control technologist. Where this is not feasible and during the physicist's absence, the physician should oversee the QC program.
5. The physician is ultimately responsible for the quality of the biopsy procedures performed under his or her direction and bears ultimate responsibility for both proper QC testing and QA procedures.

Working as a team, the physician, QC technologist, and medical physicist should develop and follow a stereotactic breast biopsy quality assurance procedure manual that is available to all members of the staff. The QC testing described in this manual should be part of the facility's QA procedures manual. In addition, the facility's procedures manual should contain:

- clearly assigned responsibilities and clearly developed procedures for QA/QC testing
- records of the most recent QC tests performed by the QC technologist and medical physicist
- procedures for proper use and maintenance of equipment
- mammographic techniques to be used, including image quality testing and average glandular doses;

IV. Comments

- procedures for maintaining the cleanliness of the room and equipment, including sterility of needles, needle guides or other sampling devices used on patients;
- procedures for testing of needle positioning accuracy;
- precautions to protect the operator of the equipment, the patient, and individuals in surrounding areas from unnecessary radiation exposure;
- policies and employee responsibilities concerning personnel radiation monitoring; and
- proper maintenance of records, including records of QC and QA testing, equipment acceptance testing, equipment service and maintenance, and QA meetings.

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Stereotactic Breast Biopsy Quality Control Manual 1999

Radiologic Technologist's Section

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INTRODUCTION

The goal of quality control (QC) for stereotactic breast biopsy systems is to ensure that image quality in stereotactic breast biopsy equals or exceeds that of screening and diagnostic mammography, that equipment designed specifically for stereotactic breast biopsy performs properly, and that needle localizations are accurate. A by-product of conducting the stereotactic breast biopsy QC tests described in this manual is greater familiarity with the operation and performance of your stereotactic breast biopsy system, particularly greater familiarity with the image quality in stereotactic breast biopsy (and how it compares to image quality in standard mammography) and with the accuracy of needle placement during stereotactic breast biopsy.

The QC tests necessary for stereotactic breast biopsy depend on the particular manner in which stereotactic breast biopsy is performed at your facility. Table 1 lists the recommended stereotactic breast biopsy QC tests at any facility. If your stereotactic breast biopsy equipment manufacturer recommends additional tests, then those additional tests should be performed as well. You should be familiar with the user's manual for your stereotactic breast biopsy system and any unit-specific QC tests called for by your stereotactic breast biopsy equipment manufacturer.

If stereotactic breast biopsy is performed using a digital image receptor and localizations are done by marking the locations of lesions using a computer monitor, then the tests at the top of Table 1 should be performed. If stereotactic breast biopsy is performed using screen-film cassettes and localizations are done by marking the locations of lesions on film, then the Hardcopy Output Test should be deleted and the additional processor and darkroom tests listed at the bottom of Table 1 also should be performed. The minimum test frequencies for stereotactic breast biopsy QC tests are also listed in Table 1.

The first seven tests listed in Table 1 are either new tests or are tests that are specific to stereotactic breast biopsy equipment. The objectives, test equipment required, test procedures, data forms, recommended performance criteria, and corrective actions are listed for each of the first six tests in this document. The zero alignment test is not described in this manual but should be performed according to manufacturer's recommendations, if required. The data forms are designed to be reproduced for routine use.

I. Introduction

Table 1. STEREOTACTIC BREAST BIOPSY QUALITY CONTROL TESTS AND MINIMUM TEST FREQUENCIES

Test	Minimum Frequencies
Localization Accuracy Test (in air)	Daily
Phantom Images	Weekly
Hardcopy Output Quality (if hard copy is produced from digital data)	Monthly
Visual Checklist	Monthly
Compression	Semiannually
Repeat Analysis	Semiannually
Zero Alignment Test (if required by manufacturer)	Before each patient

If screen-film images are used for stereotactic breast biopsy localizations, add these tests from the ACR Mammography QC Manual to the tests listed above.

Test	Minimum Frequencies
Darkroom Cleanliness	Daily
Processor Quality Control	Daily
Screen Cleanliness	Weekly
Viewbox and Viewing Conditions	Weekly
Analysis of Fixer Retention in Film	Quarterly
Screen-film Contact	Semiannually
Darkroom Fog	Semiannually

The additional tests listed at the bottom of Table 1 are only to be performed for stereotactic breast biopsy systems using screen-film image receptors. These tests, specific to the darkroom, processor, film, screens, viewboxes and viewing conditions, are listed in the 1999 ACR Mammography Quality Control Manual, Radiologic Technologist's Section. That manual should be consulted for detailed information about performing those seven QC tests.

Typically, daily tests need only be performed on days in which stereotactic breast biopsy procedures are performed. Tests also should be carried out initially (when the QC program is started), when problems are suspected, and after service or preventive maintenance. For example, after major service to the stereotactic breast biopsy equipment, the first five tests listed

in Table 1 should be performed prior to its use on patients. If new computer software is installed on a digital stereotactic breast biopsy system, the first four tests listed in Table 1 should be performed prior to use of the stereotactic breast biopsy system on patients.

The intent of ongoing quality control is that a test should be performed, results charted and analyzed, and any necessary corrective actions taken prior to use of the equipment on patients. Ongoing QC tests are pointless if performed only sporadically, if tests are performed incorrectly, if test results are not charted and analyzed, or if appropriate corrective actions are not taken prior to clinical use when action limits are exceeded. Care and attention on the part of the stereotactic breast biopsy QC radiologic technologist are essential to ensure that the stereotactic breast biopsy QC program is effective in identifying equipment performance problems before they affect patient care.

Due to the importance of QC in stereotactic breast biopsy, it is recommended that the supervising radiologist review the stereotactic breast biopsy QC program conducted by the QC technologist at least quarterly and that the medical physicist review the stereotactic breast biopsy QC program at least annually. Sign-off charts for the supervising physician and medical physicist have been provided on the stereotactic breast biopsy QC Monthly, Quarterly, and Semiannual Checklist on pages 49 and 50 of this supplement.

It is important to have clearly established technique factors for stereotactic breast biopsy and to ensure that established techniques are posted, followed, and lead to adequate clinical images. With screen-film image receptors, inappropriate technique factors will lead to underexposed or overexposed images or excessively long exposure times for some patients. With digital image receptors, inappropriate technique factors will lead to noisy images (due to inadequate X-ray intensity) or saturated detector systems (due to excessive X-ray intensity) for some patients. All of these errors can reduce the visualization of breast lesions on stereotactic breast biopsy systems and should prompt revision of the stereotactic breast biopsy Clinical Technique Chart. Figure 1 provides a blank Clinical Technique Chart which can be copied and filled in for either manual or automatic exposure control (AEC) techniques.

Manual Technique Chart

Compressed Breast Thickness	Target	Filter	kVp	mAs
< 3 cm				
3-5 cm				
5-7 cm				
> 7 cm				

Automatic Exposure Control (AEC) Technique Chart

Compressed Breast Thickness	Target	Filter	kVp	Density Control
< 3 cm				
3-5 cm				
5-7 cm				
> 7 cm				

Figure 1. Stereotactic breast biopsy unit technique chart.

1. PROCEDURE: LOCALIZATION ACCURACY TEST (IN AIR)

OBJECTIVE

To ensure that the stereotactic breast biopsy system accurately places the biopsy needle at its directed target prior to tissue sampling.

FREQUENCY

This procedure, or a similar procedure specifically recommended by the stereotactic breast biopsy equipment manufacturer, should be carried out prior to patient use at least each day that the stereotactic breast biopsy equipment is used on patients.

REQUIRED TEST EQUIPMENT

A straight calibration needle identical in length to the needle most commonly used for clinical stereotactic breast biopsy procedures

A stereotactic breast biopsy needle holder or automated biopsy device (e.g. biopsy gun) and needle guide

Stereotactic breast biopsy equipment used clinically

If film is used, a screen-film cassette, film digitization table, and processor

TEST PROCEDURE STEPS

1. Place the calibration needle in the biopsy device (gun) and cock the biopsy device.
2. Mount the stereotactic breast biopsy equipment, cocked biopsy device with needle, needle guide, and front compression paddle with biopsy window.
3. Zero the needle z-position, if needed (some units require this and specify the procedure).
4. Place the needle tip at a known horizontal, vertical, and depth location that positions the needle near the center of the biopsy window in the compression paddle. Record the horizontal, vertical, and depth coordinates on the data form (Figure 2).
5. Acquire separate +15° and –15° scout view images ensuring that the needle tip is visible in both images and is within the biopsy window.
6. Mark the tip of the biopsy needle as if it were a lesion in both +15° and –15° scout view images.
7. Allow the stereotactic breast biopsy system to compute the horizontal, vertical, and depth coordinates of the marked needle tip and record the results.

8. Compare the stereotactic breast biopsy-calculated location of the needle tip to the location at which the needle tip was originally set by taking the difference between stereotactic breast biopsy-calculated and pre-set horizontal, vertical, and depth locations and entering the difference on the data form.

NOTE: An alternative to this procedure is to use a localization phantom and a suitable needle holder and guide. In this procedure the phantom is placed in the biopsy field, a particular point on the phantom is treated as the targeted lesion, a prescribed needle and holder are used, and accuracy is visually determined by measuring the difference between the needle tip and the targeted region on the phantom. If this procedure is recommended by your equipment manufacturer, then follow the instructions in your manufacturer's user manual.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

Each of the indicated needle tip coordinates (horizontal, vertical, and depth) should be within 1 mm of the actual preset needle tip location. That is, the difference between the preset location and the computer-determined location should be less than 1 mm in each direction. For stereotactic breast biopsy units that use rectangular coordinates, this is relatively straightforward. For stereotactic breast biopsy units using polar or spherical coordinates, it will be necessary to determine the angular difference corresponding to 1 mm in horizontal and vertical location. This can be done by placing a ruler with 1 mm gradations in the plane of the breast support surface. First place the ruler along the horizontal direction and place the needle tip just in front of the ruler at a centimeter marker. Record the angular reading at this location. Then move the needle tip 1 mm along the horizontal direction, recording the angular reading at this second location. Take the difference between these two angular readings. This difference is the angle that corresponds to 1 mm of horizontal (x) deflection. Re-orient the ruler so that it is along the vertical direction and repeat the procedure to determine the vertical angle corresponding to 1 mm of vertical (y) deflection at the breast support surface. These horizontal and vertical angular deflections should be taken as the limit of disagreement between the known location of the needle tip and the computer-indicated location of the needle tip. If the stereotactic breast biopsy unit manufacturer recommends using a tighter range of accuracy in horizontal, vertical, or depth coordinates, that tighter limit should be applied.

If a localization phantom is used, the localization accuracy test should result in the needle tip being within 1 mm of the targeted phantom location in each direction.

If the stereotactic breast biopsy unit fails to determine the correct location of the needle tip within 1 mm in each direction, possible sources of error should be investigated. Possible causes could include an uncocked biopsy device, a wobbly needle guide, a bent needle, a gap between the biopsy device and its holder, the wrong needle being used, or incorrect needle and throw length data entered into the computer system. Once the cause has been identified it should be eliminated. The localization accuracy test described above should then be repeated. If the stereotactic breast biopsy unit again fails to meet the performance criteria, the authorized stereotactic breast biopsy unit service person should be contacted, and service to correct the problem should be provided.

A form (Figure 2) is provided to record results of the localization accuracy test each day the stereotactic breast biopsy unit is used on patients. The form is also useful for reviewing previous test results to see if systematic errors or trends are occurring in the difference between specified and indicated locations of the needle tip.

Localization Accuracy Test
Stereotactic Breast Biopsy Quality Control

Site: _____

Room: _____ Year: _____

Month:												
Date:												
Performed by:												
Preset Specified Location	**X or Horizontal Angle**											
	Y or Vertical Angle											
	Z or Depth											
Location Determined (Indicated) By System	**X or Horizontal Angle**											
	Y or Vertical Angle											
	Z or Depth											
Difference Indicated Location Minus Preset Location	**X or Horizontal Angle Difference**											
	Y or Vertical Angle Difference											
	Z or Depth Difference											
Accuracy Test	**Pass/Fail**											

Date: **Action:**

Figure 2. Localization accuracy test data sheet.

2. PROCEDURE: PHANTOM IMAGE QUALITY TEST

OBJECTIVE

To ensure that image quality on the stereotactic breast biopsy system equals or exceeds image quality on screening or diagnostic mammography equipment.

FREQUENCY

Phantom image quality assessment should be carried out at least weekly during weeks that the stereotactic breast biopsy equipment is used on patients.

REQUIRED TEST EQUIPMENT

Stereotactic phantom (approximately equivalent to a 4.2 cm thick compressed breast consisting of 50% glandular, 50% adipose tissue) containing appropriate details ranging from visible to invisible on the stereotactic image. At the time of publication, either the Radiation Measurement, Inc. RMI-156 or Nuclear Associates 18-220 Mammographic phantoms (used for the ACR Mammography Accreditation Program) or Nuclear Associates "Mini" Digital Stereotactic Phantom 18-250 (or a similar phantom) may be used.

Note: It is recommended that the acrylic disc not be used if phototimed exposures are acquired. Variations in the position of the acrylic disc can cause variations in resulting technique factors under phototimed conditions. If the acrylic disc is used with phototimed exposures, care should be taken to ensure that the acrylic disc does not overlay any portion of the phototiming detector or the digital image receptor.

Digital images evaluated on a monitor should be viewed in a darkened room.

Original phantom image and the previous phantom image acquired on this unit

For Screen-film Image Receptors:

Cassette and film of the types used clinically, appropriate masking to eliminate light reaching the viewer's eye from beyond the borders of the exposed phantom image. Images should be viewed on the same viewbox(es) used clinically. If a 14" by 17" box is used, a film mask for a 14" by 17" viewbox can be made by exposing a 14" by l7" film to light, processing it, and cutting a hole just the size and shape of the phantom being used.

Magnifying lens of the same type used clinically

Densitometer

II. Stereotactic Breast Biopsy Equipment QC Tests

TEST PROCEDURE STEPS:

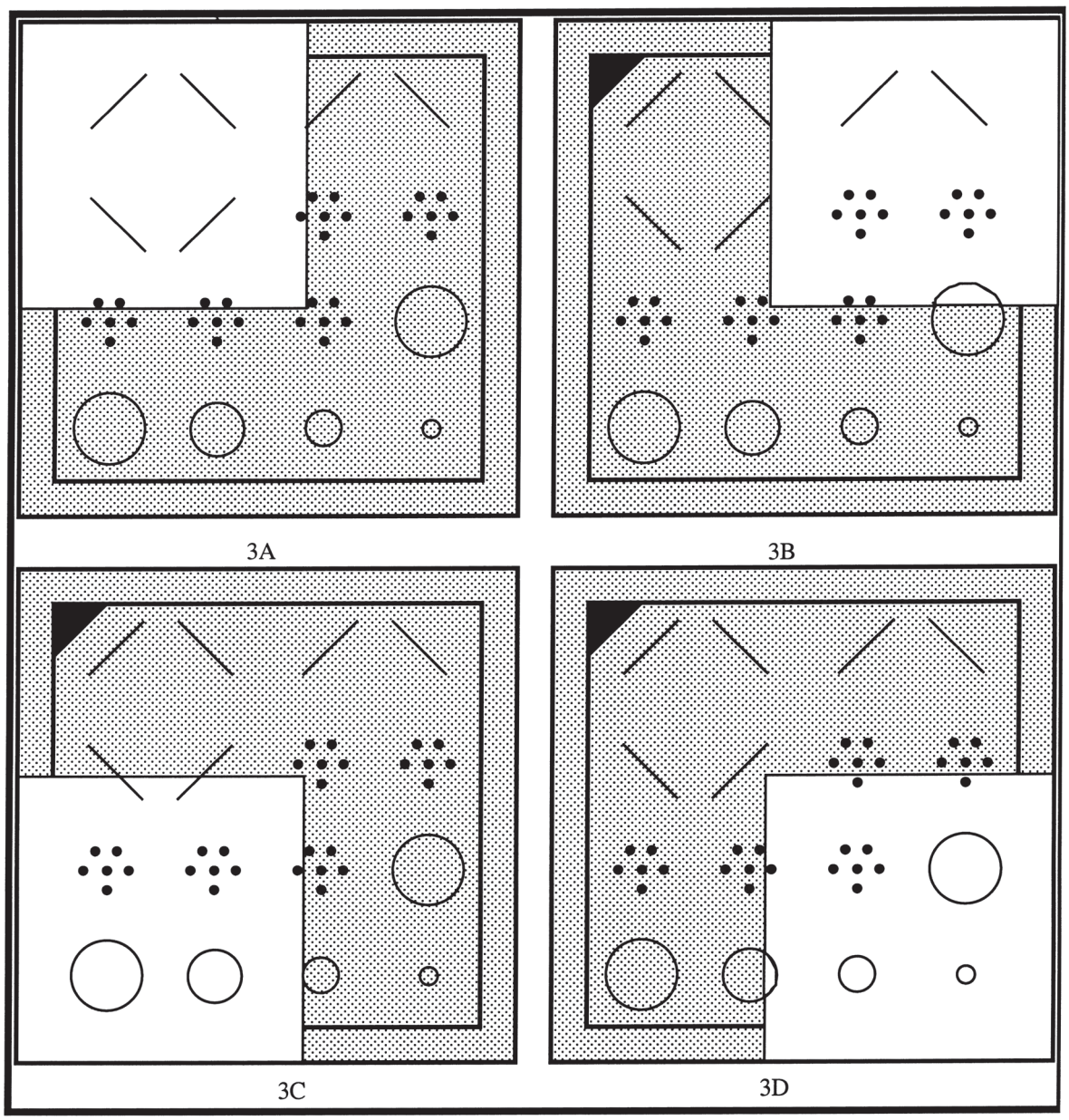
For Screen-film Image Receptors:

1. Prepare the system for a stereotactic procedure.
2. Load the film in the cassette.
3. Place the cassette in the cassette holder assembly of the stereotactic system.
4. Place the phantom on the breast support device, positioning the phantom so that the chest wall edge of the phantom is aligned with the chest wall side of the image receptor.

> **NOTE: Facilities using the Mammography Accreditation Phantom with stereotactic imaging systems that have a limited field of view may find it necessary to make four exposures to image the entire phantom (see Figure 3). All facilities using the digital mini-phantom should be able to image the entire wax insert of the phantom in a single exposure (see Figure 4).**

5. Move the needle holder out of the way or remove it, if possible.
6. a. For sites using phototimed techniques, verify that the phototimer detector is located beneath the center of the phantom and in the same location as used for previously acquired phantom images. Select the focal spot, target, filter, kVp, and density control setting used clinically for a 4.2 cm thick breast.

   b. For sites using manual techniques, select the appropriate exposure time and mA setting (or mAs setting) for the phantom thickness.
7. Make sure that these technique factors agree with techniques for previously acquired phantom image techniques.
8. Make an exposure, recording all technique factors on the image quality evaluation form.
9. Process the film in the processor normally used for mammography films.
10. Measure the central background optical density on the film (usually measured in the center of the phantom insert, away from any test objects), recording this density as the background optical density on the data sheet. Be sure to measure this density at the same location each time.



Figures 3A, B, C & D. Positioning of the ACR MAP phantom over the small field-of-view image receptor (white area) on digital and some screen-film stereotactic systems. This procedure covers the entire phantom in four exposures.

II. Stereotactic Breast Biopsy Equipment QC Tests

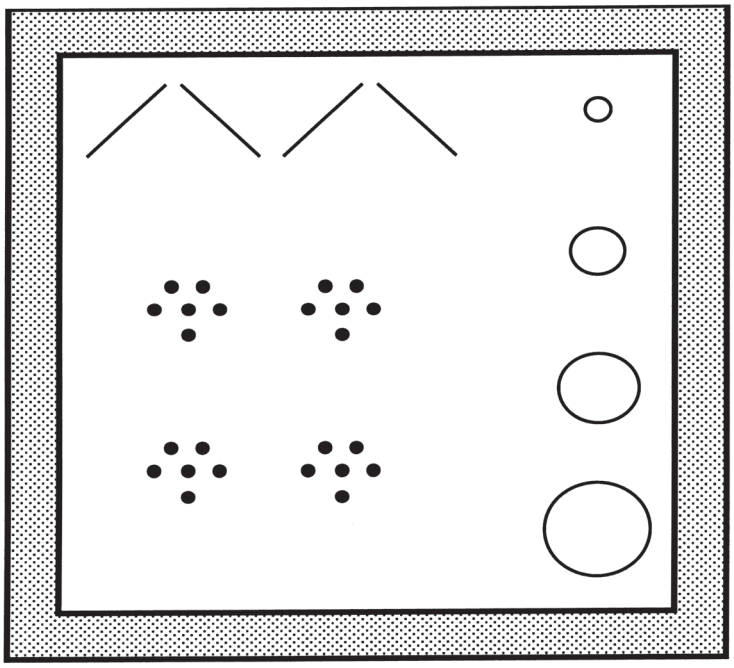


Figure 4. "Mini" Digital Stereotactic Phantom.

NOTE: There are differences in numbers of objects and their respective sizes between the mammography accreditation phantom and the mini-phantom. (See Table 2)

11. Measure the optical density of the film in the area of the disc (if present) and just outside the disc to the left or right (perpendicular to the anode-cathode axis), recording the difference as the density difference on the image quality evaluation form.
12. Using appropriate film masking, determine the number of test objects of each type that are visible in the phantom image as described in Data Analysis and Interpretation. This may require four separate images, each of which contains a quadrant of the phantom.

NOTE: Film stereotactic phantom images, like mammograms, should always be viewed under good viewing conditions:

1. **Mask the viewbox so that extraneous light does not come from the viewbox to the viewer's eye without passing through the exposed portion of the phantom image. A mask is essential for appropriate viewing of phantom images.**
2. **Ambient room lighting reflecting off the film should be minimized.**
3. **Use a large field of view magnifying lens (2x is recommended), preferably the same type of magnifying lens used for reading clinical mammograms.**

For Digital Image Receptors

1. If using the ACR MAP phantom, position the phantom (if possible, without the acrylic disc) with its upper left-hand quadrant over the small field-of-view digital image receptor, as shown in Figure 3A. If the "mini" Digital Stereotactic Phantom is used, position the phantom over the digital IR and acquire a single phantom image as shown in Figure 4.
2. Take a scout view (0°) digital exposure using the site's standard technique for a 4-4.5 cm thick compressed breast. Inspect the digital image to make sure that the largest two fibers and the fifth fiber have been included for the ACR phantom or that the entire insert area has been included for the "mini" phantom. Record the technique factors on the data form.
3. For the ACR MAP phantom, reposition as shown in Figure 3B-D and take three additional 0° exposures using the same technique factors, saving each image.
4. View all four images together (sequentially or at the same time) on the monitor. **Digital images evaluated on a monitor should be viewed in a darkened room.** Determine the number of fibers, speck groups, and masses visible. Adjust window level and width settings to maximize detection of each object type. Use the scoring method for fibers, specks, and masses described below.
5. Examine the phantom image(s) for artifacts. It may help to use several different window level and width settings to be sensitive to all artifacts. For example, digital detector element dropout may be visible by using a narrow window width and varying the level setting,

searching for white dots in the image. On the other hand, overall detector sensitivity differences may be better seen by using a somewhat wider window width and a level setting that averages over signal in the entire field of view.

DATA ANALYSIS AND INTERPRETATION

1. When scoring the image of one of the ACR-approved accreditation phantoms, each object type is scored separately. See Table 2 for phantom object sizes. Always count the number of visible objects from the largest object of a given type (i.e., fiber, speck group, or mass) downward until a score of 0 or 0.5 is reached, then stop counting for that object type.
2. Count each fiber as one point if the full length of the fiber is visible and the location and orientation of the fiber are correct. Count a fiber as 0.5 point if not all, but more than half, of the fiber is visible, and its location and orientation are correct. Add each full or partial fiber to the total score, from largest down to smallest visible, until a score of 0 or 0.5 is reached.
3. After determining the last fiber to be counted, look at the overall background for artifacts. If a fiber-like artifact appears anywhere in the wax insert area of the image, but not in an appropriate location or orientation, deduct the "artifactual" fiber from the last "real" half or whole fiber scored if the artifactual fiber is equally or more apparent. Deduct only from the last real fiber, not from additional fibers. Record the final score after artifact deduction in the appropriate space on the chart (see Figure 5).
4. If needed, use a magnified display of the phantom to assist in the visualization of specks. Starting with the largest speck group, count each speck group as 1 point if four or more of the six specks in the group are visible in the proper locations. Count a speck group as 0.5 if two or three of the six specks in the group are visible in the proper locations. Add each full or partial speck group to the total speck group score, from largest down to smallest visible group, until a score of 0 or 0.5 is reached.
5. After determining the last speck group to be counted, look at the overall background for artifacts. If noise or speck-like artifacts are visible in the wrong locations within the area of the wax insert, and are as apparent as the "real" specks, deduct them one for one from the individual specks counted in the last whole or half speck group scored, and adjust the score of the last group appropriately. Record the final score after artifact deduction in the appropriate space on the chart.

Table 2. COMPARISON OF PHANTOM OBJECT SIZES

	ACR Accreditation Phantom		Mini Phantom	
	Object Number	Object size (mm)	Object Number	Object Size (mm)
Fibers	1	1.56		
	2	1.12		
	3	0.89	1	0.93
	4	0.75	2	0.74
	5	0.54	3	0.54
	6	0.40	4	0.32
Specks	1	0.54	1	0.54
	2	0.40		
	3	0.32	2	0.32
	4	0.24	3	0.24
	5	0.16	4	0.20
Masses	1	2.00		
	2	1.00	1	1.00
	3	0.75	2	0.75
	4	0.50	3	0.50
	5	0.25	4	0.25

6. Count each mass as 1 point if a minus density object is visible in the correct location, and the mass appears to be generally circular against the background (i.e., greater than ¾ of the perimeter is visible). A mass is counted as 0.5 point if a minus density object is visible in the correct location, but the mass does not have a generally circular appearance. Add each full or partial mass to the total mass score, from the largest mass down and until a score of 0 or 0.5 is reached.
7. After determining the last mass to be counted, look at the overall background for artifacts. If a mass-like artifact is seen in the wrong location within the area of the wax insert, deduct the "artifactual" mass from the last "real" whole or half mass scored if the artifactual mass is equally or more apparent. Record the final score after artifact deduction on the appropriate space on the chart.
8. Using magnification, if needed, carefully examine the image for non-uniform areas, the presence of dirt or dust artifacts, detector dropout or saturation, processing artifacts, and compare the image to the original or previous images.

Stereotactic Breast Biopsy Phantom Control Chart

Site: _____ Room: _____ Year: _____

Image Receptor: ❑ Film/Screen _____ ❑ Digital _____

Phantom Used: ❑ ACR Mammo Accreditation Phantom ❑ Digital "Mini" Phantom ☐ Other

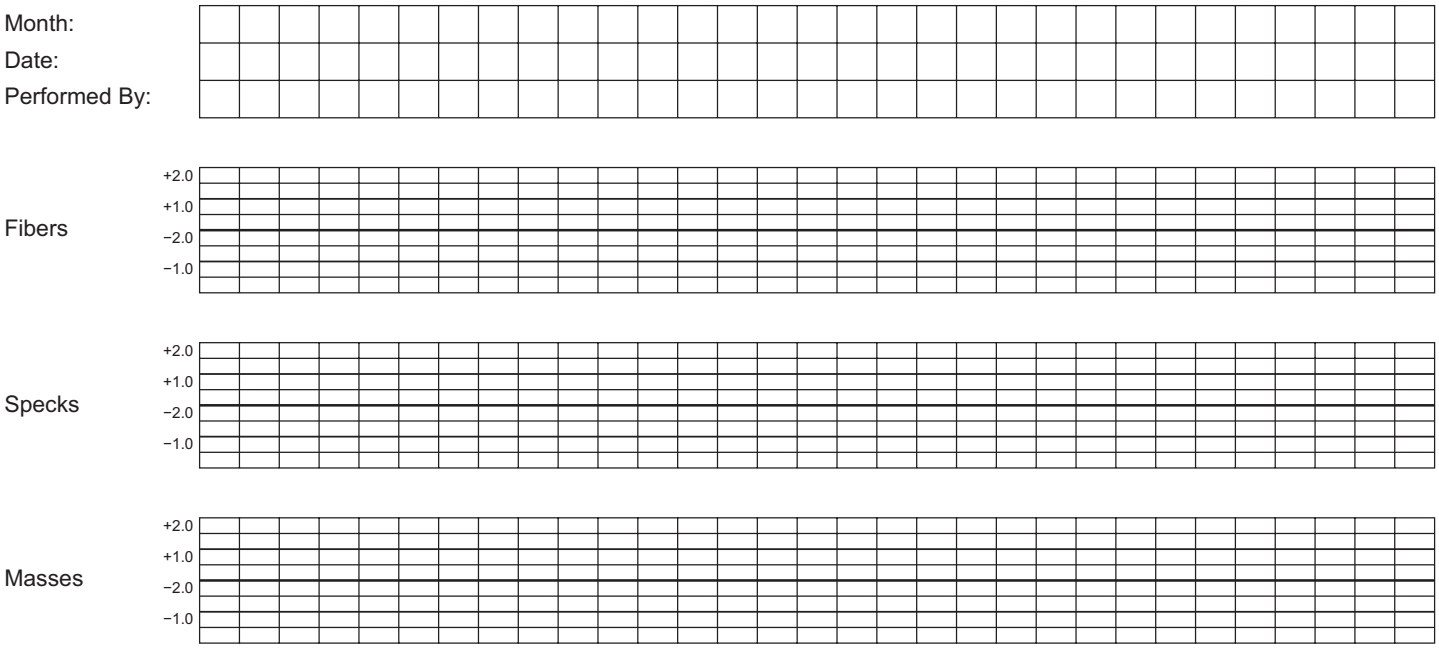
Technique Factors: Target/Filter: _____ kVp Setting: _____

❑ Phototimed
Density Control Setting: _____

❑ Manual
mA Setting: _____

Exposure Time (or mAs): _____

Phantom Control Chart – Phantom Scores



Date	Action

Figure 5A. Phantom Control Chart.

Stereotactic Breast Biopsy Phantom Control Chart (cont.)

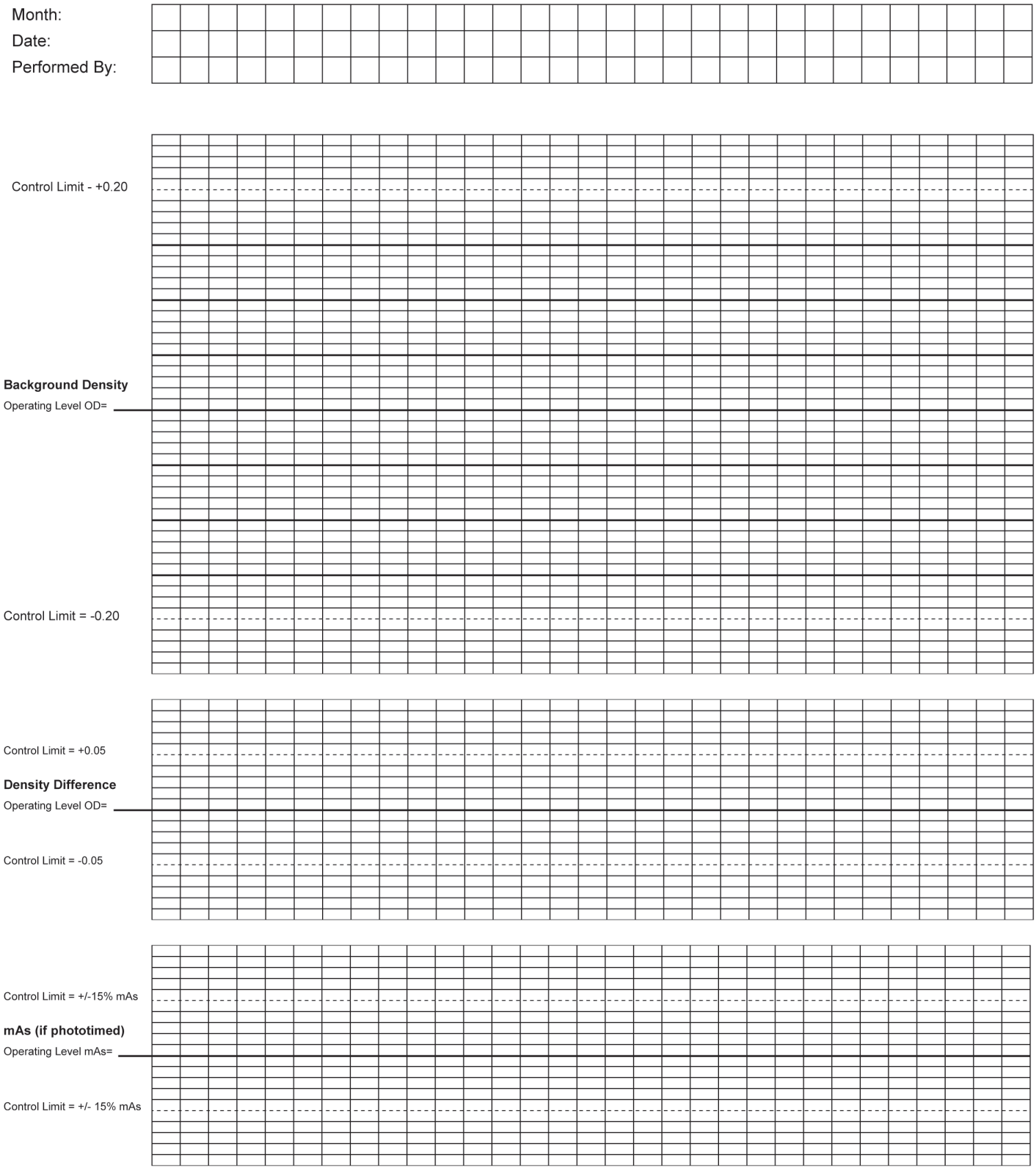


Figure 5B. Phantom Control Chart – Screen-Film Optical Densities.

This test includes most components of the imaging chain. Observed changes in phantom image quality may be due to any component of the imaging chain, from the X-ray generator or tube to the digital image receptor or display monitor. As a result, other tests will be needed to determine the component(s) of the imaging chain that is at fault and in need of corrective action if a problem is identified.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

Table 3 below shows acceptable scores for fibers, specks and masses for each of the phantoms.

The number of objects detected in each group (fibers, specks, and masses) should meet the minimum detection criteria shown in Table 3 for the appropriate image receptor and phantom. The number of objects detected in each group should not decrease by more than 0.5 if viewed under ideal conditions by the same observer. If the observed number of test objects in one or more groups decreases by more than 0.5, then further comparison with the original and previously acquired phantom images should be made to determine whether the change is real.

A decrease from the original or previous phantom image to the current phantom image of more than 0.5 for any object type should be investigated to determine the source or sources of the change. Once the source has been identified, the problem or problems should be corrected immediately.

Screen-film Image Receptors

The optical density of the film in the center of the phantom image should be greater than 1.40, while the density difference across the acrylic disc (if evaluated) should be greater than 0.35 for a 4-mm-thick disc, using the

Table 3.

	Mammography Accreditation Phantom		Mini-Phantom	
	Screen-film	Digital	Screen-film	Digital
Fibers	4.0	5.0	2.0	3.0
Specks	3.0	4.0	2.0	3.0
Masses	3.0	3.5	2.0	2.5

site's clinical techniques. Some discs available commercially have thicknesses different than 4 mm; check the disc thickness if optical density differences less than 0.35 occur. If optical density differences are less than 0.35 for a 4 mm thick acrylic disc and background optical density greater than 1.40, then there is a problem with the film or processing. Constancy from phantom image to phantom image is crucial whether manual or phototimed exposures are used. If the exposure is made identically to previous phantom images, the optical density in the center of the phantom should not change by more than ±0.20 and the density difference should not change by more than 0.05. For phototimed systems, the exposure time or mAs noted on the generator read-out should not change by more than ±15% from one phantom image exposure to another.

Some mammography sites may choose an AEC set-up that yields a higher range of optical densities for average breast tissues, so that glandular tissues are adequately exposed and have adequate contrast. While this approach also requires adequate viewbox intensity for appropriate film viewing, it is an acceptable approach to improving clinical image quality in screen-film mammography.

3. PROCEDURE: HARDCOPY OUTPUT QUALITY TEST (DIGITAL ONLY)

OBJECTIVE

To ensure that the quality of hardcopy output is consistent over time and matches the grayscales presented on the CRT monitor.

FREQUENCY

This test, or a similar test specifically recommended by the hardcopy equipment manufacturer, should be carried out at least monthly.

REQUIRED TEST EQUIPMENT

Densitometer

SMPTE (Society of Motion Picture and Television Engineers) Test Pattern, or another, similar test pattern or phantom image having a wide range of grayscales (The same test image should be used each time.)

TEST PROCEDURE STEPS

1. Display the SMPTE test pattern or phantom image on the monitor with grayscales ranging from white to black and a reasonable range of grayscales in between.
2. Record the window width and window level settings used to display the image; the same window width and level settings should be used for each subsequent display and printed image.
3. Print the image on film.
4. Process the film.
5. View the recorded film image on an appropriately masked viewbox next to the monitor.
6. Measure the optical density at four consistent locations on the film and record.
7. Compare all optical density measurements to those from the previous month's image.

DATA ANALYSIS AND INTERPRETATION

1. Visually compare grayscales on the film and monitors using the same window width and window level settings as used to produce the film.
2. The first time this procedure is performed and there is consistency between the monitor and film, record these window width and window level values and measured optical density film values on the chart (Figure 6) as your control level.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

The image on the film should not be lighter or darker than the image displayed on the monitor when viewed with the same window width and level settings used for printing. If there are significant differences, the contrast and brightness of the monitor should first be checked by the medical physicist or service engineer. If the monitor was correctly set-up according to manufacturer's instructions, then contact the appropriate service engineer for adjustment of the hardcopy output device.

If optical densities measured at the four locations differ by more than 0.20 from the control level values, check that the same window width and level settings have been used as were used to establish control levels. If differences persist, repeat the test. If the optical density differences in the repeated test differ from control levels by more than 0.20, then contact the service engineer for adjustment of the hardcopy output device. A drop in film optical densities may be due to film emulsion differences from batch to batch or processing chemistry changes. If the processing chemistry is used infrequently and the film emulsion batch has not changed, a decrease in optical density is likely to be due to developer oxidation. In such cases, the developer chemistry should be changed to fresh chemistry with starter.

Stereotactic Breast Biopsy Hardcopy Output Quality Control

Site: _____ Room: _____ Year: _____

Hardcopy Display Unit: _____ Image(s) Used for Hardcopy Output Check: _____

		Note: Circle Values Established as Control Values											
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Filming Window Level													
Filming Window Width													
Hardcopy & Monitor Demonstrate Comparable Gray Scales (Yes/No)													
FILM OD	Location #1_____												
	Location #2_____												
	Location #3_____												
	Location #4_____												
All measured Film ODs are within ± 0.2 of Control Levels (Yes/No)													
Performed By (initials)													
Physician Review*													
Medical Physicist Review*													

Date: **Action:**

_____ _____

_____ _____

_____ _____

Figure 6. Stereotactic breast biopsy hardcopy output quality control form.

4. PROCEDURE: VISUAL EQUIPMENT CHECK

OBJECTIVE

Ensure that the stereotactic breast biopsy system indicator lights, displays, mechanical locks, detents, and any other mechanical functions are working properly and that the mechanical rigidity and stability of the equipment is adequate.

FREQUENCY

This test should be carried out at least monthly or after any service or maintenance on the stereotactic breast biopsy system is performed.

REQUIRED TEST EQUIPMENT

Visual Checklist (Figure 7)

TEST PROCEDURE STEPS

1. Review all the items listed on the Visual Checklist and indicate their status with "Y" for yes, "N" for no, or "N/A" for not applicable.
2. Date and initial the checklist where indicated.

PRECAUTIONS AND CAVEATS

Some of the items on the Visual Checklist are operator convenience features. Many of the items, however, are essential for patient safety, operator safety, high-quality images, and accurate needle placement. It may be necessary to add additional items to the list that are specific to your site's particular equipment or procedures. These additional items should be included on the checklist and reviewed in each evaluation.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

Some items listed on the Visual Checklist may not apply to your stereotactic breast biopsy system; those items should be marked N/A for "not applicable." Each of the items listed in the Visual Checklist which do apply to your stereotactic breast biopsy system should receive a "Y" checkmark. Items that do not pass should received a "N" for no and should be corrected or replaced immediately.

Items missing from the room should be replaced immediately. Malfunctioning equipment should be reported to the X-ray service engineer for repair or replacement as soon as possible.

STEREOTACTIC BREAST BIOPSY QC VISUAL CHECKLIST

	Year											
	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
Date												
Checked By												
Do all x-ray tube locks and detents work properly?												
Is the table immobilized relative to the compression device when locked?												
Do image receptor locks hold?												
Does the light field work properly?												
Is properly sized collimation or diaphragm being used?												
Do all moving parts move smoothly?												
Do all foot switches work properly?												
Is compression force adequate?												
Is compression force sustained during procedure?												
Does the localization system zero coordinates properly?												
Is the biopsy device properly immobilized to prevent recoil?												
Are needle guides free from excessive wobble?												
Are all needed paddles available and free from cracks, sharp edges, and other hazards?												
Is the operator shielded from radiation during exposure?												
Is the patient visible to the operator during exposure?												
Are technique charts posted?												
Are cleaning supplies and disinfectants available and used regularly?												
Is there any accumulation of blood on the equipment? (Check cracks or joints for dried blood.)												
Is the digital system monitor clean?												
Other tests as recommended by manufacturer:												
Physician Review												
Medical Physicist Review												

Figure 7. Stereotactic breast biopsy QC visual checklist

5. PROCEDURE: COMPRESSION

OBJECTIVE

Ensure that compression force during stereotactic breast biopsy is adequate to immobilize the breast during the entire biopsy procedure and to ensure that the maximum compression force is not excessive.

FREQUENCY

This test should be carried out initially, at least semiannually, after service to the compression device, and any time reduced or excessive compression is suspected.

REQUIRED TEST EQUIPMENT

Bathroom scale: The scale should be a flat, conventional, analog type. Digital scales sample the data and may not respond properly as additional pressure is applied slowly to the scale or if the compression force decreases. Digital scales designed specifically to measure compression force may be used.

Several towels or pot-holder pads to protect the surfaces of the compression paddles from the surfaces of the scale.

TEST PROCEDURE STEPS

1. Place (or for prone systems, tape) a towel or pad on the breast support surface, then place the bathroom scale on top of (or in front of) the towel with the dial positioned outward for easy reading. Center the scale directly under (or behind) the upper compression paddle (for prone systems, it may help to place small objects under the scale for support and stability).
2. Place (or tape) a towel or pad between the upper (front) compression paddle and the scale.
3. Using power drive (if available), activate the compression device and operate until compression stops automatically.
4. Read and record the power driven compression force on the Monthly, Quarterly, Semiannual QC Checklist (Figure 12).
5. Manually, apply additional compression until the compression stops.
6. Read and record the maximum manual compression force on the Monthly, Quarterly, Semiannual QC Checklist (Figure 12).
7. Ensure that the compression force is sustained for a reasonable period of time (about 5 minutes) after initial application.
8. Release the compression device.

II. Stereotactic Breast Biopsy Equipment QC Tests

PRECAUTIONS AND CAVEATS

If the compression force is not properly adjusted, it may be possible to damage the compression device and associated components. If the compression force exceeds 40 lbs. in the power drive mode, immediately release the compression and ask a service engineer to adjust the maximum compression force in the power drive mode to be between 25 and 40 lb.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

For adequate compression to immobilize the breast during breast biopsy, the maximum compression force should be at least 25 lb. Under power drive, the maximum compression force should be between 25 and 40 lb. Compression force may exceed 40 lb. under manual adjustment, but care should be taken to ensure that the patient is not harmed and equipment is not damaged by applying excessive compression force during breast biopsy.

6. PROCEDURE: REPEAT ANALYSIS

OBJECTIVE

To determine the number and cause of repeated patient exposures. Analysis of these data will help identify ways to improve efficiency and reduce costs, as well as reduce patient breast dose.

FREQUENCY

This test should be carried out initially and at least semiannually. For the repeat rates to be meaningful, an adequate number of total stereotactic breast biopsy exposures is needed.

REQUIRED TEST EQUIPMENT

All rejected stereotactic breast biopsy images or repeated digital images

Means to count the total number of films consumed during the test period

Facility for sorting films during analysis

Data sheets (Figures 8-10)

TEST PROCEDURE STEPS

Screen-film Stereotactic Breast Biopsy System

1. Start by disposing of all existing rejected films in the department.
2. Take inventory of film supply used for stereotactic breast biopsy as a starting point or keep a tally sheet of film to determine total number of films consumed in stereotactic breast biopsy during this test period.
3. Start to collect all rejected stereotactic breast biopsy films, keeping them separate from repeated films from conventional mammography and other procedures.
4. At the end of the six-month collection period, sort the rejected films into the categories listed in Figure 8, such as poor positioning, patient motion, too light, too dark (these might be due to exposure or processing), artifacts (streaks, spots, etc.), and good films (rejected films which appear to be acceptable).
5. Tabulate the counts from step 4 and determine the total number of repeated films and the total number of films exposed. The overall SBB repeat rate is the total of repeated stereotactic films divided by the total number of stereotactic films exposed during the analysis period, multiplied by 100%.
6. Determine the percentage of repeats in each category by dividing the repeats in the category by the total number of repeated films from all categories and multiplying by 100%.

Digital Stereotactic Breast Biopsy System

1. Keep track of each repeated digital exposure using a copy of the Digital Stereotactic Breast Biopsy Repeat Analysis Worksheet in Figure 9. Enter the starting and ending date for each worksheet.
2. Collect the set of worksheets spanning a six-month period and total the causes of repeated digital exposures in each category using a copy of the Digital Stereotactic Breast Biopsy Repeat Analysis Summary Form in Figure 10.
3. Estimate the total number of digital exposures taken in the six-month period and enter the value on the Summary Form. This is aided by keeping a numbered log of stereotactic patients and by multiplying the number of stereotactic patients per six-month period by the typical number of digital images per patient.
4. Calculate the overall repeat rate by dividing the number of repeated digital exposures by the estimated total number of digital exposures for the six-month period and multiplying by 100%.
5. Determine the percent of repeats in each category by dividing the number of repeats in each category by the total number of repeated digital images and multiplying by 100%.

PRECAUTIONS AND CAVEATS

There is a real concern that technologists may alter their routine procedures or criteria for accepting images if they know that rejected films will be analyzed. This should be avoided.

Repeated films (or digital images) are those patient images that had to be repeated and resulted in additional exposure to the patient. All images that are repeated should be included in the repeat analysis. Given the difficulty of initially positioning the patient correctly to visualize a lesion with small field-of-view biopsy systems, a repeat rate higher than that obtained in screen-film mammography should be expected.

Including stereotactic breast biopsy procedures on at least 150 patients allows for a sufficient number of repeated films so that reasonable statistics can be obtained for the analysis. Facilities that do not examine 150 patients in each six-month period should still assess repeated images at least every six months to determine the primary causes of repeats.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

The overall repeat rate ideally should be lower than 20% once the stereotactic breast biopsy quality control program is fully operational. These rates should be based on a film volume of at least 150 screen-film or digital patients (approximately 1000 images) to be meaningful. A repeat rate category that is significantly higher than the others indicates an area for improvement.

STEREOTACTIC BREAST BIOPSY
SCREEN-FILM REPEAT ANALYSIS SUMMARY

Site: _____

Date: From: _____ To: _____

Cause	Number of Films	Percentage of Repeats
1. Positioning		
2. Patient Motion		
3. Light Films		
4. Dark Films		
5. Black Film		
6. Static		
7. Fog		
8. Incorrect Patient I.D., or Double Exposure		
9. Mechanical		
10. Artifacts		
11. Other		

$$\text{Repeat Rate} = \frac{\text{Total Repeated SBB}}{\text{Total SBB Films Used}} \times 100\%$$

Total Repeated SBB Films 1-11	
Total SBB Films Used	
Repeat Rate	

Performed by: _____ Date: _____

Action for Quality Improvement: _____

_____

_____

Physician Review: _____ Date: _____

Medical Physicist Review: _____ Date: _____

Figure 8. Stereotactic breast biopsy screen-film repeat analysis summary.

STEREOTACTIC BREAST BIOPSY
DIGITAL REPEAT ANALYSIS WORKSHEET

(Enter any repeated exposures that required the patient to have additional dose beyond that of the normal exam.)

Site: _____

Stereotactic Breast Biopsy System: _____

Date: From: _____ To: _____

Causes	# of Times	Date	Technologist

Causes:
1. Positioning
2. Patient Motion
3. Detector Underexposure (excessively noisy images)
4. Detector Overexposure (saturation)
5. Incorrect Patient I.D.
6. X-Ray Equipment Failure
7. Software Failure
8. Blank Image
9. Other

Figure 9. Stereotactic breast biopsy digital repeat analysis data collection worksheet.

STEROTACTIC BREAST BIOPSY
DIGITAL REPEAT ANALYSIS SUMMARY

Site: _____

Digital Stereotactic Breast Biopsy System: _____

Date: From: _____ To: _____

Cause	Number of Exposures	Percentage of Repeats
1. Positioning		
2. Patient Motion		
3. Detector Underexposure (excessively noisy images)		
4. Improper Detector Exposure (saturation)		
5. Incorrect Patient I.D.		
6. X-Ray Equipment Failure		
7. Software Failure		
8. Blank Image		
9. Other		

$$\text{Repeat Rate} = \frac{\text{Total Repeated SBB}}{\text{Total SBB Films Used}} \times 100\%$$

Total Repeated SBB Films 1-9	
Total SBB Films Used	
Repeat Rate	

Performed by: _____ Date: _____

Action for Quality Improvement: _____

_____

_____

Physician Review: _____ Date: _____

Medical Physicist Review: _____ Date: _____

Figure 10. Digital stereotactic breast biopsy repeat analysis summary.

7. PROCEDURE: OTHER TECHNOLOGIST'S QC TESTS

Technologist's QC tests relevant for screen-film stereotatic breast biopsy systems (see Table 1) are described in the 1999 ACR Mammography Quality Control Manual. These tests should be performed as described and using the forms provided in that manual.

To assist in the oversight of all of the QC tests, two quality control checklists are provided (Figures 11 and 12). These checklists provide a quick reminder of when QC tests are due and also provide a record indicating that the appropriate tasks have been completed in a timely manner. All dates should be filled in prior to use of the checklist. Each time a task is completed, the individual carrying out the task should initial the appropriate area on the checklist. The completed forms should be placed in the site's Stereotactic Breast Biopsy Quality Control Log Book.

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STEREOTACTIC BREAST BIOPSY QUALITY CONTROL CHECKLISTS

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Stereotactic Breast Biopsy Quality Control Checklist

Site: ______________________________________

Daily and Weekly Tests

Year																															
Month																															
Date																															
Performed by																															
Darkroom Cleanliness (daily)																															
Processor QC (daily)																															
Phantom Images (weekly)																															
Screen Cleanliness (weekly)																															
Viewing Conditions (weekly)																															

Year																															
Month																															
Date																															
Performed by																															
Darkroom Cleanliness (daily)																															
Processor QC (daily)																															
Phantom Images (weekly)																															
Screen Cleanliness (weekly)																															
Viewing Conditions (weekly)																															

Year																															
Month																															
Date																															
Performed by																															
Darkroom Cleanliness (daily)																															
Processor QC (daily)																															
Phantom Images (weekly)																															
Screen Cleanliness (weekly)																															
Viewing Conditions (weekly)																															

Physician Review: ______________________________ Date: ________________

Medical Physicist Review: ________________________ Date: ________________

Figure 11. Daily and weekly checklist for stereotactic breast biopsy QC tests.

Stereotactic Breast Biopsy Quality Control Checklist

Department of Diagnostic Radiology

Monthly, Quarterly, and Semi-Annual Tests

(date, initial and enter number where appropriate)

Year												
Month	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
Visual Checklist (monthly)												
Repeat Analysis (≤ 20%) (Semi-annually)												
Fixer (≤ 0.05 gm/m^2) (quarterly)												
Darkroom Fog (≤ 0.05) (Semi-annually)												
Screen-film Contact (Semi-annually)												
Compression (25-40 lb) (Semi-annually)												

Date: **Test:** **Comments:**

Physician Review: _____ Date: _____

Medical Physicist Review: _____ Date: _____

Figure 12. Monthly, quarterly, and semiannual checklist for Stereotactic Breast Biopsy QC Tests.

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Stereotactic Breast Biopsy Quality Control Manual 1999

Medical Physicist's Section

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INTRODUCTION

Stereotactic breast biopsy units should produce the same quality of image as produced by dedicated mammography equipment. Furthermore, the accuracy of the stereotactic needle placement should be assured. This supplement to the Mammography Quality Control Manual provides detailed procedures for a number of tests designed to be conducted at least annually by a medical physicist and intended to assess the continuing performance of stereotactic breast biopsy equipment. The tests presented in the "Medical Physicist's Section" were selected as the minimum set of tests that should be conducted on an annual basis to help assure proper system performance. Tests should be performed at technique factors used clinically. It is assumed that stereotactic breast biopsy equipment will have been subjected to extensive acceptance testing or a thorough performance evaluation prior to the initiation of quality control testing.

Most digital units can also accommodate screen-film. If the facility plans to use both digital and screen-film image receptors, both must be tested. If all biopsies will be performed with the digital system, screen-film components need not be tested.

It is the responsibility of the medical physicist conducting these tests accurately to convey test results and observations in a written report, to make recommendations for corrective actions according to the test results, and to review the results with the radiologist and QC technologist. Corrective actions should not be limited to repair of X-ray equipment by a qualified service person, but also should include recommendations that might improve image quality, including recommendations concerning image receptors, technique factors, processing, viewing conditions, and quality control. The medical physicist should periodically review the results of the routine quality control tests conducted by the QC technologist and make recommendations regarding these tests, if appropriate. Furthermore, the medical physicist should participate in periodic reviews of the mammography quality control program as a whole to assure that the program is meeting its objectives.

Section III provides data recording forms to record the site's clinical techniques and results of the eleven QC tests described in this manual. These forms are provided for duplication so that they can be used repeatedly for medical physicist QC testing of stereotactic breast biopsy systems.

I. Introduction

Communications from the medical physicist to the QC technologist and radiologist should be clear and concise. To assist the physicist in communicating test results and recommendations, Summary Forms have also been included as the first two pages in Section III. These forms should be used or appropriately modified to summarize the results and recommendations of the medical physicist's QC testing and surveys.

A list of resources and additional references relevant to mammography physics are included at the end of this manual.

1. PROCEDURE: STEREOTACTIC BREAST BIOPSY UNIT ASSEMBLY EVALUATION

OBJECTIVE

Ensure that all locks, detents, angulation indicators, and mechanical support devices for the X-ray tube, compression plate and image receptor holder assembly are operating properly.

TEST PROCEDURE STEPS

1. Verify that the stereotactic breast biopsy unit is mechanically stable under normal operating conditions.
2. Verify that all moving parts move smoothly, without undue friction, that cushions or bumpers limit the range of available motions, and that no obstructions hinder the full range of motions within these limits. This includes table and X-ray assembly motions for prone units.
3. Set and test each stereo X-ray table location to ensure that movement from that position will not occur inadvertently.
4. Verify that the image receptor assembly, compression plate and biopsy window location are free from wobble and vibration during normal operation.
5. Verify that the image receptor is held in place for any clinical orientation of the image receptor holder assembly. For screen-film image receptors, verify that the cassette slides smoothly into the proper position in the image receptor holder assembly.
6. Verify that the indicated compressed breast thickness is accurate to within ±5 mm and reproducible to within ±2 mm.
7. Verify that in normal operation, the patient and operator are not exposed to sharp or rough edges, cracked compression paddles, or other hazards.
8. Verify that operator technique charts are posted.
9. Verify that the operator is protected during exposure by adequate radiation shielding.
10. Verify that the needle holder and needle guides are firmly attached and support the needle without allowing the needle to bend, curve, or droop excessively (i.e. by more than 1 mm in any direction).

II. Stereotactic Breast Biopsy Equipment QC Tests

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

Items that are hazardous, inoperative, out of alignment or operate improperly should be repaired by appropriate service personnel.

2. PROCEDURE: COLLIMATION ASSESSMENT

OBJECTIVE

Assure that the X-ray collimation does not allow significant radiation to extend beyond the edges of the image receptor (IR) and assure that the biopsy window aligns with the X-ray field.

REQUIRED TEST EQUIPMENT

Four coins

Tape

One or two mammography screen-film cassettes and sheets of mammography film

Ruler with mm scale

TEST PROCEDURE STEPS

1. Tape coins to the front compression plate so that their edges are tangent to the edges of the biopsy window (See Figure 1).
2. Place the X-ray tube in the scout view (0^{o}) position. For screen-film imaging systems, insert a cassette into the cassette holder.
3. For both screen-film and digital image receptor systems, place a film in a screen-film cassette and center the screen-film cassette behind the biopsy window so that the cassette extends beyond all edges of the biopsy window. Compress the cassette centered in the field on top of the breast support surface (or for a prone unit, in front of the breast support surface) (see Figure 1). This cassette will be called the "front cassette."
4. Take an exposure with technique factors sufficient to adequately expose both cassettes (screen-film) or to adequately expose the front cassette and record an image on the digital detector (digital). Suggested technique factors to properly expose the front cassette without added attenuation are: Mo/Mo, 25 kVp, 20 mAs.
5. Process one or both film images and ensure that appropriate optical densities (above 1.0) are obtained within the radiation field outside the coins. If a digital image receptor was used, observe the digital image and, if possible, record it on film as well.

Figure 1. Coins taped to four corners in front of compression plate with edges tangent to edges of biopsy window.

DATA ANALYSIS AND INTERPRETATION

Screen-film Image Receptor System

Display the two films side by side. Distances measured on these two films should be referred to the film that was located in the cassette tunnel. Distances measured in the front cassette film should be multiplied by a size magnification factor slightly greater than 1.00 to correct distances measured in the front film to distances measured in the plane of the image receptor. This magnification factor can be determined by taking the ratio of the coin diameter in the IR film to the coin diameter in the front film, using the same coin in the two films.

Digital Image Receptor System

Display the digital image on the monitor or on a printed film. The recorded image region defines the "image receptor." The front cassette film should be viewed on a viewbox nearby. Distances should be referred to actual distances measured in the plane of the digital image receptor. Some digital display systems are capable of measuring distances in the plane of the image receptor using distance-measuring software. Sys-

tems without this feature will require measuring distances on the monitor or printed film and converting those to actual distances measured in the plane of the image receptor.

1. The edges of the biopsy window are delineated by the outer edges of the four coins. These coins should be fully visible in the front cassette film, but may be only partially visible in the IR image, especially if a digital IR is being used. Note whether the full area of the biopsy window is recorded on the IR image and, if so, how much beyond the biopsy window the IR image extends on each side, measured in the plane of the image receptor. If the outer edges of all four coins are not visible in the IR image, note the difference between the biopsy window and the IR image by measuring the amount of each coin that is missing. Refer all measured distances to actual distances measured in the plane of the image receptor. Note any asymmetries between the biopsy window and the IR field of view.

2. The location of the edges of the radiation field are given by the radiation field pattern on the front cassette film. When properly positioned, the radiation field should be fully contained within the front cassette film; if not, Test Procedure Steps 3-5 above should be repeated with a repositioned (and possibly larger) front cassette.

   For screen-film IRs, the radiation field should be within the IR film on all edges except the chest wall edge, where the radiation field may extend beyond the chest wall edge of the IR by up to 2% of the source-to-image receptor distance. Verify that the radiation field is within the screen-film IR on all edges except the chest wall edge. Measuring on the front film and referring all distances to the IR film, measure the distance that the radiation field extends beyond the image receptor at the chest wall edge.

   For digital IRs, the radiation field should extend beyond the edges of the digital IR, but not by more than 5 mm on any edge. Examine the digital IR image to verify that the radiation field exceeds the digital IR field. Compare the front cassette film to the digital IR image to determine the distance that the radiation field exceeds the digital IR field on all edges. Refer these distances to the plane of the image receptor. Enter results on the data sheet provided.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

For screen-film systems, the X-ray field should be contained within the image receptor film on all three sides except the chest wall edge; the X-ray field should not extend beyond the chest wall edge of the image receptor film by more than 2% of the source-to-image receptor distance (SID).

II. Stereotactic Breast Biopsy Equipment QC Tests

For digital image receptors, the X-ray field may extend beyond the edge of the IR on all four sides, but no edge of the X-ray field should extend beyond the IR by more than 5 mm on any side. Distances should be measured in, or referred to, the plane of the digital image receptor.

The biopsy window should be generally centered over the image receptor.

Any gross mismatch between X-ray field and image receptor should prompt a check of the X-ray collimation or diaphragm that is being used with the stereotactic breast biopsy system. If the correct collimation or diaphragm is being used, and the criteria above are exceeded, the system should be repaired by a qualified X-ray service person.

3. PROCEDURE: FOCAL SPOT PERFORMANCE AND SYSTEM LIMITING SPATIAL RESOLUTION

OBJECTIVE

Evaluate focal spot performance by measuring limiting spatial resolution using a high-contrast resolution pattern both parallel to and perpendicular to the anode-cathode axis using film. System limiting spatial resolution of the digital image receptor, if present, is also evaluated.

REQUIRED TEST EQUIPMENT

To measure focal spot performance, a line pair (lp) test pattern that goes up to 20 lp/mm is needed. To measure system limiting resolution on digital image receptors, it is preferable to have a line pair phantom with continuous or discrete line pair gradations up to at least 10 lp/mm.

Direct exposure, ready-pack film (such as Kodak XTL-2)

OR

Loaded mammographic screen-film cassette, as long as the screen-film cassette does not limit the measured resolution (This can be tested by imaging the test pattern in contact with the cassette.)

Lead marker to designate the anode-cathode axis direction

Tape measure or long ruler

An optical magnifier with 10x to 30x magnification

Note: Digital image receptors must not be used for focal spot performance measurements.

TEST PROCEDURE STEPS

Measurement of Focal Spot Limiting Spatial Resolution

1. Place the 20 lp/mm test pattern 4.5 cm above, or for prone units in front of, the breast support plate, either with no extraneous materials between the bar pattern and the breast support or with a homogeneous phantom supporting the pattern. Position the pattern with its center 2 cm from the chest wall edge of the image receptor, centered laterally. The pattern's bars should be oriented parallel to the anode-cathode axis for the first image. It is important that the test pattern be positioned in a reproducible manner. The pattern can also be attached to the biopsy window on the compression paddle and positioned 4.5 cm from the breast support surface.
2. Place the film or cassette where it would normally be located for mammography, i.e., in the cassette holder for contact mammography. If a stationary grid is normally used with the imaging system, remove it

to avoid moiré patterns. For digital systems, place the film in front of the digital receptor on the breast support plate.

3. If necessary, tape an additional uniform attenuator (e.g., 2-4 cm of acrylic or BR-12 material) beneath the collimating device of the X-ray tube to allow a manual exposure or AEC exposure with correct film optical density to read the bar pattern image.
4. Place the lead marker in the X-ray field of view along the anode-cathode axis.
5. Select the most common kVp value used clinically. The mAs may be obtained using the AEC if the pattern rests on an attenuator. An image with background optical density of 1.0 to 1.5 is preferred. If no AEC is available, a clinical technique for a breast as thick as the attenuator used is a good starting point. Several exposures may be needed to achieve a background optical density of 1.0 to 1.5 giving good visibility of the line pair pattern on film.
6. Make an exposure and process the film.
7. Repeat steps 1- 6 with the bars oriented perpendicular to the anode-cathode axis.

DATA ANALYSIS AND INTERPRETATION

Under masked conditions, view the high-contrast resolution pattern images with 10x to 30x magnification. Note the highest frequency pattern whose lines are distinctly visible throughout at least half of the bar length (for a bar pattern) and record the highest frequency visible for each test image.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

Measurements made with film or screen-film image receptors and with the bars parallel to the anode-cathode axis should resolve at least 13 lp/mm; measurements with film or screen-film and with the bars perpendicular to the anode-cathode axis should resolve at least 11 lp/mm.

Measurement of Digital System Limiting Spatial Resolution (digital IR systems only)

TEST PROCEDURE STEPS

1. Use the digital image receptor without a film or screen-film cassette and place the bar pattern 4.5 cm in front of the breast support plate, with bars running nearly parallel to the anode-cathode axis. This measures limiting spatial resolution perpendicular to the anode-cathode axis direction.
2. Acquire a digital image using all of the clinical acquisition matrix sizes.

3. Repeat with the bar pattern running perpendicular to the anode-cathode axis.

NOTE: If a hardcopy output device is used, then produce a hardcopy of this image, and evaluate the limiting spatial resolution in the hardcopy aided by a 10x by 30x magnifier. Enter results on the data form.

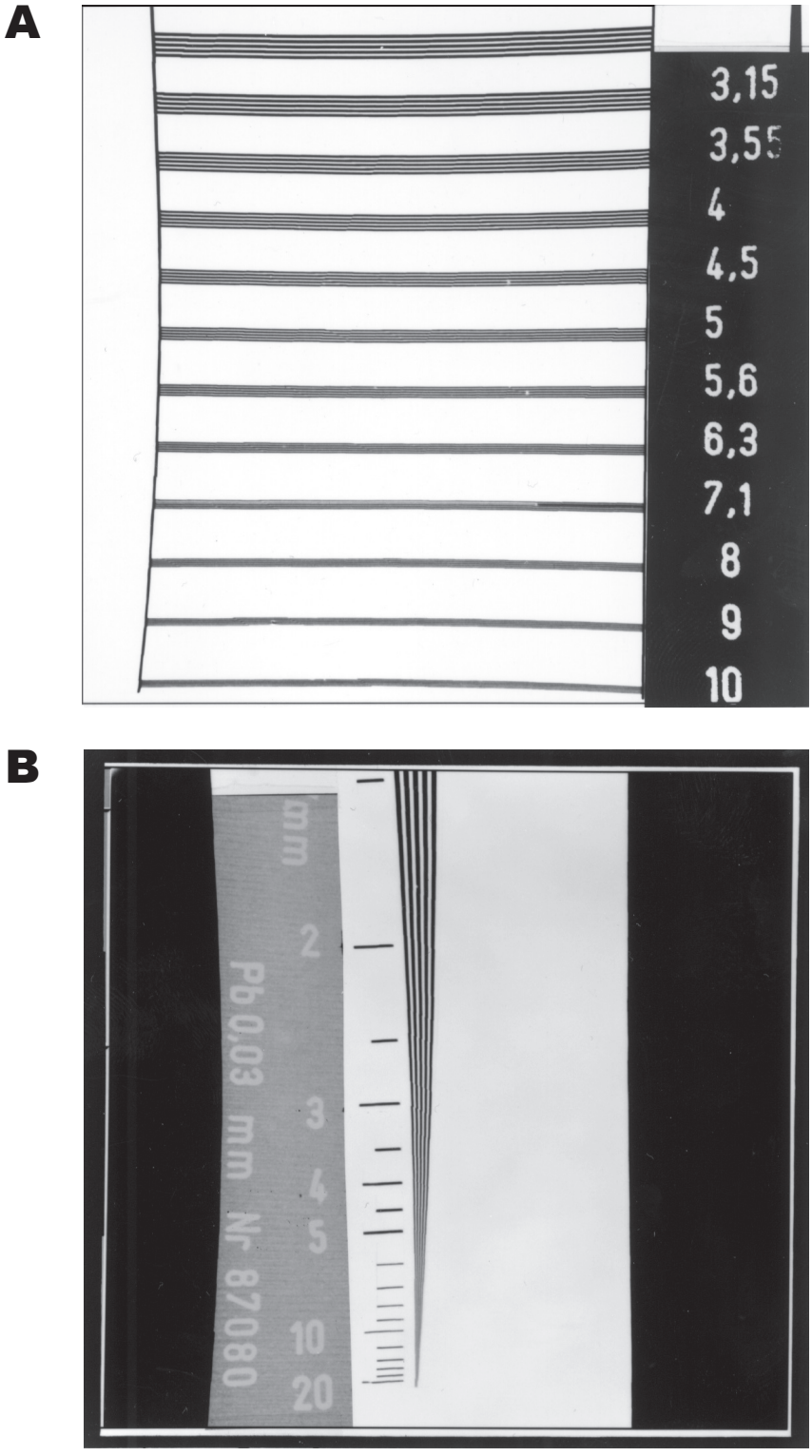
DATA ANALYSIS AND INTERPRETATION

Using the monitor, magnify or zoom the digital image and adjust window width and level settings so that the bars in the bar pattern are most readily resolved. Determine the smallest bar pattern (highest number of line pairs per unit length) in which the bars are distinctly resolved (and the correct number of bars is visualized) across some part of the bar pattern. There are likely to be regions where the bar pattern fades from being resolved to being unresolved due to imperfect alignment of the bar pattern with the image matrix (see Figure 2). The bar pattern should be considered to be resolved if any portion of the line pair pattern shows distinctly the correct number of bars. Once a blur across the entire length of the bars, a phase shift (bright bars shift to dark and vice versa), or aliasing (fewer bars are demonstrated) occurs, record the last correctly resolved bar pattern spatial frequency (in line pairs per mm) as the limiting spatial resolution.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

It is important to assess consistency of system-limiting spatial resolution over time and in comparison to acceptance testing results. Any significant degradation of the observed test results should be brought to the attention of the facility and promptly serviced by a qualified service engineer.

II. Stereotactic Breast Biopsy Equipment QC Tests



Figures 2A & B. Line Pair patterns photographed from the monitor of a stereotactic breast biopsy system. A: A discrete line pair pattern with a maximum of 10 line pairs per millimeter. B: A continuous line pair pattern with a maximum of 20 line pairs per millimeter.

4. PROCEDURE: kVp ACCURACY AND REPRODUCIBILITY

OBJECTIVE

Assure that the actual kVp is accurate (within ±5% of the indicated kVp) and that the kVp is reproducible, having a coefficient of variation equal to or less than 0.02.

REQUIRED TEST EQUIPMENT

Test device capable of measuring kVp to an accuracy of ±1.5 kVp and a precision of 0.5 kVp within the mammographic kVp range.

TEST PROCEDURE STEPS

1. In manual exposure mode, select the most commonly used clinical kVp and record on the data form. Also record nominal focal spot size, exposure time, and mA (or mAs) setting.
2. Be sure that the needle support system is not in the field during this test. It should be moved out of the active area of the meter. For add-on stereotactic systems, set up the test device following the manufacturer's instructions. For prone stereotactic systems, center the equipment using the window in the compression plate (or the light field). This may require that the kVp meter project above the breast support system so that the active area is as close to the chest wall as possible. If the active area of the kVp meter cannot be contained within the biopsy window, remove the compression paddle before exposing the kVp meter.
3. Test the kVp reproducibility by making four exposures in the manual mode at the most commonly used clinical kVp. Record the measured kVp values.
4. Repeat the procedure at other clinically important kVps but make only one exposure at each setting. (Reproducibility needs to be checked at only the most commonly used clinical kVp unless variability is suspected at other settings.)

DATA ANALYSIS AND INTERPRETATION

To determine kVp accuracy, average the four kVp readings for each kVp setting tested and compare this average value with the value of the preset nominal kVp. To determine kVp reproducibility, compute the standard deviation of the kVp values for each kVp setting and then calculate the coefficient of variation (standard deviation divided by the average value) for each.

II. Stereotactic Breast Biopsy Equipment QC Tests

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

If the average measured kVp differs by more than ±5% (±1.5 kVp at 30 kVp) from the nominal kVp setting, the unit should be checked by appropriate service personnel. If the coefficient of variation exceeds 0.02 for any kVp setting, the unit should be checked by appropriate service personnel.

NOTE: If the reproducibility results with four exposures are questionable, make six additional readings and recalculate the coefficient of variation using all 10 readings.

5. PROCEDURE: BEAM QUALITY ASSESSMENT (HALF-VALUE LAYER MEASUREMENT)

OBJECTIVE

Assure that the half-value layer of the X-ray beam is adequate to minimize patient breast dose, while not so excessive that contrast is lost in the resultant image.

REQUIRED TEST EQUIPMENT

Ionization chamber and electrometer calibrated at mammographic X-ray beam energies (calibration factor constant to within ±1% over the HVL range from 0.2 to 0.5 mm Al).

Five 0.1-mm thick sheets of 99.9% pure aluminum (type 1145 aluminum alloy) or 99% pure aluminum (type 1100 aluminum alloy) of length and width sufficient to cover the ionization chamber fully. The stated thicknesses should be accurate to within ±1%.

NOTE: The use of type 1100 aluminum alloy for HVL measurement can give (depending on specific samples) HVL values up to 7.5% lower than those measured using pure aluminum. If type 1100 aluminum is used, results should be corrected to agree with those obtained using type 1145 aluminum alloy.

TEST PROCEDURE STEPS

1. Place the ionization chamber 4.5 cm above (or in front of) the breast support surface and centered in the X-ray field. This may require using tape for prone units. The window in the compression paddle or in the light field may help center the chamber. If any part of the X-ray beam is attenuated by the compression plate before reaching the sensitive volume of the ionization chamber, remove the compression plate or take other steps to assure that the ionization chamber measures unattenuated X-ray output. Move the needle holder so it is not in the path between the X-ray field and the ion chamber._
2. Select the target-filtration and kVp at which the system is normally used clinically and record the settings on the data form. Adjust the line voltage to within tolerance, if possible, and assure that the filtration normally used for that kVp setting is in place.
3. Set the unit to manual exposure mode, with a time setting sufficiently long to provide an exposure of approximately 500 mR, and record mA and time (or mAs).
4. Make an exposure without any aluminum sheets between the X-ray tube and the ionization chamber. Make sure that the ionization chamber is fully exposed. Record the ionization chamber reading (as E_o).

5. Add 0.2 mm of aluminum between the X-ray tube and the ionization chamber, by placing the aluminum on top of the compression paddle or for prone units, by taping the aluminum over the X-ray port. Use the light field (if available) to verify that the X-ray path to the ionization chamber is fully blocked by the aluminum sheet. Make an exposure and record the ionization chamber reading.
6. Repeat step 5 with additional 0.1-mm sheets of aluminum between the X-ray tube and ionization chamber, recording the ionization chamber reading each time until the reading is less than one-half the unattenuated exposure reading.
7. Remove all aluminum sheets and make a final exposure and record the chamber reading. If the result of this repeat E_o measurement differs by more than 2% from the exposure E_o measured in step 4, repeat the measurement sequence.
8. Repeat steps 3-7 for other target-filter and kVp settings used clinically during a biopsy.

DATA ANALYSIS AND INTERPRETATION

To calculate the HVL by logarithmic interpolation, use the following notation and procedure. Denote the direct exposure reading, without any added aluminum, as E_o. Divide this value in half and find the two exposure readings and added aluminum thicknesses that bracket the $E_o/2$ exposure. Let E_a be the exposure reading that is just greater than one-half of E_o and t_a be the corresponding aluminum thickness. Let E_b be the exposure reading that is just less than one-half of E_o and t_b the corresponding aluminum thickness. E_a will be greater than E_b, while t_a will be less than t_b. With this notation, the HVL may be computed using the formula:

$$HVL = \frac{t_b \ln[2E_a/E_o] - t_a \ln[2E_b/E_o]}{\ln[E_a/E_b]}$$

where the HVL will be given in the same units as t_a and t_b, usually millimeters of aluminum.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

At a given kVp setting in the mammographic kilovoltage range (below 50 kVp), the measured HVL with the compression paddle not in place or inside the biopsy window must be equal to or greater than the value:

$$HVL \geq \frac{kVp}{100} \text{ (in units of mm of aluminum)}$$

For example, if the nominal tube potential is 28 kVp, the HVL must equal or exceed 0.28 mm of aluminum. If the measured HVL is below this limit at any kVp setting, service personnel should be contacted to check whether appropriate filtration is in place.

If the HVL for screen-film units is excessive, both subject contrast and image contrast will be reduced. For screen-film units using Mo/Mo, Mo/Rh, or Rh/Rh target filtration combinations, it is recommended that the HVL be within a constant value (C) of the minimum acceptable HVL:

$$\text{HVL} < \frac{\text{kVp}}{100} + \text{C (in mm of aluminum)}$$

where C = 0.12 mm Al for Mo/Mo, C = 0.19 mm Al for Mo/Rh, and C = 0.22 mm Al for Rh/Rh. (Note: these HVL upper bounds are based on molybdenum filter thicknesses of 30 μm or less and rhodium filter thicknesses of 25 μm or less.)

For example, for Mo/Mo at the 28 kVp, the upper limit is HVL < 0.40 mm of aluminum. Excessive HVL violates no federal standards but should prompt a check by service personnel to assure that the X-ray tube has an appropriate (beryllium) window and that mirror and filtration are correctly installed.

6. PROCEDURE: AUTOMATIC EXPOSURE CONTROL (AEC) OR MANUAL EXPOSURE PERFORMANCE ASSESSMENT

OBJECTIVE

Assess the performance of the stereotactic breast biopsy unit's AEC system or manual techniques with regard to appropriate film optical density or detector signal levels over the range of breast thicknesses.

REQUIRED TEST EQUIPMENT

A phantom made of either acrylic or BR-12 and consisting of at least four 2-cm-thick slabs to provide thicknesses of 2 cm, 4 cm, 6 cm, and 8 cm with surface areas representative of typical breast sizes

Lead numbers

A densitometer (if screen-film image receptors are used clinically)

TEST PROCEDURE STEPS

The following test procedures are designed to assess the ability of the AEC system or manual techniques to maintain a constant image optical density or digital signal over the range of clinical imaging techniques used at the site.

1. Prepare the imaging system for operation in the AEC or manual mode (whichever is used clinically). If AEC is used, position the AEC sensor under the biopsy window and select the density control setting indicated on the technique chart.
2. Use the clinical technique factors for 4, 6 and 8 cm thick breasts. Acquire an image with appropriate thicknesses of phantom material. Use a lead number indicating breast thickness if it can be done so that the numbers do not affect AEC performance. Record all technique factors.
3. For screen-film systems, process the exposed film in the film processor normally used for processing stereotactic images.
4. On the processed films, measure the image optical density at the center of the phantom image and record.
5. For digital systems, measure the signal at the center of the digital field of view using a region-of-interest (ROI) measurement and record the results for each thickness.

DATA ANALYSIS AND INTERPRETATION

For screen-film systems, review the consistency of film optical density across phantom thicknesses. For digital image receptors, review the consistency of mean signal across all phantom thicknesses.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

For screen-film systems, the image optical density should remain constant within ±0.15 of the mean as phantom thickness is varied using the site's clinical techniques (whether AEC or manual). If the optical densities do not meet this criterion, the medical physicist should develop a technique chart which meets this criterion and should provide the revised technique chart to the facility. If the revised technique chart requires use of different manual techniques or different density control settings, the effects of these new techniques or new density control settings on image optical density must be assessed. For digital systems, the signal value should remain within ±20% of the signal obtained for the 4 cm phantom, assuming the signal level for a 4 cm phantom is appropriate. If it does not meet this criterion, the medical physicist should develop a technique chart which meets this criterion and provide the revised technique chart to the facility. Ideally, clinical techniques (whether AEC or manual), should keep exposure times under 2 seconds while meeting these OD or signal requirements.

7A. PROCEDURE: UNIFORMITY OF SCREEN SPEED (SCREEN-FILM SYSTEMS)

OBJECTIVE

Assess the uniformity of the radiographic speed of image receptors routinely used for mammographic imaging. If screen-film is not used at the facility, this test does not need to be done (Test 7B should be performed instead). If the screens used for stereotactic biopsy have already been checked for uniformity using the procedure in the *ACR Mammography Quality Control Manual*, then this test does not need to be repeated.

REQUIRED TEST EQUIPMENT

The screen-film cassettes normally used for stereotactic breast biopsy

A single box of film of the type used for stereotactic breast biopsy

A uniform 4.0-cm-thick (approximately) cassette-sized phantom made of either acrylic or BR-12 material

A densitometer

Lead numbers (optional)

TEST PROCEDURE STEPS

1. Identify all of the image receptors (cassettes) to be evaluated with some form of numbering system for further reference.
2. Select one of the cassettes and load it with a sheet of film from a box set aside for this test. Record on the data form the specifics of the image receptor being evaluated and the emulsion number of the film used for the test.
3. Select the imaging mode, target, filter and kVp most commonly used for stereotactic breast biopsy. Choose the exposure mode (AEC or manual) used clinically.
4. Position the phantom on the cassette holder assembly at a location over the image receptor that would be occupied by the patient's breast. Place the compression device in contact with the phantom.
5. Using the imaging mode and kVp selected in Step 3, determine the +/– density control setting (if phototimed) or mAs (if manual) required to obtain an image optical density greater than 1.40, as measured in the center of the phantom image. Record this technique on the data form.
6. Load all of the imaging cassettes to be evaluated with film from the same box as used in Step 2.
7. Sequentially expose each cassette under the conditions determined in Step 5. It may be useful to use lead numbers to identify the images. If AEC exposures are used, make sure that the lead numbers are not

placed in the vicinity of the AEC detectors. Record the actual mAs for each exposure on the data form. It is important to ensure that the position of the phantom and compression device are unchanged during all exposures.

8. After half of the cassettes have been exposed, unload the film from the first (control) cassette, process the film, reload the cassette, and expose the control cassette as noted in Step 7. Also repeat this step after all of the cassettes have been exposed. This will result in three control films using the same cassette.
9. Process the exposed films in the film processor routinely used for stereotatic images.
10. Measure the optical density in the same place at the center of the phantom on each of the processed images and record on the data form. (Identify the center by diagonals "drawn" from corner to corner across the X-ray field.)
11. If more than one size or type of image receptor is used for stereotactic breast biopsy, repeat Steps 1 through 10 for each.

DATA ANALYSIS AND INTERPRETATION

Using the measured densities from the three films exposed in the control cassette, calculate the standard deviation of the control film optical densities. If the standard deviation exceeds 0.05, the variability of the X-ray exposures or film processing is excessive and the screen speed uniformity test cannot be carried out adequately under these conditions. Corrective action should be taken to reduce this variability before assessing screen speed uniformity. If the standard deviation of the control films does not exceed 0.05, then determine the maximum and minimum optical densities from all cassettes.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

The difference between the maximum and minimum optical densities should not exceed 0.30. Corrective action is necessary for any cassette that does not fall within this range.

Any individual cassette within a given speed group that does not meet the above criteria should be checked to try to determine the cause of the problem. One obvious item to check is misidentification of a cassette with the type of screen it contains. Also, if screens of the same speed are contained within cassettes of different manufacturers, it is possible that variations in attenuation of the cassette may cause significant variations in film optical densities under AEC exposures. Should no identifiable cause for image density variation be determined, it is reasonable to replace cassettes that result in optical densities outside the 0.30 range.

II. Stereotactic Breast Biopsy Equipment QC Tests

NOTE: The uniformity of the screen speed test also provides the physicist with an opportunity to check for screen and cassette artifacts. Any artifacts should be noted by cassette number and brought to the attention of the facility.

7B. PROCEDURE: DIGITAL RECEPTOR UNIFORMITY (FOR DIGITAL IMAGE RECEPTORS)

OBJECTIVE

For digital image receptors, geometrical distortion, misalignment of the lens system, poor fiber optic contact, and CCD element drop-out can cause signal non-uniformities that should be corrected. This test is performed to determine the adequacy of digital detector uniformity.

REQUIRED TEST EQUIPMENT

4 cm thick acrylic or BR-12 sheet (large enough to fully cover the digital image receptor)

Mammographic screen-film contact mesh (if digital system is not equipped with region-of-interest (ROI) measurements, see below)

TEST PROCEDURE STEPS

For digital systems that permit ROI signal mean and standard deviation measurements.

1. Obtain a digital image with the uniform 4 cm thick sheet of acrylic or BR-12 material covering the entire image field (and without the screen-film contact mesh), using the site's clinical techniques for a 4 cm thick compressed breast.
2. On the resultant image, acquire signal means and standard deviations (if available) using circular or square ROIs at locations in the center (see Figure 3) and in each corner of the image field. Use of small ROIs is recommended to minimize the effect of non-uniformities on signal standard deviations.

DATA ANALYSIS AND INTERPRETATION

1. Compute signal-to-noise ratios (SNR) in each region of interest by dividing the mean signal by the standard deviation of signal (if available) for each ROI.
2. If other specific regions of the image appear to be non-uniform, acquire signal means and standard deviations (if available) and compute SNR values in those additional regions.
3. Calculate the ratio of SNR values in each region to the SNR values in the center of the image field. If the standard deviation values are not available, then calculate the ratio of mean signals in each region to the mean signal in the center of the image field.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

The SNR (or signal values) measured in each corner of the image should be within ±15% of the SNR (or signal) measured at the center of the field of view on a properly calibrated digital system. If not, service correction of image receptor homogeneity should be sought.

II. Stereotactic Breast Biopsy Equipment QC Tests

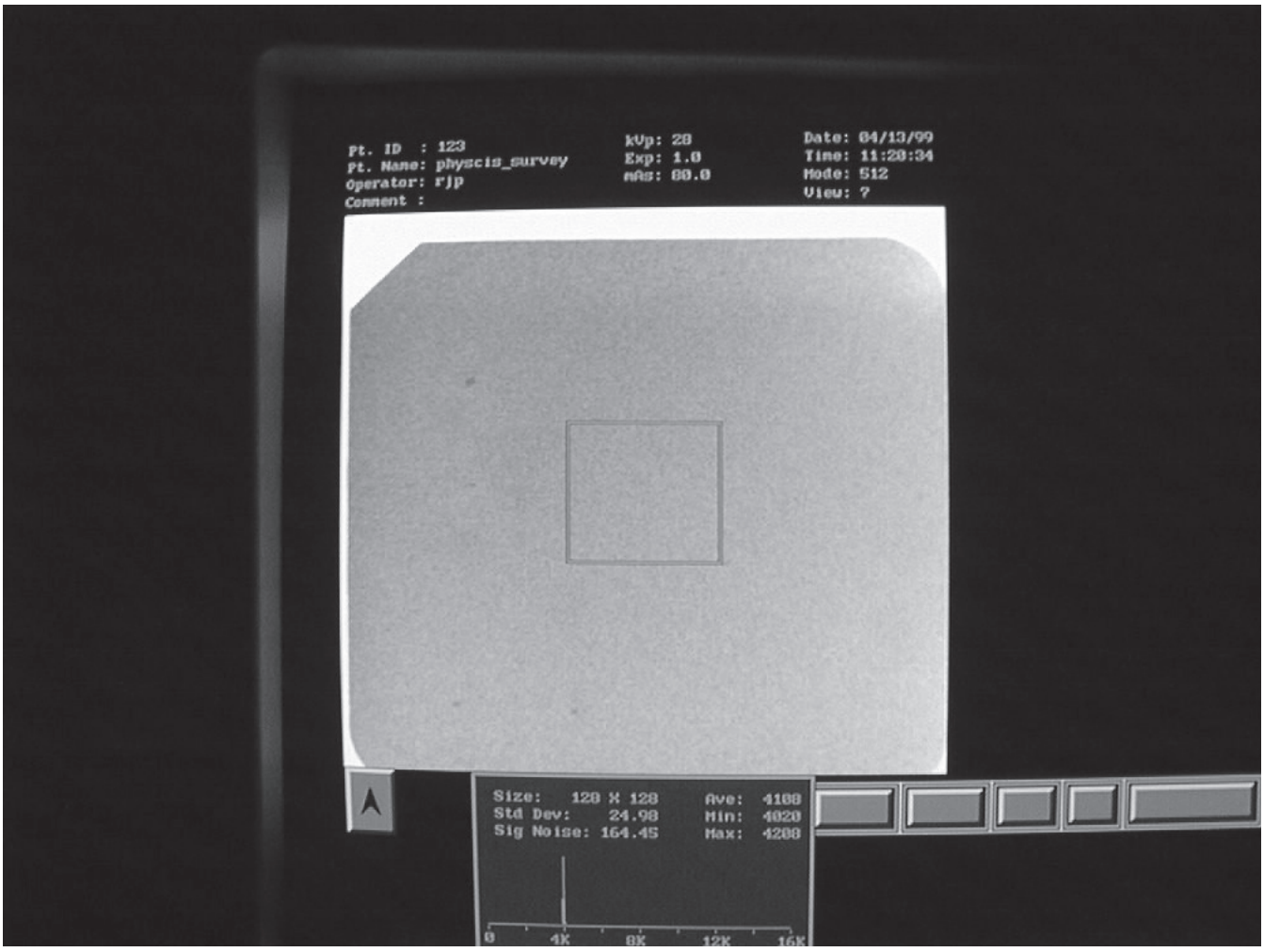


Figure 3. Use system software to obtain ROI statistics in the center (shown above) and in each corner of the image field.

TEST PROCEDURE STEPS

For digital systems that are not equipped with ROI signal measurements

1. Place the mammographic screen-film contact mesh as close to the digital image receptor as possible and completely covering the image receptor.
2. Place 4 cm of acrylic between the compression paddle and the mesh and compress.
3. Select a reasonable manual exposure technique, for example, the clinical technique (target, filter, kVp and mAs) used for a 4 cm thick breast, and acquire a digital image.

DATA ANALYSIS AND INTERPRETATION

1. Examine the edges of the digital image for geometric pincushioning.
2. Narrow the window width and adjust the window level on the mesh image until only black dots on a white field remain.
3. Inspect the resulting image for large areas of non-uniformity.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

Call the service engineer if any of the following are observed:

- If excessive geometric pincushioning extends more than 1 cm from the edge of the field of view.
- If areas without black dots occupy more than 10% of the image.
- If a line without black dots extends more than ¼ the length of the image.

8. PROCEDURE: BREAST ENTRANCE EXPOSURE, AVERAGE GLANDULAR DOSE, AND EXPOSURE REPRODUCIBILITY

OBJECTIVE

Measure the typical entrance exposure for a standardized breast thickness and composition (approximately 4.2 cm compressed breast thickness—50% adipose, 50% glandular composition), calculate the associated average glandular dose, and assess short-term exposure reproducibility.

REQUIRED TEST EQUIPMENT

Ionization chamber and electrometer calibrated at mammographic X-ray beam energies (calibration factor constant to within ±1% over the HVL range from 0.2 to 0.5 mm Al)

Mammographic phantom (equivalent to approximately 4.2 cm compressed breast tissue—50/50 composition—at screen-film energies; for example, Radiation Measurement, Inc., Model 156 or Nuclear Associates, Model 18-220 Mammographic Phantom)

Mammographic cassette loaded with mammography film (film will not be processed or reviewed) or a digital receptor

TEST PROCEDURE STEPS

1. Prepare the imaging system for operation in the stereo mode with the image receptor normally used. Center the chamber as for HVL measurements and remove the compression device, if possible. Record the conditions on the data form.
2. For prone systems with a variable source-to-breast support distance, use a setting appropriate for a 4.2 cm thick phantom and record it.
3. If the stereotactic breast biopsy unit is a screen-film system, position a loaded cassette (of the type and size consistent with the imaging mode selected in Step 1) in the image receptor holder assembly.
4. Select the exposure technique normally used for stereotactic localizations. For screen-film systems, it will normally be AEC; for digital systems, it may be AEC or manual exposure technique. If AEC techniques are used, select the density control setting that is normally used clinically for an average patient.
5. Position the ionization chamber in the X-ray field to measure the entrance exposure for an ACR-approved stereotactic breast biopsy accreditation phantom. Assure that the entire chamber is exposed without attentuation by the breast compression device.

NOTE: If AEC is used, ensure that the chamber is not between the X-ray source and the AEC detector. If this is not possible then it will be necessary to take an AEC exposure with the phantom and without the ion chamber, noting all techniques: target-filter, kVp, and mAs. Then take a manual exposure with the same technique factors (and with the mAs as close as possible to that obtained on the AEC conditions) with the chamber in the field of view. Recalculate the entrance exposure corresponding to the exact mAs recorded for the phantom exposure under AEC conditions.

6. Position the mammographic phantom on the breast support surface at the position which would normally be occupied by the patient's breast (laterally centered in the X-ray field with one edge coincident with the chest wall edge of the breast support).
7. Expose the ion chamber four times using the clinical exposure techniques and record the measured entrance exposure and, if AEC, mAs values from each exposure.

NOTE: Stereotactic breast biopsy systems have a significant X-ray intensity gradient in the X-ray field along the anode-cathode direction. Maintaining a constant chamber position during measurements is critical. When measurements are to be compared with others made previously, it is also critical that the original measurement position be re-established as closely as possible.

DATA ANALYSIS AND INTERPRETATION

Compute the mean and standard deviation for the measured exposure and, if AEC is used, for mAs. Record the values. Determine the coefficients of variation (standard deviation divided by the mean) for the exposure and, if AEC is used, for mAs.

Using the average exposure value, calculate the average glandular dose as follows:

1. Determine whether the target is molybdenum, tungsten, or rhodium and find the appropriate column in Tables 1, 2, or 3 for the target and filtration combination used clinically.
2. Find the HVL of the system (see the beam quality assessment procedure) in the left-hand column of Tables 1 to 3. In the right-hand column of the table appropriate for the target-filter and kVp setting,

find the exposure to average glandular dose conversion factor (all 3 tables are for a 4.2 cm compressed breast thickness). Multiply this factor by the average entrance exposure value computed above. The product obtained represents the mean dose received by the glandular tissue for that specific target-filter, kVp breast composition, and compressed thickness and is an approximation of the actual patient dose.

NOTE: The conversion factor and the average glandular dose change substantially for other breast thicknesses, so these factors only apply to a 4.2-cm compressed breast thickness. Conversion factors for other breast or phantom thicknesses may be found in the listed references by Dance and by Wu et al. Until appropriate small field-of-view data are available, we recommend using the standard tables for mammographic dosimetry, as above.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

The maximum acceptable coefficient of variation for both exposure and mAs reproducibility is 0.05. If this value is exceeded, the unit should be checked by the appropriate service personnel.

The average glandular dose to an average (4.2 cm compressed) breast should not exceed 3 mGy (0.3 rads) per view for screen-film or digital image receptors. If the coefficient of variation or the average glandular dose exceeds these levels, action should be taken to evaluate and eliminate the cause of excessive AEC variability or excessive dose. In the case of excessive breast dose, technique factors should be revised to reduce the average glandular dose to a 4.2 cm thick compressed breast to less than 3.0 mGy. After this change and any other recommended changes in technique factors, phantom image quality should be re-evaluated.

Table 1. GLANDULAR DOSE (IN mrad) FOR 1 ROENTGEN ENTRANCE EXPOSURE 4.2 CM BREAST THICKNESS – 50% ADIPOSE – 50% GLANDULAR BREAST TISSUE USING A Mo/Mo OR W/Al TARGET FILTER COMBINATION*

	X-ray Tube Voltage (kVp)											W/Al Target-Filter
HVL	23	24	25	26	27	28	29	30	31	32	33	Combination
0.23	116											
0.24	121	124										
0.25	126	129	131									
0.26	130	133	135	138								
0.27	135	138	140	142	143							
0.28	140	142	144	146	147	149						
0.29	144	146	148	150	151	153	154					
0.30	149	151	153	155	156	157	158	159				170
0.31	154	156	157	159	160	161	162	163	164			175
0.32	158	160	162	163	164	166	167	168	168	170	171	180
0.33	163	165	166	168	169	170	171	173	173	174	175	185
0.34	168	170	171	172	173	174	175	176	177	178	179	190
0.35		174	175	176	177	178	179	180	181	182	183	194
0.36			179	181	182	183	184	185	185	186	187	199
0.37				185	186	187	188	189	190	191	191	204
0.38					190	191	192	193	194	195	195	208
0.39						196	197	198	198	199	200	213
0.40							201	202	203	204	204	217
0.41								206	207	208	208	221
0.42									211	212	212	225
0.43										215	216	230
0.44											220	234
0.45												238

To convert from entrance exposure in air in Roentgen to mean glandular breast dose in millirads, multiply the entrance exposure by the factor shown in the table for the appropriate kVp and beam quality (HVL) combination. For example, a measured entrance exposure of 0.50 Roentgen from a Mo/Mo target/filter system at 30 kVp with a measured HVL of 0.36 mm aluminum yields an average glandular dose of (0.50R) x (185 mrad/R) = 93 mrad or 0.93 mGy.

* Adapted from: Wu X. Breast dosimetry in screen-film mammography. In: Barnes GT, Frey GD (eds). *Screen Film Mammography: Imaging Considerations and Medical Physics Responsibilities*. Madison, Wis: Medical Physics Publishing; 1991:159-175. W/Al conversion factors are derived from fits to data from: Stanton L., et al. Dosage evaluation in mammography. *Radiology.* 1984;150:577-584.

Table 2. GLANDULAR DOSE (IN mrad) FOR 1 ROENTGEN ENTRANCE EXPOSURE TO A 4.2 CM BREAST THICKNESS – 50% ADIPOSE – 50% GLANDULAR BREAST TISSUE – USING A Mo/Rh TARGET-FILTER COMBINATION*

	X-ray Tube Voltage (kVp)										
HVL	25	26	27	28	29	30	31	32	33	34	35
0.28	149	151	154								
0.29	154	156	158	159							
0.30	158	160	162	162	163						
0.31	163	164	166	166	167	167					
0.32	167	169	171	171	171	172	172				
0.33	171	173	175	176	176	176	176	177			
0.34	176	178	179	179	180	180	180	181	181		
0.35	180	181	183	183	184	185	185	186	187		
0.36	185	186	187	187	188	188	189	190	191	191	
0.37	189	190	191	191	192	193	193	194	195	195	
0.38	193	194	196	196	197	197	197	198	199	199	200
0.39	198	199	200	200	201	201	202	202	203	203	204
0.40	202	203	204	204	205	205	206	207	208	208	208
0.41	206	207	208	208	209	209	210	211	212	212	212
0.42	211	211	212	212	213	213	214	215	216	216	217
0.43	215	216	217	217	218	218	219	219	220	220	221
0.44	220	220	221	221	222	222	223	223	224	224	225
0.45	224	224	225	225	226	226	227	227	228	228	229
0.46		228	229	229	230	231	231	232	233	233	234
0.47			233	233	234	235	235	236	237	237	238
0.48			238	238	239	240	240	241	241	242	242
0.49				242	243	243	244	244	245	245	246
0.50					247	247	248	248	249	250	251
0.51						251	252	253	254	254	255
0.52							257	257	258	258	259
0.53							261	261	262	263	264
0.54								265	266	267	268
0.55								269	270	271	272
0.56									275	276	276
0.57									279	280	281
0.58										284	285
0.59										288	289
0.60											293

* Adapted from Wu X, Gingold EL, Barnes GT, Tucker DM. Normalized average glandular dose in Mo/Rh and Rh/Rh target-filter mammography. *Radiology.* 1994;193:83-89.

Table 3. GLANDULAR DOSE (IN mrad) FOR 1 ROENTGEN ENTRANCE EXPOSURE TO A 4.2 CM BREAST THICKNESS – 50% ADIPOSE – 50% GLANDULAR BREAST TISSUE – USING A Rh/Rh TARGET-FILTER COMBINATION*

	X-ray Tube Voltage (kVp)										
HVL	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
0.28	150	155	159								
0.29	155	160	164	168							
0.30	160	164	168	172	176						
0.31	165	168	172	174	180	182					
0.32	169	173	177	181	184	186	188				
0.33	174	178	181	185	188	190	192				
0.34	179	183	186	190	193	195	196	199			
0.35	184	187	190	194	197	199	201	203			
0.36	189	192	195	198	201	204	205	207	209		
0.37	193	196	199	202	205	207	209	211	213		
0.38	198	201	204	207	209	211	213	215	217	219	221
0.39	203	206	208	211	214	216	217	219	221	223	224
0.40	208	211	213	216	218	220	221	223	224	226	228
0.41	213	215	217	220	222	224	225	227	228	230	232
0.42	218	220	222	224	226	228	229	231	232	234	236
0.43	222	224	226	228	230	232	233	235	236	238	240
0.44	227	229	231	233	235	237	238	239	240	242	243
0.45	232	234	235	237	239	241	242	243	244	246	247
0.46			239	241	243	245	246	247	248	250	251
0.47					247	249	250	251	252	254	255
0.48					251	253	254	255	256	258	259
0.49						257	258	259	260	261	262
0.50						261	262	263	264	265	266
0.51							266	267	268	269	270
0.52							270	271	272	273	274
0.53							275	276	276	277	278
0.54								279	280	280	281
0.55								283	284	284	285
0.56									288	288	289
0.57										292	293
0.58										296	297
0.59											300
0.60											304

*Adapted from Wu X, Gingold EL, Barnes GT, Tucker DM. Normalized average glandular dose in Mo/Rh and Rh/Rh target-filter mammography. *Radiology.* 1994;193:83-89.

9. PROCEDURE: IMAGE QUALITY EVALUATION

OBJECTIVE

Ensure that image quality for stereotactic biopsy meets or exceeds that of mammography and to detect temporal changes in image quality.

REQUIRED EQUIPMENT

Stereotactic phantom (approximately equivalent to a 4.2 cm thick compressed breast consisting of 50% glandular, 50% adipose tissue) containing appropriate details ranging from visible to invisible on the image. At the time of publication, either the Radiation Measurements, Inc. RMI-156 or Nuclear Associates 18-220 mammographic phantoms (used for the ACR Mammography Accreditation Program) or Nuclear Associates "Mini" Digital Stereotactic Phantom 18-250 (or a similar phantom) may be used.

Note: It is recommended that the acrylic disc <u>not</u> be used if phototimed exposures are acquired. Variations in the position of the acrylic disc can cause variations in resulting technique factors under phototimed conditions. If the acrylic disc is used with phototimed exposures, care should be taken to ensure that the acrylic disc does not overly any portion of the phototiming detector or the digital image receptor.

Digital images evaluated on a monitor should be viewed in a darkened room.

Screen-film Image Receptor: Cassette and film of the types used clinically, with appropriate masking to eliminate light reaching the viewer's eye from beyond the borders of the exposed phantom image. Images should be viewed on the same viewbox(es) used clinically. If a 14" by 17" viewbox is used, a film mask for a 14" by 17" viewbox can be made by exposing a 14" by l7" film to light, processing it, and cutting a hole just the size and shape of the phantom being used.

Original phantom image and the previous phantom image acquired on this unit

Magnifying lens of the same type used clinically

Densitometer

TEST PROCEDURE STEPS

For Screen-film Image Receptors

1. Prepare the system for a stereotactic procedure.
2. Load the film in the cassette.

3. Place the cassette in the cassette holder assembly of the stereotactic system.
4. Place the phantom on the breast support device, positioning the phantom so that the chest wall edge of the phantom is aligned with the chest wall side of the image receptor.

NOTE: Facilities using the Mammography Accreditation Phantom with stereotactic imaging systems that have a limited field of view may find it necessary to make four exposures to image the entire the phantom (see Figure 4). All facilities using the digital mini-phantom should be able to image the entire wax insert of the phantom in a single exposure (see Figure 5).

5. Move the needle holder out of the way or remove it, if possible.
6. a. For sites using phototimed techniques, verify that the phototimer detector is located beneath the center of the phantom and in the same location as used for previously acquired phantom images. Select the focal spot, target, filter, kVp, and density control setting used clinically for a 4.2 cm thick breast.

   b. For sites using manual techniques, select the appropriate exposure time and mA setting (or mAs setting) for the phantom thickness.
7. Make sure that these technique factors agree with techniques for previously acquired phantom image techniques.
8. Make an exposure, recording all technique factors on the image quality evaluation form.
9. Process the film in the processor normally used for stereotactic films.
10. Measure the central background optical density on the film (usually measured in the center of the phantom insert, away from any test objects), recording this density as the background optical density on the data sheet. Be sure to measure this density at the same location each time.
11. Measure the optical density of the film in the area of the disc (if present) and just outside the disc to the left or right (perpendicular to the anode-cathode axis), recording the difference as the density difference on the image quality evaluation form.
12. Using appropriate film masking, determine the number of test objects of each type that are visible in the phantom image as described in Data Analysis and Interpretation. This may require four separate images, each of which contains a quadrant of the phantom.

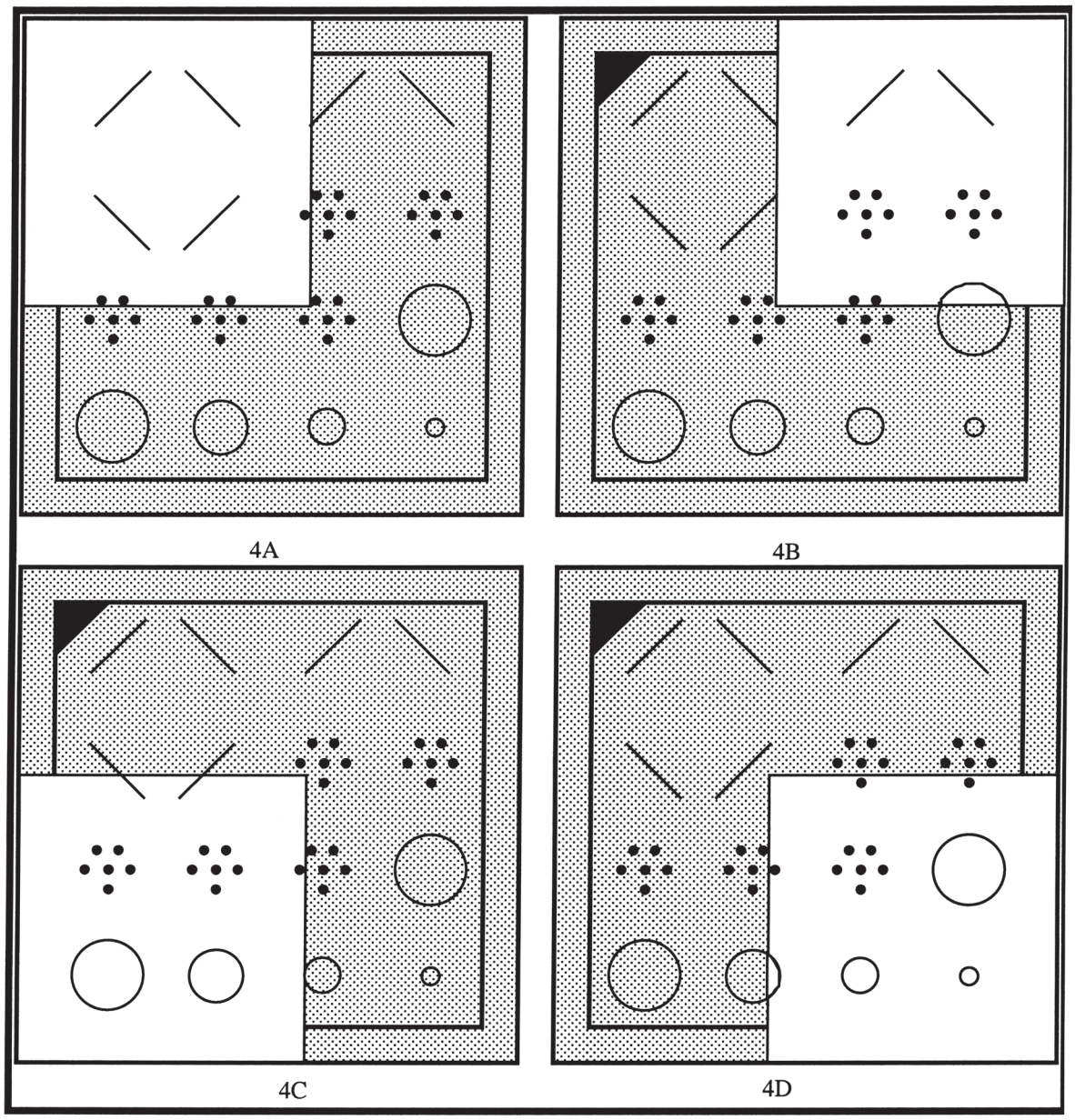
13. If artifacts are present in the phantom image, be sure to conduct the Artifact Evaluation Test described in Procedure 10 of this manual.

NOTE: Film mammography phantom images, like mammograms, should always be viewed under good viewing conditions:

1. **Mask the viewbox so that extraneous light does not come from the viewbox to the viewer's eye without passing through the exposed portion of the phantom image. A mask is essential for appropriate viewing of phantom images.**
2. **Ambient room lighting reflecting off the film should be minimized.**
3. **Use a large field-of-view magnifying lens (2x is recommended), preferably the same type of magnifying lens used for reading clinical mammograms.**

For Digital Image Receptors

1. If using the ACR MAP phantom, position the phantom (if possible, without the acrylic disc) with its upper left hand quadrant over the small field-of-view digital image receptor, as shown in Figure 4A. If the "Mini" Digital Stereotactic Phantom is used, position the phantom over the digital IR and acquire a single phantom image as shown in Figure 5.
2. Take a scout view (0°) digital exposure using the site's standard technique for a 4-4.5 cm thick compressed breast. Inspect the digital image to make sure that the largest two fibers and the fifth fiber have been included for the ACR phantom or that the entire insert area has been included for the "mini" phantom. Record the technique factors on the data form.
3. For the ACR MAP phantom, reposition as shown in Figure 4B-D and take three additional 0° exposures using the same technique factors, saving each image.
4. View all four images together (sequentially or at the same time) on the monitor. **Digital images evaluated on a monitor should be viewed in a darkened room.** Determine the number of fibers, speck groups, and masses visible. Adjust window level and width settings to maximize detection of each object type. Use the scoring method for fibers, specks, and masses described below.
5. Examine the phantom image(s) for artifacts. It may help to use several different window level and width settings to be sensitive to



Figures 4A, B, C & D. Positioning of the ACR MAP phantom over the small field-of-view image receptor (white area) to cover the entire phantom in four exposures

all artifacts. For example, digital detector element dropout may be visible by using a narrow window width and varying the level setting, searching for white dots in the image. On the other hand, overall detector sensitivity differences may be better seen by using a somewhat wider window width and a level setting that averages over signal in the entire field of view.

II. Stereotactic Breast Biopsy Equipment QC Tests

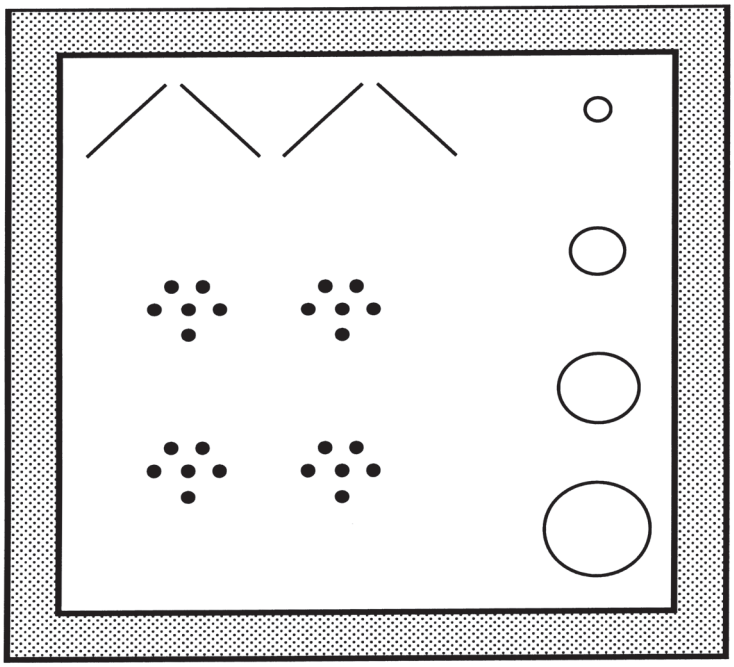


Figure 5. "Mini" Digital Stereotactic Phantom

NOTE: There are differences in numbers of objects and their respective sizes between the mammography accreditation phantom and the mini-phantom (see Table 4 below).

Table 4. COMPARISON OF PHANTOM OBJECT SIZES

	ACR Accreditation Phantom		Mini Phantom	
	Object Number	Object size (mm)	Object Number	Object Size (mm)
Fibers	1	1.56		
	2	1.12		
	3	0.89	1	0.93
	4	0.75	2	0.74
	5	0.54	3	0.54
	6	0.32	4	0.32
Specks	1	0.54	1	0.54
	2	0.40		
	3	0.32	2	0.32
	4	0.24	3	0.24
	5	0.16	4	0.20
Masses	1	2.00		
	2	1.00	1	1.00
	3	0.75	2	0.75
	4	0.50	3	0.50
	5	0.25	4	0.25

DATA ANALYSIS AND INTERPRETATION

1. When scoring the image of one of the ACR-approved accreditation phantoms, each object type is scored separately. Always count the number of visible objects from the largest object of a given type (i.e., fiber, speck group, or mass) downward until a score of 0 or 0.5 is reached, then stop counting for that object type.
2. Count each fiber as one point if the full length of the fiber is visible and the location and orientation of the fiber are correct. Count a fiber as 0.5 point if not all, but more than half, of the fiber is visible, and its location and orientation are correct. Add each full or partial fiber to the total score, from largest down to smallest visible, until a score of 0 or 0.5 is reached.
3. After determining the last fiber to be counted, look at the overall background for artifacts. If a fiber-like artifact appears anywhere in the wax insert area of the image, but not in an appropriate location or orientation, deduct the "artifactual" fiber from the last "real" half or whole fiber scored if the artifactual fiber is equally or more apparent. Deduct only from the last real fiber, not from additional fibers. Record the final score after artifact deduction in the appropriate space on the chart.
4. If needed, use a magnified display of the phantom to assist in the visualization of specks. Starting with the largest speck group, count each speck group as 1 point if four or more of the six specks in the group are visible in the proper locations. Count a speck group as 0.5 if two or three of the six specks in the group are visible in the proper locations. Add each full or partial speck group to the total speck group score, from largest down to smallest visible group, until a score of 0 or 0.5 is reached.
5. After determining the last speck group to be counted, look at the overall background for artifacts. If noise or speck-like artifacts are visible in the wrong locations within the area of the wax insert, and are as apparent as the "real" specks, deduct them one for one from the individual specks counted in the last whole or half speck group scored, and adjust the score of the last group appropriately. Record the final score after artifact deduction in the appropriate space on the chart.
6. Count each mass as 1 point if a minus density object is visible in the correct location, and the mass appears to be generally circular against the background (i.e., greater than ¾ of the perimeter is visible). A mass is counted as 0.5 point if a minus density object is visible in the

correct location, but the mass does not have a generally circular appearance. Add each full or partial mass to the total mass score, from the largest mass down, and until a score of 0 or 0.5 is reached.

7. After determining the last mass to be counted, look at the overall background for artifacts. If a mass-like artifact is seen in the wrong location within the area of the wax insert, deduct the "artifactual" mass from the last "real" whole or half mass scored if the artifactual mass is equally or more apparent. Record the final score after artifact deduction on the appropriate space on the chart.
8. Using magnification, if needed, carefully examine the image for non-uniform areas, the presence of dirt or dust artifacts, detector dropout or saturation, and processing artifacts. Compare the image to the original or previous images.

This test measures most components of the imaging chain, other than breast positioning by the technologist, patient-induced errors such as motion, and image interpretation by the radiologist. Observed changes in phantom image quality may be due to any component of the imaging chain, from X-ray generator or tube to digital image receptor or display monitor. As a result, other tests will be needed to determine the component(s) of the imaging chain that is at fault and in need of corrective action, if a problem is identified.

Because the medical physicist may not have the opportunity to measure phantom image quality as frequently as the QC technologist, it is important to review the phantom images acquired by the technologist since your previous visit, comparing results with your own assessment of image quality.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

Table 5 below shows acceptable scores for fibers, specks and masses for each of the phantoms.

Table 5.

	Mammography Accreditation Phantom		Mini-phantom	
	Screen-film	Digital	Screen-film	Digital
Fibers	4.0	5.0	2.0	3.0
Specks	3.0	4.0	2.0	3.0
Masses	3.0	3.5	2.0	2.5

The number of objects detected in each group (fibers, specks, and masses) should meet the minimum detection criteria shown in Table 5 for the appropriate image receptor and phantom. The number of objects detected in each group should not decrease by more than 0.5 if viewed under ideal conditions by the same observer. If the observed number of test objects in one or more groups decreases by more than 0.5, then further comparison with the original or previous phantom image and previously acquired phantom images should be made to determine whether the change is real.

Any decrease from the original or previous phantom image compared to the current phantom image by more than 0.5 for any object type should be investigated to determine the sources for the change. Once the sources have been identified, the problems should be corrected immediately.

For Screen-film Image Receptors

The optical density of the film in the center of the phantom image should be greater than 1.40, while the density difference across the acrylic disc should be greater than 0.35 for a 4 mm thick disc, using the site's clinical techniques. Some discs available commercially have thicknesses different than 4 mm; check the disc thickness if optical density differences less than 0.35 occur. If optical density differences are less than 0.35 for a 4 mm thick acrylic disc, and background optical density is greater than 1.40, then there is likely to be a problem with the film processing. Constancy from phantom image to phantom image is the crucial factor.

If the exposure is made identically to previous phantom images, the optical density in the center of the phantom should not change by more than ±0.20 and the density difference should not change by more than 0.05. For AEC exposures, the exposure time or mAs noted on the generator read-out should not change by more than ±15% from one phantom image exposure to another.

Some mammography sites may choose an AEC set-up that yields a higher range of optical densities for average breast tissues, so that glandular tissues are adequately exposed and have adequate contrast. While this approach also requires adequate viewbox intensity and good film masking for appropriate film viewing, it is an acceptable approach to improving clinical image quality in mammography.

10. PROCEDURE: ARTIFACT EVALUATION

OBJECTIVE

Assess the degree and source of artifacts visualized in screen-film or digital stereotactic images. This procedure allows the source of artifacts to be isolated to X-ray equipment, image receptor, or film processor (for screen-film images) so that appropriate measures for elimination of artifacts can be taken.

REQUIRED TEST EQUIPMENT

A 1-inch-thick uniform sheet of acrylic

Screen-film systems

Mammographic cassette and film (the cassette should be used for all tests)

A mask appropriate for stereotactic mammographic films

A radiographically-visible linear marker (lead arrow or paper clip)

A densitometer

TEST PROCEDURE STEPS

Screen-film Image Receptors

1. Use technique factors normally used clinically for stereotactic imaging, choosing the lowest kVp setting used clinically to be most sensitive to artifacts. If phototiming is normally used for stereotactic imaging, use it in this test, choosing the density adjustment on the unit to produce an optical density greater than 1.40. If a grid is normally used for stereotactic imaging, make sure the same grid is used in this testing. Record these technique factors on the data form.
2. Place a uniform sheet of acrylic large enough to cover the biopsy window or the full area of the image receptor on the breast support assembly.
3. Place the radiographically visible marker in an exposed area of the image, oriented lengthwise along the cassette, and make an exposure.
4. Process the film, taking care to insert the film lengthwise into the processor as shown in the upper part of Figure 6A (so that the film travels parallel to the direction of the arrow on the latent image). Measure the optical density in the center of the film, verifying that it is greater than 1.40, and record this on the data form for this test.
5. Reload the same cassette with film, place it in the image receptor holder assembly under the same sheet of acrylic. Orient the radiographically visible marker at 90° to its original direction so that the marker runs parallel to the short axis of the film. Repeat the exposure using exposure factors identical to the previous image.

6. Process this film, taking care to insert the film widthwise into the processor as illustrated in the lower part of Figure 6A (at right angles to the previous film) so that the film travels through the processor parallel to the direction of the arrow on the latent image.

TEST PROCEDURE STEPS

Digital Image Receptors

1. Place a uniform sheet of acrylic large enough to cover the full area of the exposed image receptor on the breast support assembly.
2. Make an exposure.

DATA ANALYSIS AND INTERPRETATION

Using appropriate masking and viewing conditions, examine the acquired images for density variations, especially those that might simulate or mask visualization of breast structures or breast pathology. For screen-film image receptors, orient the two films for viewing at right angles to one another so that the arrows indicating the direction that they were run through the processor are parallel. For digital image receptors, alter the window level and width to be sensitive to more subtle image artifacts, such as detector non-uniformity, cluster non-uniformity, and detector dropout.

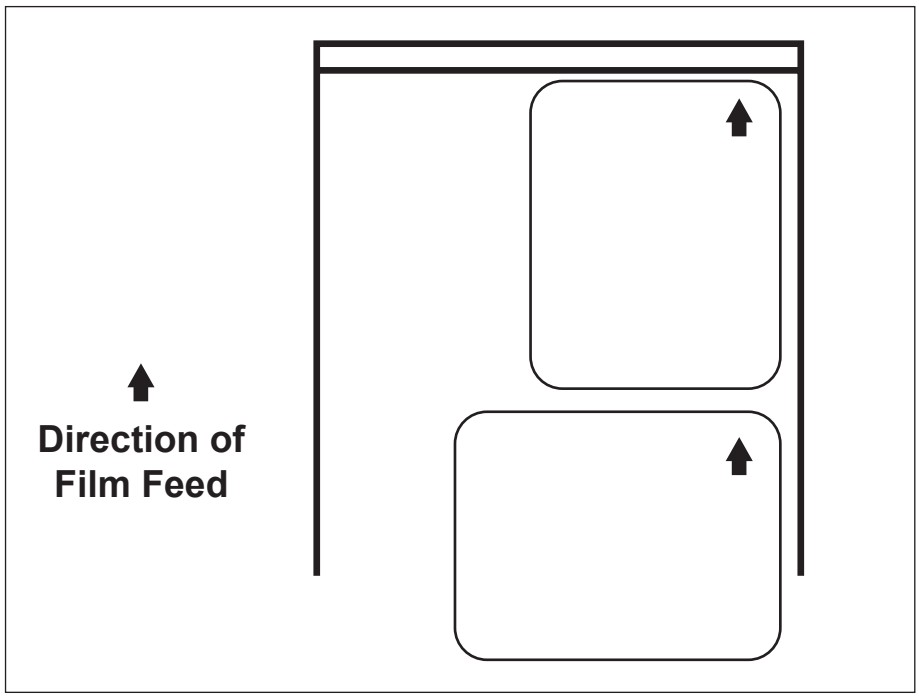


Figure 6A. Direction of insertion of film into the film processor. The first exposed film should be inserted lengthwise, parallel to the direction of the arrow on the latent image. The second film should be inserted widthwise, again parallel to the direction of the arrow on the latent image.

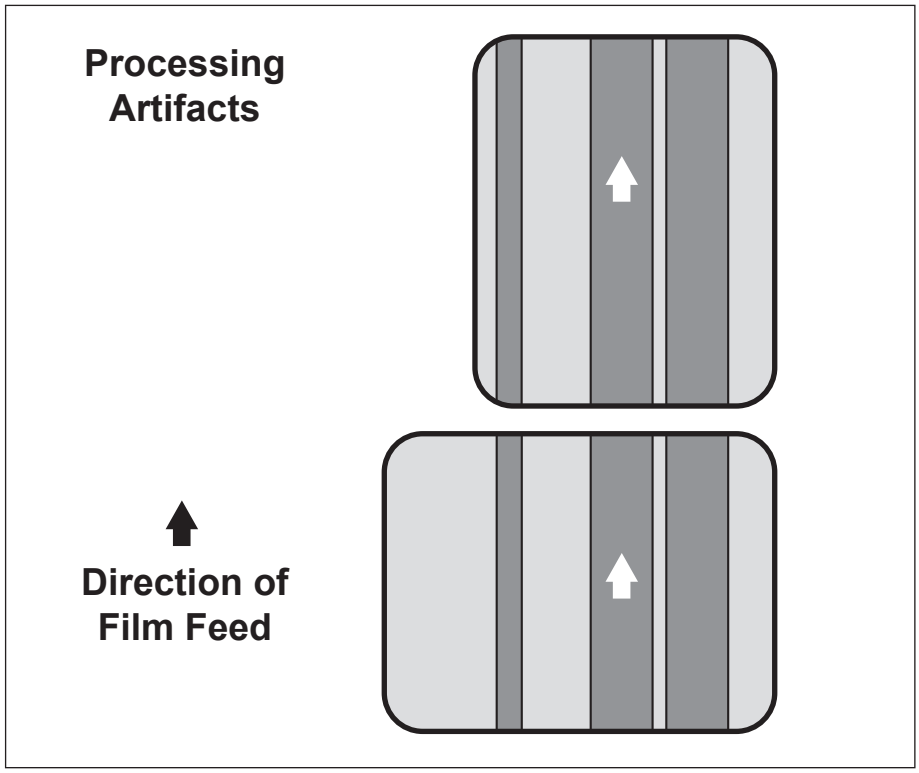


Figure 6B. Orient the films for viewing at right angles to one another, so that the arrows or markers indicating the direction the film travels through the processor are parallel. Any artifacts running parallel in the two films are due to the processor.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

Screen-film Image Receptors

Any artifacts that are parallel in the two films were caused by the processor. This is true whether the artifacts run parallel to or perpendicular to the direction of film travel. For example, film processor artifacts due to dirty or defective rollers can produce plus or minus density streaks running parallel to the direction of film travel or plus density bands running perpendicular to the direction of film travel. If film processor artifacts are detected, contact the person maintaining the processor or the film processor service organization or dealer.

Any artifacts that are oriented perpendicular between the two films are localized to the X-ray equipment. Artifacts localized to the X-ray equipment can be due to several sources, including the grid, the image receptor holder, the compression paddle, the collimator, the filter and the X-ray tube itself. Further testing will be required to determine the specific source within the X-ray equipment that is causing the artifact.

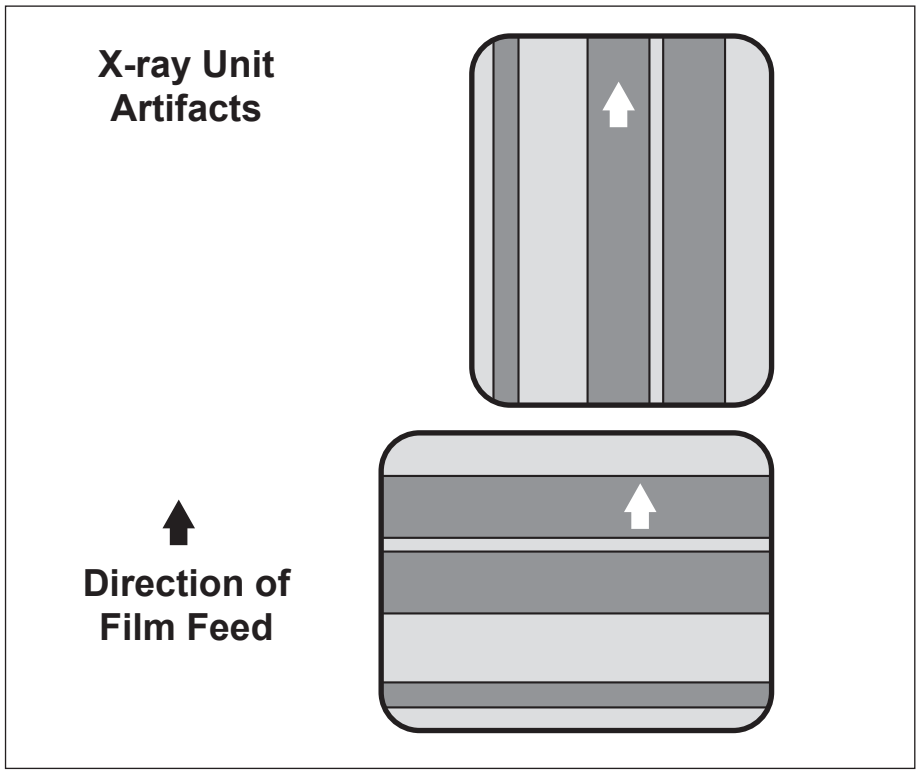


Figure 6C. Orient the two films at right angles to one another, as in Figure 6a. Any artifacts running perpendicular in the two films are due to X-ray equipment.

Contact the X-ray equipment service person for suggestions on additional testing procedures and for help in correcting X-ray equipment artifacts.

Other artifacts may appear sporadically in stereotactic images, having no consistent appearance in artifact evaluation images. These artifacts may be due to other sources, such as the patient, film handling, a defective cassette screen (that was not used in these tests), or moving grid artifacts that show up only under certain patient or timing conditions. Additional testing under specific conditions may be necessary to isolate the causes of sporadically occurring artifacts.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

Digital Image Receptor

Narrow the window width and adjust window level on the workstation to increase contrast until slight changes in gray scale are apparent at the edges of the image. Contrast should not be so extreme that a black and white image is present. Examine the image for black or white dots, streaks or areas of density variation across the FOV. Artifacts that may affect clinical imaging by simulating masses or calcifications, areas of non-uniformity, missing clusters of pixels, or other significant and recurrent image artifacts should be investigated and corrected by a qualified service engineer. In some cases, it may be helpful to acquire a second digital image with a different sheet or shifted or slightly rotated positioning of uniform acrylic to confirm that the observed artifacts are due to the imaging system and not due to the phantom material.

11. PROCEDURE: LOCALIZATION ACCURACY TEST (Gelatin Phantom)

OBJECTIVE

Assure that the biopsy needle is accurately placed for sampling as directed from the stereotactic scout images.

REQUIRED TEST EQUIPMENT

A gelatin biopsy phantom with appropriately small (<5 mm diameter) targets, available commercially from radiological phantom manufacturers

A core biopsy gun and core biopsy needle or alternative tissue sampling device will be needed. Facilities should have an unsterile biopsy needle for use in this test.

> **Note: A technologist who assists in performing stereotactic biopsies should perform this test while the physicist observes and analyzes the results. This method of testing needle placement accuracy supplements the daily needle placement tests performed by the QC technologist each day before procedures.**

TEST PROCEDURE STEPS

Use the manufacturer's recommended procedures for targeting a lesion. The following steps are provided as a generic guide.

1. The gelatin phantom should be placed in the beam with the biopsy compression plate centered over a simulated lesion no larger than 5 mm in diameter.
2. A 0° scout-view image of the phantom should be acquired with the image receptor used clinically to confirm proper positioning of the lesion within the biopsy window.
3. Two stereo views (ususally +15° and –15°) are acquired and the center of the simulated lesion marked in each.
4. Once the simulated lesion's center location is determined by the system, the needle should be installed in the biopsy device and the biopsy device assembly securely attached to the device holder.
5. For some units, the z-axis must be zeroed.
6. The horizontal, vertical and depth coordinates determined by the system must be entered on the unit. This will require advancing the needle into the phantom.
7. Acquire stereotactic pre-fire images; if the unit is well calibrated, the needle tip should be within the targeted lesion. On some units a small amount of needle pull-back is required before firing.

8. Once the gun is fired, a second set of stereotactic images should show the tip of the needle beyond the center of the lesion.

DATA ANALYSIS AND INTERPRETATION

1. View the pre-fire and post-fire images to ensure that the needle tip is within the lesion in the pre-fire images and beyond the lesion in the post-fire images.
2. Verify that phantom lesion material is in the biopsy needle after firing (or suction sampling) is performed.

RECOMMENDED PERFORMANCE CRITERIA AND CORRECTIVE ACTION

For cutting needle samples, if pre-fire images and visual inspection fail to demonstrate the needle tip within the targeted lesion, if post-fire images and visual inspection fail to demonstrate the needle tip beyond the targeted lesion, or if lesion material is not present in the biopsy needle after sampling, the reasons for these errors should be determined and the procedure repeated. For suction biopsy, if pre-sampling images fail to demonstrate the sampling aperture within one (1) mm of the simulated lesion, then repeat the procedure. If localizations continue to be inaccurate, a qualified equipment service person should be contacted by facility personnel and the problem corrected.

NOTE: This procedure assumes use of a large-gauge cutting needle or suction biopsy needle for tissue sampling. Other sampling methods, including fine needle aspiration, may also be used or may be used exclusively by the site. Testing procedures may require modification to accommodate those different methods of tissue sampling to test the accuracy of needle placement based on stereotactic imaging.

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III. SUMMARY REPORTING, DATA RECORDING AND ANALYSIS FORMS

Return to Table of Contents

Medical Physicist's Stereotactic Unit QC Test Summary

Site _____ **Report Date** _____

_____ **Survey Date** _____

X-Ray Unit Manufacturer _____ **Model** _____

Film Processor Manufacturer _____ **Model** _____

Medical Physicist _____ **Signature** _____

Technologist _____

Medical Physicist's QC Tests

Pass/Fail/NA

1. *Stereotactic Breast Biopsy Unit Assembly Evaluation* _____

2. *Collimation Assessment*
   - A. X-ray field adequately matches image receptor _____
   - B. Biopsy window generally centered over digital IR _____

3. *Focal Spot Performance and System Limiting Resolution*
   - A. Focal spot performance acceptable _____
   - B. Digital system spatial resolution acceptable _____

4. *kVp Accuracy and Reproducibility*
   - Measured average kVp within ±5% of nominal kVp _____
   - kVp coefficient of variation ≤ 0.02 _____

5. *Beam Quality (Half-Value Layer Measurement)*
   - HVL is within acceptable lower and upper limits at all kVp values tested _____

6. *AEC System or Manual Exposure Performance Assessment*
   - Optical density or signal range acceptable _____

7. *Receptor Speed Uniformity*
   - Screen speed uniformity or digital receptor uniformity acceptable _____

8. *Breast Entrance Exposure, Average Glandular Dose and Exposure Reproducibility*
   - Exposure reproducibility is within acceptable limits _____
   - Average glandular dose to a 4.2 cm thick breast is less than 3 mGy _____
   - Average glandular dose to a 4.2 cm thick breast on your unit is _____

Pass/Fail/NA

9. *Image Quality Evaluation* _____

Phantom image quality is acceptable

Phantom type:

ACR Mammography Accreditation ____

Digital Mini ____

Phantom image quality scores on your unit are:

Fibers: _____

Specks: _____

Masses: _____

10. *Artifact Evaluation*

Artifacts were not apparent or not significant: _____

Artifacts identified:

11. *Localization Accuracy Test*

Localization and sampling accurate/object captured _____

Medical Physicist's Recommendations for Quality Improvement:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Stereotactic Equipment Evaluation

Site: _____ Date: _____

_____

Equipment

X-ray unit manufacturer _____ Model _____

Processor manufacturer _____ Model _____

Cycle _____

Screen Manufacturer _____ Type _____

Film manufacturer _____ Type _____

Clinical Technique Factors

Breast Thickness	Exposure Mode	kVp Setting	Density Control Setting	Phototimed (Yes or No)	Grid (Yes or No)
< 3 cm					
3 to 5 cm					
5 to 7 cm					
> 7 cm					

I. Stereotactic Breast Biopsy Unit Assembly Evaluation (Y = yes, N = no; N/A = not applicable)

Free-standing dedicated unit is mechanically stable.	Y N N/A
All moving parts move smoothly, without obstructions to motion.	Y N N/A
All locks and detents work properly.	Y N N/A
Image receptor holder assembly is free from vibrations.	Y N N/A
Image receptor is held securely by assembly in any orientation.	Y N N/A
Image receptor slides smoothly into holder assembly (screen-film only).	Y N N/A
Compressed breast thickness scale is accurate to 5 mm, reproducible to ± 2 mm.	Y N N/A
Patient or operator is not exposed to sharp or rough edges, or other hazards.	Y N N/A
Operator technique control charts are posted.	Y N N/A
Operator protected during exposure by adequate radiation shielding.	Y N N/A
Needle holder and needle guides adequately support needle	Y N N/A
Evaluation (Pass or Fail):	

2. Collimation Assessment

Source to image receptor distance (SID): _____ cm

Screen-Film Units:

X-ray field contained within the IR on all 3 non-chest wall edges Y N

X-Ray field extends beyond IR on chest wall edge Y N

Distance of X-ray field from chest wall edge of IR ☐

2% of SID ☐

X-Ray field does not extend beyond IR by more than 2% of SID Y N

Digital Units

		Collimator:					
Digital Image	Left Edge:	Deviation (mm)					
	Right Edge:	Deviation (mm)					
	Anterior Edge:	Deviation (mm)					
	Chest Edge:	Deviation (mm)					
Film Image	Left Edge:	Deviation (mm)					
	Right Edge:	Deviation (mm)					
	Anterior Edge:	Deviation (mm)					
	Chest Edge:	Deviation (mm)					
Evaluation:							

Action Limit: If any edge of radiation field deviates more than 5 mm from the edge of the image receptor, or if any edge of the compression paddle projects into the X-ray field by more than 5 mm, then seek service adjustment.

Biopsy window generally centered over digital IR **Y** **N**

Evaluation (Pass or Fail): ☐

3. Focal Spot Performance and System Limiting Spatial Resolution

A. Evaluation of Focal Spot Performance (high-contrast resolution pattern)

Image Receptor		Screen-Film
Viewing Mode		Film
Limiting Resolution	bars parallel to A-C axis	
	bars perpendicular to A-C axis	

Action Limit: If the limiting resolution is <13 line-pairs per mm with the parallel to the anode-cathode axis or is <11 line-pairs per mm with the bars perpendicular to the anode-cathode axis, then a more detailed investigation of the reason should be made using a slit camera.

B. Digital System Limiting Spatial Resolution (Digital Imaging Systems only)

(make additional copies for additional matrix sizes)

CRT Display System		Current Data	Previous Data
Digital Image Receptor Matrix Size			
Viewing Mode		CRT	CRT
Limiting Resolution	bars parallel to A-C axis		
	bars perpendicular to A-C axis		

Action Limit: Note any significant degradation from previous measurement and seek service.

Hardcopy, if available		Current Data	Previous Data
Digital Image Receptor Matrix Size			
Viewing Mode		Hardcopy	Hardcopy
Limiting Resolution	bars parallel to A-C axis		
	bars perpendicular to A-C axis		

Action Limit: Note any significant degradation from previous measurement and seek service.

Evaluation (Pass or Fail): ☐

4. kVp Accuracy and Reproducibility

kVp meter used:

Nominal kVp setting						
Nominal focal spot size						
Exposure time						
mA (or mAs) Setting						
Measured kVp values	kVp1					
	kVp2					
	kVp3					
	kVp4					
Mean kVp	<kVp>					
Standard dev.	σ_{kVp}					
Additional kVp Measurements (if needed)	kVp5					
	kVp6					
	kVp7					
	kVp8					
	kVp9					
	kVp10					
Recalculated: **Mean kVp**	<kVp>					
Standard dev. *(using 10 readings)*	σ_{kVp}					
<kVp> - Nominal kVp						
0.05 x Nominal kVp						
kVp coefficient of variation	$\frac{\sigma_{kVp}}{<kVp>}$					
Evaluation (Pass or Fail)						

Action Limit: If <kVp> differs from nominal kVp by more than ±5% of nominal kVp, or if the kVp coefficient of variation exceeds 0.02, then seek service correction.

5. Beam Quality Assessment (Half-Value Layer Measurement)

Dosimetry system used: _____

Target Filter selected						
Nominal kVp setting						
mA setting						
Time or mAs setting						
Filter / Anode Track						
Exposure Measurements:						
No aluminum filtration, E_o						
0.1 mm of added aluminum, E_1						
0.2 mm of added aluminum, E_2						
0.3 mm of added aluminum, E_3						
0.4 mm of added aluminum, E_4						
0.5 mm of added aluminum, E_5						
Repeat E_o Measurement, E_o,						
Record thicknesses ($t_a < t_b$)	t_a					
and exposures	t_b					
that bracket $E_o/2$: ($E_a > E_b$)	E_a					
	E_b					
Calculated HVL:						
Evaluation (Pass or Fail)						

Calculated HVL = $$\frac{t_b * \ln[2*E_a/E_o] - t_a * \ln[2*E_b/E_o]}{\ln[E_a/E_b]}$$

Action Limit: If measured HVL < (kVp/100) (in mm Al)

or

if measured HVL ≥ (kVp/100) + C (in mm Al)

where C = 0.12 for Mo/Mo, C = 0.19 for Mo/Rh, and C = 0.22 for Rh/Rh,

then seek service correction.

6. Automatic Exposure Control (AEC) or Manual Exposure Performance Assessment

AEC sensor position: _____

Cassette ID: _____

Performance Capability

Thickness Compensation					
Imaging mode					
Focal spot:	Large				
mA:					
Phantom thickness	Target	Filter	kVp	mAs	Optical Density or Mean Signal Value
4 cm					
6 cm					
8 cm					

Mean Density	Density or Signal Range	Allowable Range	Evaluation (Pass or Fail)

Action Limit (Screen-Film): If the density range exceeds ±0.15 of mean, revise technique chart.

Action Limit (Digital): If the signal range exceeds ±20% of signal for 4 cm phantom, revise technique chart.

7A. Uniformity of Screen Speed

Screen type: _____

Film type: _____ Size: _____

Emulsion no.: _____ Processor used: _____

Imaging mode: _____

Focal spot size: _____

Target Filter _____

kVp setting: _____

Phototimed

Density Control setting: _____

Manual

mA: _____

Exp. time: _____

or nominal mAs: _____

Cassette ID #	Image ID #	Recorded mAs	Measured Optical Density
Control cassette:			
_____	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

Standard Deviation of Control Cassette Optical Densities _____

Other Cassettes:

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Maximum Optical Density: _____

Minimum Optical Density: _____

Optical Density Range: ☐

Evaluation (Pass or Fail)

Action Limit: If standard deviation of control cassette optical densities is less than 0.05 *and* optical density range exceeds 0.30, then corrective action is needed.

7B. Digital Receptor Uniformity

Image Receptor: _____
Phantom used: _____

Target-filtration _____
kVp setting: _____
mAs: _____

I. For units with ROI measurement capability

ROI Center	Minimum	
	Maximum	
	Mean	
	SD	
	SNR (center)	

ROI Upper Left	Minimum	
	Maximum	
	Mean	
	SD	
	SNR	
	$\frac{\text{SNR}}{\text{SNR(Center)}}$	

ROI Upper Right	Minimum	
	Maximum	
	Mean	
	SD	
	SNR	
	$\frac{\text{SNR}}{\text{SNR(Center)}}$	

ROI Lower Left	Minimum	
	Maximum	
	Mean	
	SD	
	$\frac{\text{SNR}}{\text{SNR(Center)}}$	

ROI Lower Right	Minimum	
	Maximum	
	Mean	
	SD	
	$\frac{\text{SNR}}{\text{SNR(Center)}}$	

Evaluation (Pass or Fail) _____

Action Limit: If SNR(I) / SNR(Center) is > 1.15 or < 0.85, seek service correction.

II. For units without ROI measurement capability

Digital Field Appearance	
Pincushioning	
Areas w/o black dots	
Line w/o black dots	

Evaluation (Pass or Fail) _____

Action Limits: If geometric pincushioning > 1 cm from edge of image or
If non-uniform areas (w/o black dots) > 10% of image or
If line w/o black dots > 1/4 length of image, seek service correction

8. Breast Entrance Exposure, Average Glandular Dose, and Exposure Reproducibility

Dosimetry system used: _____ Energy correction factor: _____

Imaging mode: _____

Image receptor: _____

Field restriction: _____

SID: _____

Phantom: _____

Target Filter:			
Nominal kVp setting:			
AEC density control setting:			
mA setting:			
Measured HVL (mm Al):			

Measured entrance exposure:	mR	mAs	mR	mAs	mR	mAs
Exposure #1						
Exposure #2						
Exposure #3						
Exposure #4						
Mean values						
Standard deviations (SD)						
Coefficients of variation (CV)						

Energy-corrected exposure:			
Dose conversion factor from Table 1-3 (rad/R):			
Computed average glandular dose (mrad):			

Evaluation (Pass or Fail) _____

Action Limit: If CV for exposure or mAs exceeds 0.05, then seek service correction.
If average glandular dose exceeds 300 mrad, then seek service correction.

9. Image Quality Evaluation

Image Receptor: _____ Display Device: ❑ CRT ❑ Film

Phantom used: ❑ ACR Mammography Accreditation
❑ Digital Mini

❑ Phototimed Technique ❑ Manual Technique

Phototimer Detector Position (If applicable) _____ mA Setting _____

Target/Filtration _____ Exposure Time _____

	Previous Image (if any)	Current Image
kVp setting		
Phototimed mAs (or exposure time)		
Number of fibers seen		
Fiber difference		
Number of speck groups seen		
Speck group difference		
Number of masses seen		
Mass difference		
Optical Density inside contrast disk (optional)		
Optical Density outside contrast disk (optional)		
Optical Density Difference (optional)		

Evaluation (Pass or Fail):

Action Limit (minimum acceptable score):

	Mammography Accreditation Phantom		Digital Mini-Phantom	
	Screen-Film	Digital	Screen-Film	Digital
Fibers	4.0	5.0	2.0	3.0
Specks	3.0	4.0	2.0	3.0
Masses	3.0	3.5	2.0	2.5

10. Artifact Evaluation

Type of attenuator _____

Thickness of attenuator _____

Target-Filter _____

kVp setting _____

Density Control Setting _____

Nominal Focal Spot Size _____

Image receptor	Film/Screen	Digital
Image Viewed on	Film	CRT
Resultant film O. D.		
Artifacts visible? (if yes, continue by checking the appropriate boxes.)		
Processor artifact*		
Equipment artifact**		
Other artifact		
Describe these artifacts		

Film-Screen: * Artifacts parallel in the two films processed and viewed as in Figure 6A.

** Artifacts perpendicular in the two films processed and viewed as in Figure 6B.

Evaluation (Pass or Fail): ☐

Action Limit: If significant artifacts are visible, contact the appropriate person maintaining or servicing the processor or x-ray equipment. For digital systems, significant artifacts include detector non-uniformity, clusters of missing pixels and areas of detector dropout.

11. Localization Accuracy (Gelatin Phantom) Test

Object Capture

Was the object captured? **Y** **N**

Action Limit: If the biopsy needle captures the intended object, then the unit passes. If the unit fails the test, then service should be called.

If pre-fire images or visual inspection fail to demonstrate needle tip (or sampling notch for suction systems) within (or adjacent to) targeted lesion, then service should be called.

Evaluation (Pass or Fail):

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