

## ACR Accreditation Update: Ultrasound

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*Past member, ACR UAP & BUAP Committees*

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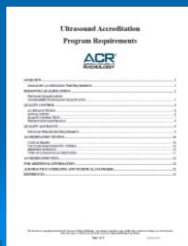
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### Topics

- New QC sections in the ACR Ultrasound and Breast Ultrasound accreditation programs
  - What is new?
  - What is required?
  - What is not included?
- Example annual survey test methods and results
- Conclusions



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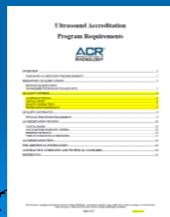
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### New QC sections in the ACR Ultrasound and Breast Ultrasound Accreditation Programs

- Under development and review for  $\geq 2$  years
  - Last revised April 9-10, 2014
  - Effective June 1, 2014
- Identical QC sections for both Ultrasound and Breast Ultrasound Accreditation Programs



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- Includes sections on
  - Acceptance testing
  - Annual survey
  - Quality control testing (routine)
  - Preventive maintenance
- Most recent signed Annual Survey report must be included with applications for ACR (re)accreditation
- Physicist involvement in the program is strongly recommended, but not required



## Acceptance testing

- This is designated as an **optional** component of the program, although the value of acceptance testing is recognized in the document
- Testing should include all tests to be performed in subsequent annual surveys, but may be more comprehensive

## Annual survey

- This is a **required** component of the program
- Specific tests are designated, some required and some optional

Annual System Performance Evaluation	
QC Test	Description
1. Physical and Mechanical Inspection	Assures the mechanical integrity of the equipment, and the safety of patient and operator.
2. Image Uniformity and Artifact Survey	Identifies the presence of artifacts, often axial or lateral streaks in scans of uniform sections of phantoms. The use of "air" images (i.e., images acquired without the use of gel or phantoms) may also be useful in detecting superficial artifacts.
3. Geometric Accuracy	Commonly involves use of the scanner calipers to measure known distances between phantom test targets in the axial and lateral directions, and also in the elevational direction for 3D probes. Other tests of geometric accuracy are acceptable, e.g., verifying accuracy of the post-size calibration in the image header.
4. System Sensitivity	Methods relying on visual determination of the maximum depth of visualization of speckle patterns or phantom targets, and quantitative measurements of signal-to-noise ratio (SNR), have been reported.
5. Ultrasound Scanner Electronic Image Display Performance	Maintaining the performance of the image display is critical for providing the greatest diagnostic benefit of the scanner. Display characteristics that are evaluated may include gray scale response and luminance calibration, presence of pixel defects, and overall image quality. These evaluations are typically performed using specialized test pattern images, and may also require photometric equipment. See <a href="#">ACR Technical Standard for Electronic Practice of Medical Imaging</a> .
6. Primary Interpretation Display Performance*	Primary diagnostic displays may be electronic soft-copy displays on a PACS workstation or hard-copy films. They should also include worklist monitors only if used for primary interpretation (other than color analysis). Display characteristics that are evaluated may include gray scale response and luminance calibration, presence of pixel defects, and overall image quality. These evaluations are typically performed using specialized test pattern images, and may also require photometric equipment. See <a href="#">ACR Technical Standard for Electronic Practice of Medical Imaging</a> for additional information on tests and testing methods. (* Only required if located at the facility where ultrasound is performed.)
7. Contrast Resolution (Cytelnet)	The use of both anechoic and low-contrast echogenic targets has been suggested, as has the use of 2D cylindrical targets and 3D spherical targets.
8. Spatial Resolution (Cytelnet)	Should be measured in the axial, lateral, and elevational directions. Various approaches have been described for these measurements via visual interpretation of groups of phantom profile targets and using computer-based algorithms to measure pixel dimensions.
9. Evaluation of QC Program (if applicable)	Provides an independent assessment of the QC program, checks that appropriate actions are taken to correct problems, identifies areas where quality and QC testing may be improved, and enables a comparison of QC practices with those of other ultrasound sites.

## Annual survey tests

1. Physical and mechanical inspection
  2. Image uniformity and artifact survey
  3. Geometric accuracy **REQUIRED**
  4. System sensitivity
  5. US scanner electronic image display performance
  6. Primary interpretation display performance
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7. Contrast resolution
  8. Spatial resolution
  9. Evaluation of QC program **OPTIONAL**

- All scanners and probes in routine clinical use must be tested
- A signed report describing results must be provided to the practice
- Phantoms must be used for uniformity, sensitivity, and geometric accuracy tests
  - No specific phantoms are described
  - Commercial and custom phantoms are acceptable
- No specific test methods are required
- Subjective & objective methods are acceptable
  - *No specific performance benchmarks or pass-fail criteria are provided*

## Example test methods and results

Annual System Performance Evaluation	
QC Test	Description
1. Physical and Mechanical Inspection	Assures the mechanical integrity of the equipment, and the safety of patient and operator
2. Image Uniformity and Artifact Survey	Identifies the presence of artifacts, often axial or lateral streaks in scans of uniform sections of a phantom. The use of "in-air" images (i.e., images acquired without the use of gel or phantom) may also be useful in detecting superficial artifacts.
3. Geometric Accuracy	Commonly involves use of the scanner calipers to measure known distances between phantom test targets in the axial and lateral directions and also in the elevational direction for 3D probes. Other tests of geometric accuracy are acceptable, e.g. verifying accuracy of the pixel size calibration in the image header.
4. System Sensitivity	Methods relying on visual determination of the maximum depth of visualization of speckle patterns or phantom targets, and quantitative measurements of signal-to-noise ratio (SNR), have been reported.
5. Ultrasound Scanner Electronic Image Display Performance	Maintaining the performance of the image display is critical for providing the greatest diagnostic benefit of the scanner. Display characteristics that are evaluated may include gray scale response and luminance calibration, presence of pixel defects, and overall image quality. These evaluations are typically performed using specialized test pattern images, and may also require photometric equipment. See <a href="#">ACR Technical Standard for Electronic Practice of Medical Imaging</a> .
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## Physical and mechanical inspection

### Scanner

- Wheel locks
- Monitor bezel
- Keyboard
- Power cable
- Probe ports
- Ancillary equipment

### Probes

- Face
- Handle / housing
- Cable connection to handle, strain relief
- Cable
- Connector



Built Connector Plug



Separation of Handle



Connector Damage



Lens Pitting

Complete Cable Tear

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## Image uniformity & artifact survey

### Most effective test for identifying problems

### Scan a uniform test object/phantom showing moving speckle

- Inspect image while scanning
- Process a clip to produce a median or mean image (AAPM)



Gammex

### Assess artifact severity and needed action (clinical images)




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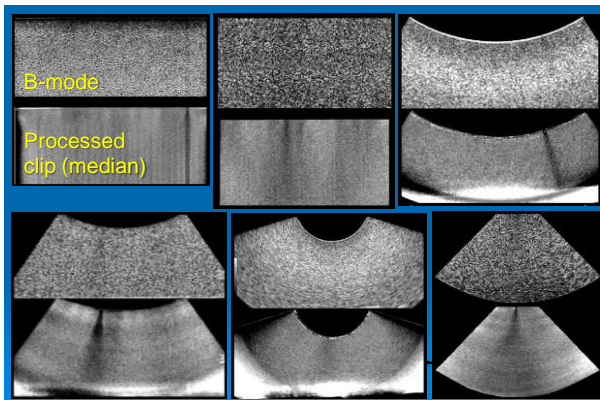
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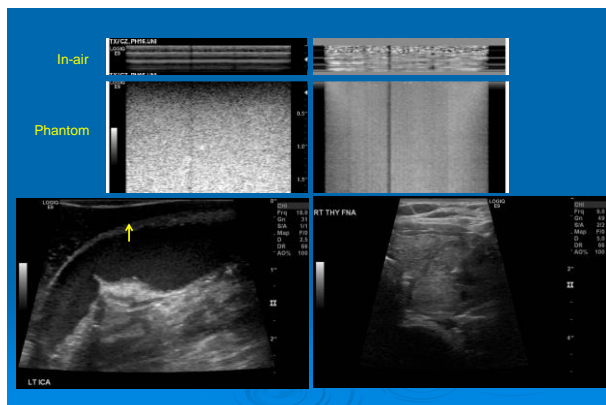
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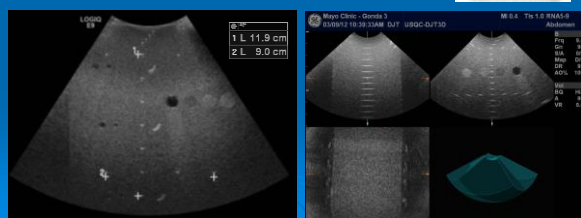
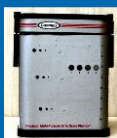
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## Geometric accuracy:

- Measure known axial, lateral, and (reconstructed) elevational distances with scanner calipers or an automated program




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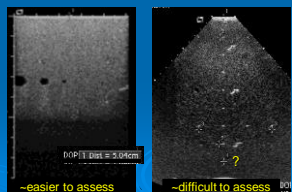
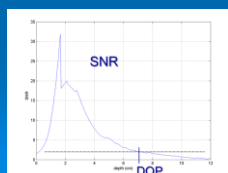
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## System sensitivity

- Common approaches
  - Visual DOP estimation
  - Calculation of DOP from SNR vs depth curve
    - IEC 61391-2




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## Ultrasound scanner electronic image display performance

- Critical component of performance assessment:  
*Ultrasound scanner monitor is effectively a primary diagnostic display device*
- No requirements of specific tests



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## Primary interpretation display performance

- This most likely means PACS workstations
- Testing only required for diagnostic workstations used for US exam primary interpretation, *and located at same facility as the US scanner*
- No requirements of specific tests
- *Inclusion of display testing results obtained by PACS team or biomed service group would be acceptable*

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According to the new ACR ultrasound QC requirements, which of the following tests is not required during the annual survey?

- |     |   |
|-----|---|
| 22% | 1. Sensitivity                          |
| 22% | 2. Geometric accuracy                   |
| 6%  | 3. Spatial resolution                   |
| 22% | 4. Physical and mechanical integrity    |
| 28% | 5. Image uniformity and artifact survey |

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According to the new ACR ultrasound QC requirements, which of the following tests is not required during the annual survey?

1. Sensitivity
2. Geometric accuracy
3. Spatial resolution
4. Physical and mechanical integrity
5. Image uniformity and artifact survey

Reference: ACR ultrasound and breast ultrasound accreditation program requirements:  
<http://www.acr.org/~media/ACR/Documents/Accreditation/US/Requirements.pdf>  
<http://www.acr.org/~media/ACR/Documents/Accreditation/BreastUS/Requirements.pdf>

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The new ACR ultrasound QC requirements specify pass/fail criteria for which of the following evaluations?

- |     |   |
|-----|---|
| 21% | 1. Sensitivity                          |
| 25% | 2. Geometric accuracy                   |
| 4%  | 3. Image uniformity and artifact survey |
| 8%  | 4. All of these                         |
| 4%  | 5. None of these                        |

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The new ACR ultrasound QC requirements specify pass/fail criteria for which of the following evaluations?

1. Sensitivity
2. Geometric accuracy
3. Image uniformity and artifact survey
4. All of these
5. None of these

Reference: ACR ultrasound and breast ultrasound accreditation program requirements:  
<http://www.acr.org/~media/ACR/Documents/Accreditation/US/Requirements.pdf>  
<http://www.acr.org/~media/ACR/Documents/Accreditation/BreastUS/Requirements.pdf>

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## Routine quality control

- Routine QC is an **optional** (but recommended) component of the program
- Likely performed by a sonographer or service engineer

Routine QC	
QC Test	Description
1. Physical and Mechanical Inspection	Assures the mechanical integrity of the equipment, and the safety of patient and operator.
2. Image Uniformity and Artifact Survey	Identifies the presence of artifacts, often axial or lateral streaks in scans of uniform sections of a phantom. The use of "in-air" images (i.e., images acquired without the use of gel or phantom) may also be useful in detecting superficial artifacts. All transducer ports on each scanner should be tested using at least 1 transducer.
3. Geometric Accuracy (mechanically scanned transducers only)	Commonly involves use of the scanner calipers to measure known distances between test targets. Measurement is required only in the mechanically scanned directions.
4. Ultrasound Scanner Electronic Image Display Performance	Maintaining the performance of the image display is critical for providing the greatest diagnostic benefit of the scanner. They should also include worklist monitors only if used for primary interpretation (other than color analysis). Display characteristics that are evaluated may include gray scale response, presence of pixel defects, and overall image quality. These evaluations are typically performed using specialized test pattern images. See <a href="#">ACR Technical Standard for Electronic Practice of Medical Imaging</a> for additional information on tests and testing methods.
b. Primary Interpretation Display Performance*	Primary diagnostic displays may be electronic son-copy displays on a PACS workstation or hard-copy films. Display characteristics that are evaluated may include gray scale response and luminance calibration, presence of pixel defects, and overall image quality. These evaluations are typically performed using specialized test pattern images, and may also require photometric equipment. See <a href="#">ACR Technical Standard for Electronic Practice of Medical Imaging</a> for additional information on tests and testing methods. (* Only required if located at the facility where ultrasound is performed.)

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- A subset of 5 of the annual tests are designated for routine QC
  - Geometric accuracy is only needed for 3D or 4D probes, and is only checked in the elevational direction
  - Test methods may be different than for annual survey, especially if a sonographer is performing them

QC Test	
1. Physical and Mechanical Inspection	
2. Image Uniformity and Artifact Survey	
3. Geometric Accuracy (mechanically scanned transducers only)	
4. Ultrasound Scanner Electronic Image Display Performance	
b. Primary Interpretation Display Performance*	

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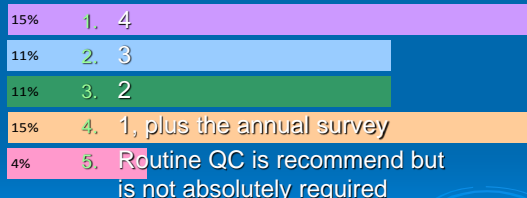
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What is the minimum number of annual routine ultrasound QC testing sessions?




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What is the minimum number of annual routine ultrasound QC testing sessions?

1. 4
2. 3
3. 2
4. 1, plus the annual survey
5. Routine QC is recommend but is not absolutely required

Reference: ACR ultrasound and breast ultrasound accreditation program requirements:  
<http://www.acr.org/~media/ACR/Documents/Accreditation/US/Requirements.pdf>  
<http://www.acr.org/~media/ACR/Documents/Accreditation/BreastUS/Requirements.pdf>

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## Preventive maintenance

- This is a **required** component of the program
- Must be performed by a qualified service engineer
- PMs must be documented
  - Corrective action addressing issues found during annual surveys must also be documented, and included with applications for ACR (re)accreditation

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## Conclusions

- New QC section for the ACR Ultrasound and Breast Ultrasound Accreditation Programs
  - Effective June 1, 2014
- This new QC program can be easily implemented with only minimal costs to the US practice
  - *Flexibility in the program makes physicist involvement critical to assure quality*

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## Acknowledgements

- Don Tradup, RDMS
- Scott Stekel, BS
- Kris Gorny, PhD
- Deirdre King, PhD
- Yi Zhang, PhD

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