QUALITY ASSURANCE GUIDELINES
FOR MEDICAL PHYSICS SERVICES

National Breast Screening Quality Assurance
Coordinating Group for Physics

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1 INTRODUCTION

All breast screening programmes in the NHSBSP must use medical physics services which conform to the guidelines set out in this document.

1.1 Aim

The aim of this document is to specify the scope and standards for medical physics services which are to be employed in the NHS Breast Screening Programme (NHSBSP). This updates earlier guidance from the NHSBSP published in 1995. It is directed at both commissioners and providers of medical physics services. The guidelines have been written with reference to the breast screening programme in England. There are different organisational and management arrangements for the breast screening programme in Scotland, Wales and Northern Ireland, but the broad principles of these guidelines are nevertheless applicable. Where regions are referred to, these are the regions in England for the organisation of quality assurance (QA) in the NHSBSP.

1.2 Scope

This document deals primarily with medical physics services for the quality assurance of X-ray mammography systems, because this is the major area of medical physics involvement in the NHSBSP. Some other aspects such as quality assurance of ultrasound equipment and radiation protection advice, are also covered. It is recognised that medical physics services may also be involved in other ways, for example electrical safety testing. Whilst these latter activities are outside the scope of this document, it is recommended that they conform to the same quality philosophy.

1.3 Background

1.3.1 Medical physics support

Medical physics support has been an essential part of QA in the breast screening programme since the inception of the UK programme in 1988. The role of the physicist is fundamental to the breast screening programme. One of the main role of the physicist in the NHSBSP is to advise breast screening centres on the optimisation of image quality ie how to achieve the required image quality while keeping radiation doses as low as practicable. Another important role is to detect any deterioration in image quality that might not be apparent in clinical mammograms, but which would reduce the diagnostic accuracy of the breast screening programme.

1.3.2 Ionising Radiation (Medical Exposure) Regulations 2000 (IRMER)

The Ionising Radiation (Medical Exposure) Regulations 2000 (IRMER) require a Medical Physics Expert to be available to advise employers on aspects such as optimisation of exposure, patient dosimetry, equipment selection and testing. Such advice was given previously as a matter of good practice but the regulations formalise the responsibility of the physicist.
1.3.3 Technical developments

There are also a number of technical and other developments which have significantly increased the requirement for physics services in the NHSBSP:

- the replacement of old equipment with new equipment
- the increased complexity of new equipment
- the requirement for physics support for ultrasound equipment
- the extension of the breast screening programme and introduction of two-view mammography.

The need for excellent image quality in breast screening has resulted in modern mammography x-ray sets that are considerably more complex than those that were in use when the programme started. This complexity should result in better image quality with lower patient dose, but only if the whole imaging system is optimised, including x-ray set, film-screen combination, film processor and viewing conditions. The greater number of features to be tested, together with the requirement to test more operating modes, approximately double the time taken to perform a full set of tests compared with the original equipment first installed by the NHSBSP. The detailed protocols for testing are given in *The Commissioning and Routine Testing of Mammographic X-ray Systems* (IPEM Report 89) published by the Institute of Physics and Engineering in Medicine (IPEM)\(^3\).

1.3.4 Programme expansion

The introduction of more sophisticated equipment including multi-track x-ray tubes, digital imaging devices and more advanced ultrasound scanners, allows better and more detailed breast assessment. Small field of view digital imaging systems used in conjunction with some breast biopsy procedures are also becoming increasingly available within the NHSBSP. These developments have required additional test protocols to be developed\(^4,5\) and physicists have had to gain additional expertise and experience with these new systems. The purchase of additional ultrasound equipment with monies from the National Opportunities Fund (NOF) has also increased the requirement for medical physics support to assess the performance of each ultrasound scanner in accordance with the protocol published by the Medicines and Healthcare products Regulatory Agency (MHRA)\(^6\).

In addition, the extension of routine invitations to women up to their 71st birthday, and the use of two view mammography at all screening attendances has further increased the number of x-ray sets and ultrasound systems used by the NHSBSP. Table 1 shows the growth in number of x-ray sets and ultrasound systems used by the NHSBSP in the period between 1991, the date of the first national audit, and 2004.

**Table 1: Growth in number of X-ray sets and ultrasound systems used by the NHSBSP**

<table>
<thead>
<tr>
<th>Year</th>
<th>1991</th>
<th>2001</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of x-ray sets</td>
<td>258</td>
<td>363</td>
<td>493</td>
</tr>
<tr>
<td>Number of ultrasound systems</td>
<td>93</td>
<td>203</td>
<td>208</td>
</tr>
</tbody>
</table>
2. MEDICAL PHYSICS SERVICES

All breast screening programmes in the NHSBSP should have a written service agreement with a medical physics service specifying the level and scope of services required.

2.1 Responsibilities

It is the responsibility of the host organisation of each breast screening service to ensure that they have the appropriate support and involvement of a medical physics service to provide medical physics services to breast screening programmes of the NHSBSP. These services include:

- provision of a Medical Physics Expert as required by the Ionising Radiation (Medical Exposure) Regulations (IRMER)\(^2\) to provide advice and support on the optimisation of dose and image quality in line with relevant NHSBSP and other professional guidance
- provision of a Radiation Protection Adviser as required by the Ionising Radiation Regulations\(^7,8\) to provide advice and support on radiation safety for staff and members of the public
- performance testing of mammographic x-ray systems as required by the Ionising Radiations Regulations\(^7,8\) and in compliance with recommended IPEM standards\(^3\)
- performance measurements and support for the QA of breast ultrasound equipment in accordance with MHRA protocols\(^6\)
- support for in-house quality assurance.

It is the responsibility of each regional QA Director to ensure that medical physics services are commissioned in accordance with the standards in this publication.

2.2 Organisation of medical physics services

In some QA regions, a single medical physics department provides the service to the entire region; in others, several medical physics departments are involved, with overall regional coordination provided by one of these departments. For either of these arrangements, the service provision may be identified separately or it may form part of an agreement between a host organisation and the medical physics service for comprehensive services to a radiology department. A separate agreement will usually be drawn up for the provision of regional coordination where this is required (see section 2.10).

2.3 Service agreements

The medical physics service should be provided on the basis of a written agreement in which the level and scope of service should be specified. Establishing these agreements requires the
involvement of three main parties; the host organisation hosting the medical physics service, the Trust hosting the breast screening service, and the QA director. Where a tendering exercise is undertaken, a suitably qualified and experienced physicist with experience in mammography physics should be asked to advise in the drafting of the service specification and the assessment of bids. If some services (eg radiation protection or ultrasound quality assurance) are provided by other organisations, then these should be the subject of separate agreements.

The services are to be provided for specific equipment listed in the service agreement(s). Any changes to the list of equipment should be agreed jointly between the regional Quality Assurance Reference Centre (QARC) and the medical physics services.

2.4 Funding arrangements

The funding for medical physics services varies across the regions. It is usually provided directly from the QARC. However in some regions this funding is supplemented by a charge to the organisation hosting the breast screening service. The funding for regional coordination of physics services is usually identified separately and provided by the QARC. Funding for ultrasound QA and small field digital systems is also usually calculated separately.

A sub-group of the National Breast Screening Quality Assurance Coordinating Group for Physics reviewed the resources required for the provision of medical physics services. In the light of the increased complexity of modern systems and the introduction of complex accessories such as small field digital systems, it proposed that funding be provided sufficient to employ a suitably qualified and experienced Clinical Scientist or equivalent (as defined in Chapter 3) for every 13 X-ray sets. This level of funding allowed for skill mix, with junior medical physicists or medical physics technical officers (MTOs) to carry out routine tasks and a proportion of staff at a higher grade to oversee the work.

2.5 Performance testing of mammographic x-ray systems

2.5.1 Test protocols

All measurements on equipment will be performed using the test instruments and methods defined in the current edition of IPEM Report No 89. Any other additional tests recommended by the National Breast Screening Coordinating Group for QA Physicists should be agreed between the medical physics services and the regional QA director and included in the service agreement.

2.5.2 Test equipment

The instruments required for the testing of mammographic x-ray systems are detailed in the current edition of IPEM Report 89. The medical physics service must have available the basic set of test instruments. If the medical physics service covers more than one screening centre, it must have sufficient test instruments to enable emergency investigation of a suspected fault or incident, whilst the main set is in use elsewhere on a scheduled survey or away on calibration.

* In 2002, an annual sum of £2250 per X-ray set was agreed by QA Directors as appropriate. The costs of medical physics QA for one ultrasound system or small field digital system were estimated at about one quarter of the cost for an X-ray unit. These sums was broadly typical of those provided from QA budgets for physics services in that financial year.
2.5.3 Maintenance and calibration of test equipment

Test instruments should be regularly maintained and calibrated annually. Those items requiring calibration are noted in the current edition of IPEM Report 89. The medical physics service should participate in any national comparisons of test instruments. The outcome should be reported to the regional medical physics QA coordinator.

2.5.4 Access to mammography equipment

Arrangements need to be made to allow access to the mammography equipment, usually in normal working hours. Where mammography equipment is located away from the main centre hosting the medical physics department, provision should be made for in the service agreement for travel time and costs.

2.6 Services to be provided for mammography equipment

2.6.1 Advice on equipment selection

The medical physics service should provide advice on the selection of equipment for breast screening. This includes the purchase of new equipment, the relocation of existing equipment, the need to replace existing equipment and the timing of such replacement. It also includes all the radiographic items and instruments used for performing quality control tests.

2.6.2 Commissioning tests for new equipment

The medical physics service must conduct commissioning tests for new equipment before clinical use. This includes x-ray units and associated accessories such as analogue or digital stereotactic devices. These commissioning tests do not include an inventory check or tests of electrical and mechanical safety, for which separate arrangements should be made. The testing of new cassettes, screens, film, processors and viewing boxes is usually part of the radiographers’ role but physics services may be involved depending on local arrangements. For new x-ray units, the commissioning may include, depending on local arrangements, the critical examination which is required of the installer by the Ionising Radiations Regulations 1999. These tests should be done in collaboration with radiographic quality assurance staff. Detailed guidance on the tests to be carried out by medical physics service on mammographic units is contained in the current edition of IPEM Report 89. Details of the commissioning tests usually conducted by radiographers (level A tests) are given in A Radiographic Quality Control Manual for Mammography (NHSBSP Publication No 21). As part of commissioning, the medical physics service should work in conjunction with the supplier and the user to ensure that image quality and dose are optimised.

2.6.3 Routine performance testing

After commissioning, the medical physics service should check the mammography equipment at an interval of six months. Detailed guidance on the checks to be carried out is contained in IPEM Report 89 and Recommended Standards for the Routine Performance Testing of Diagnostic X-ray Imaging Systems (IPEM Report No. 77). The test procedures should include analysis of the results, comparison with local and national standards, a written report,
liaison with users and suppliers, and recommendations on corrective action. Arrangements should be in place to ensure that any recommendations are followed up.

The written survey report should comprise a summary sheet and supporting technical details. An example is shown in Appendix 1. The report should be submitted as soon as practicable after the survey to the superintendent radiographer of the breast screening service, with a copy to the director of breast screening. The report should either confirm satisfactory performance or make recommendations on corrective action where remedial or suspension levels are exceeded. The report should be sent to the relevant RPA and the regional medical physics QA coordinator. Any parameter exceeding suspension levels and other serious fault(s) requiring urgent action will be drawn to the attention of the superintendent radiographer (or the nominated representative), director of breast screening, RPA, and regional medical physics QA coordinator as soon as possible after the tests. It is the responsibility of the director of screening to ensure that appropriate action has been taken by the screening programme.

Where additional physics measurements are required following replacement of the x-ray tube or AEC, or after major breakdowns, these shall be done before the unit re-enters clinical service, unless it is agreed jointly by the medical physics service and the superintendent radiographer that the radiographer in-house QC confirms satisfactory and safe performance as an interim position.

### 2.6.4 Routine monitoring

Routine daily and weekly quality control checks on equipment performance in the NHSBSP are conducted by radiographers. These checks are detailed in *NHSBSP Report 21*11. There should be close collaboration between the medical physics service and radiographers in the development and running of this system of quality control checks. The medical physics service can offer advice to screening radiographers on the practice and results of their routine quality monitoring of equipment performance. This will normally comprise a six monthly review of the sensitometry on each processor and post exposure data on each x-ray unit. For example, the medical physics service may receive weekly, monthly or yearly reports, with or without test films, relating to image quality, film density, mAs values or breast dose. If test object films are received on a regular basis, they should be assessed for image quality and a report issued at periodic intervals to the relevant breast screening centre and the QA Director. The medical physics service may also answer enquiries from radiographers, and make enquiries of radiographers to clarify the significance of measurements made by physicists or radiographers.

### 2.6.5 Trouble shooting

Problems with equipment performance may be identified at acceptance testing, commissioning or by the routine performance tests. Some problems will be highlighted by the routine radiographic quality control checks. Medical physics services can assist in the resolution of these problems by further investigation of the initial finding and by liaison with the equipment manufacturers. The medical physics service can also provide advice regarding breakdowns and emerging concerns about the performance of the equipment.

### 2.6.6 Advice on equipment use
The medical physics service should provide advice on the use of all mammography equipment and test instruments. Examples include advice on optimisation of operating parameters, radiation safety, use of test instruments in routine quality control, interpretation of results, replacement of screens, and change of film type.

2.6.7 Assessment of image quality

The medical physics service should assess the mammographic image quality. Routine performance tests should verify whether the image quality conforms to the current NHSBSP minimum standard and whether there has been any deterioration of image quality. The medical physics service will provide advice on the implications for optimisation (ie radiation dose and image quality) of any planned or unplanned changes in screening practice.

2.6.8 Assessment of patient dose

The medical physics service should be involved in the measurement of radiation dose to the breast. This involvement includes advice on the choice of technique and instruments for dose assessment, and the critical evaluation of results and their implications. In particular, the medical physics service should verify whether the mean glandular dose to the standard breast and diagnostic reference level conform to the current NHSBSP minimum standard. Conformity with the requirements of the relevant Ionising Radiations Regulations must also be verified.

The medical physics service should also be involved in the assessment of clinical doses for samples of women at least every 3 years and when major changes are made to the equipment. Samples will consist of at least 50 women for each x-ray unit. Software for the calculation of these doses is provided by the NHSBSP. Such dose data collection should be used to review whether the x-ray system is being operated optimally, as required under IRMER. Summaries of the patient dose surveys should be sent to the superintendent radiographer, director of breast screening, and the regional medical physics QA coordinator. Patient dose surveys are subject to regular national reviews.

2.7 Performance testing of ultrasound equipment

2.7.1 Test protocols

Ultrasound equipment should be subject to acceptance testing and regular checks in accordance with the Further Revisions to Guidance Notes for Ultrasound Scanners used in the Examination of the Breast, with Protocol for Quality Testing (MDA Report No. 98/52). This service may be provided by the same medical physics group as that used for the x-ray equipment or by a specialised ultrasound group, depending on local expertise.

2.7.2 Routine performance testing

All ultrasound scanners should be tested in accordance with the standards described in the protocol, including the user tests and no less frequently than specified in the protocol. Records of the outcome of tests should be kept as specified in the protocol.

A written report including a record of the test results and any consequent recommendations for action to remedy faults or deficiencies should be sent to the superintendent radiographer.
of the breast screening programme, with a copy to the director of breast screening. A copy should also be sent to the regional medical physics QA coordinator and the QA Reference Centre. Recommendations requiring urgent action should be drawn to the attention of the superintendent radiographer (or person nominated by him/her) as soon as practicable.

The instruments used in carrying out the tests should be to a standard not inferior to the test instruments referred to in the protocol and should be maintained and/or replaced as necessary to maintain the relevant standards of testing.

2.7.3 Additional advice and support

Advice may be offered to radiographers concerned with testing ultrasound equipment. Advice and testing should be available for breakdowns and emerging concerns about the performance of breast ultrasound equipment. Advice should also be available on the selection of new and replacement breast ultrasound equipment.

2.8 Radiation protection

2.8.1 Radiation Protection Adviser

Responsibility for radiation protection rests with the organisation hosting the screening programme and its appointed Radiation Protection Adviser (RPA). It is a legal requirement for the radiation employer of each screening centre to appoint an RPA under Regulation 13 of the Ionising Radiations Regulations 7,8 Other related radiation protection services may also be required, such as personal radiation dose monitoring. Radiation protection services are usually the subject of a separate service agreement.

2.8.2 Medical Physics Expert

Regulation 9 of the Ionising Radiation (Medical Exposure) Regulations 20002 requires the organisation hosting the screening programme (‘the employer’) to involve a Medical Physics Expert. The appointed medical physics service fulfils the role of the Medical Physics Expert by conducting the tasks described in sections 2.6.1 to 2.6.8. A senior member of this service may also be appointed as the RPA. Where these two roles are supplied by different individuals or organisations, then the scope of responsibility should be clearly defined in written service agreements. The medical physics service must inform the RPA promptly of any faults or incidents which have consequences for radiation protection.

2.9 Medical physics departments

2.9.1 Department facilities

Medical physicists providing services to the NHSBSP require appropriate scientific and technical support from a medical physics department. They need the normal range of facilities associated with a medical physics department, including office, laboratory and storage space, adequate secretarial support, electronic and mechanical workshops, and access to relevant literature.

2.9.2 Policies and procedures
Medical physics departments providing services to the NHSBSP should develop written policies and procedures for all activities included in the service agreement(s). These procedures should cover the scope of work specified in the service agreement and be adhered to by all staff. Staff must act in accordance with current professional guidelines and the procedures should reflect the detailed guidance given in national guidelines. These policies and procedures should be developed by medical physics staff in consultation with representatives of other professions and the management of the breast screening centres to which the service is provided, and should be subject to a document control procedure.

Each medical physics service should have a quality management and evaluation programme in place for breast screening. This should include the objectives of the quality programme, the methods used to attain these objectives and a list of standards and requirements to be met. Provision should also be made for the evaluation of practice against current guidelines, evaluation of service users’ satisfaction and for audit of the service.

2.9.3 QA systems and manuals

The medical physics service should assist in establishing and reviewing appropriate parts of the quality assurance systems and manuals for the breast screening service. This will involve collaboration with the other professions. These manuals and written procedures should be regularly reviewed and updated.

2.9.4 Development of the service

Physicists will sometimes need to consult with other physicists, either in their own region or beyond, and to visit other centres as appropriate and to travel to meetings of scientific societies. Such visits are essential to maintain an awareness of current good practice and the funding should be included in the relevant service agreements.

2.9.5 Teaching

The medical physics service may be contracted to provide training in the physics of mammography for radiologists, radiographers and assistant practitioners. This may include advice on course content and extends to giving lectures and supervising practical teaching sessions. Training involves not only initial basic training but also study days, updates and refresher courses. It is important that training in physics is conducted by physicists involved in mammography. Some medical physics services have a special commitment to provide such a service to the NHSBSP training centres, while all have a role in training staff at local breast screening centres.

2.9.6 Research and development

It is important that the medical physics service is involved in research and development in order to improve the quality of the service provided. This may extend to any aspect of equipment performance and selection, the manner of its use, image quality, patient dose and measurement techniques and instrumentation.

2.9.7 Participation in coordination of QA activities
Medical physics departments which provide services to the NHSBSP should supply reports on request to the regional medical physics QA coordinator on the performance and state of equipment in breast screening programmes. The medical physics service should also participate and respond to any surveys and evaluations organised by the National Co-ordinating Centre for the Physics of Mammography. Physicists providing services in the NHSBSP should be members of the regional technical QA sub-committee.

2.10 Regional coordination for medical physics services

2.10.1 Role of the regional QA coordinator

The role of the regional medical physics QA coordinator is to provide regional coordination for all matters relating to the performance and quality assurance of all x-ray and ultrasound systems used in the regional breast screening programme. The detailed tasks to be undertaken by the regional coordinator are set out in Chapter 4. A summary of performance data across a region should be sent to the QA director every six months using a proforma such as shown in Appendix 2.

2.10.2 Appointment and accountability

The regional QA coordinator is appointed by the regional QA Director taking advice from an approved external assessor for clinical scientists from the Department of Health. The coordinator will normally be appointed from among the lead physicists responsible for the provision of medical physics services to breast screening programmes but other arrangements acceptable to the QA Director may be considered. The coordinator is accountable to the regional QA Director for NHSBSP managerial purposes but is professionally responsible to the head of the medical physics department in which he or she is based.

2.10.3 Service agreement for regional coordination

The provision of regional coordination should be clearly identified in a service agreement separately from the provision of other medical physics services. Funding is usually identified separately and provided by the QARC. The number of sessions required for the coordinator will depend on the size, geography and organisation of physics services within the region and is open to negotiation between the physics department in which the coordinator is based and the regional QA Director but should be in the range of 0.1 to 0.3 whole time equivalent. The agreement to provide regional coordination for medical physics services in an NHSBSP region is normally with a host organisation or other employer, rather than with an individual. However, the individual responsible for the provision of regional coordination of the regional service should be named in the relevant service agreement.
3. QUALIFICATIONS AND EXPERIENCE

Physicists and other staff providing the mammography physics service must have adequate qualifications, training and experience.

3.1 Introduction

Medical physics services to the NHSBSP will normally be provided by a team of clinical scientists and medical physics technicians. One clinical scientist, the lead physicist, should be managerially and scientifically responsible for, and closely involved in, the work of the staff providing medical physics services. Generally each team should provide support for at least two screening programmes to maintain collective diversity of experience. If a physics service does look after a single screening programme, extra arrangements to work closely with other physics services in the region should be made.

3.2 Qualifications and training for mammography physics

The lead physicist should be a clinical scientist holding corporate membership of the Institute of Physics and Engineering in Medicine (IPEM), or having equivalent experience, acting as the Medical Physics Expert (as defined under IRMER). The lead physicist should have a minimum of four years experience in diagnostic radiology. All physicists working unsupervised should be clinical scientists.

All physicists and medical technical officers providing mammography physics services to the NHSBSP (except trainees working under supervision) must:

- have received basic training in general diagnostic radiological physics and radiation protection
- have received training in mammography physics by attending the IPEM Mammography Physics basic training and update courses, or equivalent
- undertake practical training in medical physics departments with recognised expertise in mammography physics.

3.3 Experience

To achieve and maintain adequate awareness of current technology and techniques, all physicists and medical technical officers who are working unsupervised must:

either
- perform QA surveys on at least 6 mammography units at least once a year

or
- perform QA surveys on at least 2 mammography units at least once a year and have extensive experience of general diagnostic radiological work and participate in a regional scheme in which the results of the mammography QA physics surveys are critically reviewed.
The lead physicist must also

- participate in a regional (or sub-regional) review of the data from QA surveys at least once a year, and have access to such data when necessary
- liaise with other mammography physicists and medical technical officers and attend meetings on mammography physics, within their region and nationally
- keep updated with developments in mammography physics by attending relevant training and scientific meetings and reading relevant scientific papers
- periodically make visits to other centres active in mammography physics to compare techniques, especially when new equipment or techniques are introduced.

3.5 Training for ultrasound QA

All physicists and medical technical officers providing services for ultrasound scanners used by the NHSBSP (except trainees working under supervision) should:

- have received basic training in the physics of ultrasonic imaging in medicine
- have received practical training to support competency in testing breast ultrasound scanners; this may be done in-house but if suitably experienced physicists are not available, staff should visit a breast screening training centre.

3.6 Continuing professional development

Physicists and medical technical officers should maintain their expertise and knowledge by appropriate continuing professional development (CPD), which may include attendance at the update training day in mammography physics organised by the IPEM and participation in professional meetings such as the UK Mammography Physics Group. Staff may also make exchange visits with other medical physics services providing quality assurance services for the breast screening programme. They should also participate in a recognised CPD scheme such as that run by the IPEM.

3.7 Regional QA coordinator

The role of regional QA coordinator of physics services requires higher levels of experience. The person appointed should be a clinical scientist and hold corporate membership of the IPEM, or have equivalent qualifications and experience. In addition, the person should:

- have at least 10 years experience working in diagnostic radiology physics, including at least four years experience in mammography physics in the NHSBSP and acting as a lead physicist in the NHSBSP for at least two of these; equivalent experience gained outside the breast screening programme may be considered
- have a very good understanding of the physical and other aspects of breast screening and an awareness of the latest developments in these areas including quality assurance, scientific, medical, organisational and legislative aspects
• be able to demonstrate clear evidence of innovative work and a positive contribution to the development of the physics aspects of breast screening
• be able to demonstrate significant evidence of management experience and the ability to work effectively with other professional groups
• be able to direct and motivate the work of others.
4. REGIONAL AND NATIONAL QUALITY ASSURANCE

The medical physics service should be an active participant in the regional and national QA structure.

4.1 Regional organisation of QA

Quality assurance is led in each QA region by a regional director of breast screening quality assurance appointed by and accountable to the regional director of public health for the relevant Government Office. The regional QA director is responsible for reporting to the regional director of public health and the Director, NHS Cancer Screening Programmes on an ongoing basis on the performance of the breast screening programme in the region. Professional members of QA teams (professional QA coordinators) are appointed formally with a clear job specification and a paid sessional commitment. The professional QA coordinators are accountable to the regional QA director. There is a professional QA coordinator for each profession which contributes to breast screening (radiography, radiology, pathology, surgery, breast care nursing, administration and medical physics). Each professional QA coordinator is responsible for liaising with professional colleagues in the region, for convening regular meetings with them and for representing the profession in the region on the relevant national coordinating group.

4.2 Regional QA coordination

A regional QA coordinator for medical physics must be appointed in each region. This physicist is accountable to the regional QA Director and represents the regional physics services at national level. Some very large regions have split their QA structure. In this case there may be sub-regional coordinators appointed for each part of the region. A sample job description is given in Appendix 3 which sets out the detailed duties of the regional coordinator.

4.3 Regional QA coordinating groups

Where a region is covered by a number of medical physics services, a regional coordinating structure should be established with regular meetings at which all the medical physics services are represented. Physicists providing services in the NHSBSP should also be members of the regional technical QA sub-group. Regional QA coordinating groups normally meet twice per year (or as appropriate for the region).

4.3 National QA coordination

4.3.1 National QA coordinating group

The National QA Coordinating Group for Physics represents mammography physicists working in the UK Breast Screening Programmes. The constitution and terms of reference of this committee is given in Appendix 4. Membership of the Group includes the regional medical physics QA coordinators for England and the equivalent for Northern Ireland, Scotland and Wales. Where a medical physics service is not directly represented at the meetings, it is kept
informed and consulted by its regional representative to ensure that it is involved in developments.

4.3.2 National Coordinating Centre for the Physics of Mammography

Each physicist working for the NHSBSP has access to the National Coordinating Centre for the Physics of Mammography (NCCPM) for consultation and advice. The NCCPM maintains a database of all equipment used in the NHSBSP. The database includes information on physics measurements and equipment fault reports returned by radiographers. Each medical physics service providing services to the NHSBSP should respond to initiatives from the Centre for data collection.

4.3.3 National Equipment QA Coordinating Group

One physicist for each QA region is a member of the National Breast Screening QA Coordinating Group for Equipment.

4.4 Quality assurance of medical physics services

4.4.1 Monitoring of medical physics services

The QARC will monitor the delivery of medical physics services to breast screening programmes. In order to facilitate this, medical physics services should maintain the following records and make them available on request:

- copies of all equipment survey measurements and results
- calibration certificates for test instruments
- records of attendance and minutes of audit meetings
- records of training and staff development.
- Records of quality management

The service should participate in data gathering for local and national audit programmes.

4.4.2 Biennial audit of medical physics services

A biennial audit of medical physics services is carried out by the NCCPM on behalf of the National Breast Screening QA Coordinating Group for Physics. This provides the basis of a formal review of medical physics services across the NHSBSP. A copy of the resulting report is sent to each regional coordinator for medical physics QA, each regional QA director and the Director, NHS Cancer Screening Programmes.

4.4.3 QA visits

The means of achieving effective audit of medical physics services is described in detail in Guidelines on QA Visits\textsuperscript{15}. A review by an external physics auditor of the support provided by a
medical physics service should take place at least once in every round of QA visits to at least one of the breast screening services for which the physics service is responsible. The physics auditor must be external to the physics department providing the service. In most cases this will require an external physics auditor from another region. However, where several physics departments provide services, it may be acceptable for the external auditor to be from the regional coordinating department. For those breast screening services where the physics service is supplied by the coordinating department, the auditor must be from outside the region.

For these QA visits, the external physics auditor will form part of the visiting QA team. The visiting team will monitor the satisfaction of the breast screening programmes(s) with the medical physics service provided. The auditor will check that the physics service provided complies with current guidelines included in this publication and that the tests performed are in accordance with the current edition of IPEM Report 89\(^3\). This will cover the adequacy of qualifications, training and experience of staff, availability of test instruments and fulfilment of service agreement in terms of test frequencies and reports. The auditor will check that the physics service is participating in national reviews initiated by the National Breast Screening QA Coordinating Group for Physics. The external auditor will also meet the superintendent radiographer and nominated QA radiographer(s) to discuss equipment and technical QA issues.
REFERENCES


5. Commissioning and routine testing of small field digital mammography systems. NHS Cancer Screening Programmes, 2001 (NHSBSP Occasional Report 01/09).


10. Minutes of NHSBSP QA Directors Meeting on December 2002


APPENDIX 1: Sample survey report for results of routine performance testing of mammographic equipment

Diagnostic X-ray Equipment Survey Report

Report Number: _____

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<tbody>
<tr>
<td>X-ray set:</td>
</tr>
<tr>
<td>Reason For Visit:</td>
</tr>
<tr>
<td>Equipment Surveyed:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Asset/Serial Number/s:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Survey Date:</td>
</tr>
<tr>
<td>Report Date:</td>
</tr>
<tr>
<td>Report By (Name):</td>
</tr>
<tr>
<td>Reviewed by (Name):</td>
</tr>
</tbody>
</table>

Report Sent To:

CONCLUSIONS /RECOMMENDATIONS

For queries relating to this report please contact:

Actions taken by the unit:
Summary of results and comparison with recommended standards

### National performance standards

<table>
<thead>
<tr>
<th>Measured values</th>
<th>Minimum Standard</th>
<th>Pass/Fail</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard film density at clinical settings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aim density</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18x24 cm table</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24x30 cm table</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High contrast spatial resolution (broad focus)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parallel to tube axis (lp/mm)</td>
<td>≥12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perpendicular to tube axis (lp/mm)</td>
<td>≥12</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Contrast-detail performance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum detectable contrast (5/6mm detail) (%)</td>
<td>≤ 1.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum detectable contrast (0.5mm detail) (%)</td>
<td>≤ 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum detectable contrast (0.25mm detail) (%)</td>
<td>≤ 8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean Glandular Dose (MGD)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MGD to standard breast at clinical settings (mGy)</td>
<td>(Using 45mm Perspex)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Other parameters (IPEM Report 89 and IPEM Report 77)

<table>
<thead>
<tr>
<th>Measured values</th>
<th>Remedial Level</th>
<th>Pass/Fail</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. X-ray tube and generator tests (Mo/Mo)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray tube voltage accuracy (maximum kV error)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray tube output consistency with mAs (max deviation %)</td>
<td>≥ 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific tube output at 28 kV MoMo (µGy/mAs at 50cm)</td>
<td>140 ± 5 ± 260</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray tube output rate at focus-film distance (mGy/s)</td>
<td>≤ 7.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broad focus size on reference axis (mm)</td>
<td>≥ 0.45 x 0.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine focus size on reference axis (mm)</td>
<td>≥ 0.15 x 0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray beam uniformity (perpendicular to tube axis) (OD)</td>
<td>≥ 0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overlap of X-ray beam of film all edges -18 x 24 cm (mm)</td>
<td>&gt;-0, +5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overlap of X-ray beam of film all edges -24 x 30 cm (mm)</td>
<td>&gt;-0, +5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overlap of X-ray beam of film all edges –Magnification (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum motorised compression force (N)</td>
<td>130± 220*</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2. Automatic exposure control device (Clinical settings)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproducibility of exposure (%)</td>
<td>≥ 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness compensation in clinical mode to 4cm (OD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum difference 18x24 cm table</td>
<td>≥ 0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum difference 24x30 cm table</td>
<td>≥ 0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum difference Magnification mode</td>
<td>≥ 0.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Suspension level, no remedial level
## SIX MONTHLY PHYSICS REPORT TO OA DIRECTOR

<table>
<thead>
<tr>
<th>Date of Report:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Base of Physics Service:</td>
<td></td>
</tr>
<tr>
<td>NHSBSP Programmes Served:</td>
<td></td>
</tr>
</tbody>
</table>

Have all the X-ray Units had the performance measured within the last 6 months?  
Yes/No

If NO, please give reason:

Are there any instances where performance failed NHSBSP standards?  
Yes/No

If YES, please attach summary survey report(s) of non-compliant units.

Have all the ultrasound units had their performance measured in the last 6 months?  
Yes/No

If NO, please give reason:

Are there any instances where performance failed NHSBSP Standards?  
Yes/No

If YES, please attach summary survey report(s) of non-compliant units.

Have there been any problems in undertaking physics performance measurements including dose surveys on new or existing equipment since the last 6 monthly report?  
Yes/No

Comments:

Completed on behalf of the physics service by:

Name:…………………………..   Signature:………………………………….

Noted by the Physics QA Coordinator:

Name:…………………………..   Signature:…………………………………Date:……………..
APPENDIX 3:  Sample job description for the regional medical physics QA coordinator

1. Service conditions and accountability

1.1 A named regional medical physics coordinator will be appointed by the regional QA Director. The term of appointment will be three years with the possibility of re-appointment.

1.2 The coordinator will be accountable to the QA Director for the coordination of medical physics QA and the provision and collation of information within the region. The coordinator will take overall responsibility for the coordination function but may delegate functions to the services which he or she coordinates. These arrangements shall be specified in writing to the satisfaction of the QA Director.

1.3 The coordinator will remain professionally responsible to the head of the medical physics department in which he or she is based.

2 Co-ordination of services

2.1 The regional medical physics quality assurance coordinator will provide regional co-ordination of all medical physics aspects of quality assurance in the regional breast screening programme.

2.2 The coordinator should establish good liaison with the medical physics services and breast screening programmes.

2.3 The coordinator will advise the QA Director on matters relating to the performance and quality assurance of equipment used in the region.

2.4 The coordinator will collect data summarising the x-ray and ultrasound equipment performance in all the screening programmes and provide a biannual summary of that performance to the QA Director with reference to any national and regional guidelines on equipment testing and performance. The coordinator will investigate any instances of failure to meet relevant targets and report these to the QA Director.

2.5 The coordinator will participate in multi-disciplinary quality assurance visits to breast screening programmes in accordance with the Guidelines for Quality Assurance Visits (NHSBSP Publication No 40). The coordinator will check that all quality assurance testing of mammographic, ultrasound and associated equipment is performed in accordance with current NHSBSP and IPEM guidance.

2.6 The coordinator will assist the QA Director in the audit of local medical physics service against the service specification for medical physics services. The coordinator will liaise with the QA Director in the investigation of any apparent failure of a local medical physics service to meet the specification.
2.7 The coordinator will advise the QA Director on the purchase of equipment used in the screening programme when requested.

2.8 The coordinator will liaise with physics services to ensure that data is supplied to the National Coordinating Centre for the Physics of Mammography as requested. This will include data on mammography equipment, its performance and radiation doses for a sample of screened women.

2.9 The coordinator will represent the region at the National Breast Screening QA Coordinating Group for Physics and (if requested) at the National Breast Screening QA Coordinating Group for Equipment and report back to the QA Director, appropriate regional committees and all local medical physics services providing services to breast screening programmes.

2.10 The coordinator will attend the regional quality assurance team meetings, other relevant quality assurance meetings and report back to all local medical physics services providing services to breast screening programmes.

2.11 The coordinator will convene meetings as appropriate with other physicists in the region providing services to breast screening programmes.

2.12 The coordinator will participate in training other NHSBSP staff within the region as agreed.

2.13 The coordinator will provide advice for the review and update of sections of local quality assurance systems and manuals referring to physical aspects.

2.14 The coordinator will collaborate with the relevant Radiation Protection Advisers on radiation protection issues.

3 External audit

3.1 External audit of regional coordination may be commissioned from time to time by the Quality Assurance Reference Centre.

4 Continuing professional development

4.1 The coordinator will maintain personal professional experience through involvement with practical performance measurements on mammographic equipment and by regular discussion and review of results with local medical physics services which provide quality assurance to breast screening programmes.

4.2 The coordinator will maintain personal professional development through attendance at appropriate scientific and medical meetings and personal study. The coordinator will participate in a CPD scheme.
Constitution of the NHSBSP QA Coordinating Group for Physics

Remit

1. To advise the Director of the NHSBSP of the needs and priorities for physics service and research in the NHSBSP.
2. To monitor the resourcing and implementation of physics aspects of the NHSBSP.
3. To provide support and information for physicists who act as coordinators of regional physics services to the NHSBSP and through them, to other physicists involved in the NHSBSP.
4. To identify the training requirements of physicists involved in the NHSBSP and make recommendations as to how these should be met.
5. To organise teaching and training meetings as appropriate.
6. To specify the minimum requirements for physics services and to devise and promote standards in breast imaging.
7. To act as an adviser to and collaborate with the National Coordinating Centre for the Physics of Mammography (NCCPM).
8. To encourage and maintain an awareness of scientific work in mammography physics and to suggest areas for research and development.
9. To encourage and facilitate the exchange of information with other disciplines involved in the NHSBSP so as to improve clinical practice.
10. To advise the IPEM on the physics aspects of breast imaging

Membership

1. There shall be two classes of members: full and invited members
2. Full members shall comprise:
   - the Director of the NHSBSP or a nominated representative
   - the physics coordinator or other nominated representative from each of the QA regions in England
   - the physics coordinator or other nominated representative from each of Scotland, Wales and Northern Ireland
   - a representative of the private sector
   - a representative of the National Coordinating Centre for the Physics of Mammography
   - a representative from IPEM
   - a representative from KCARE
   - the physicist currently serving on the UK Advisory Committee for Breast Cancer Screening.
3. The invited members shall comprise physicists with specialist experience in mammography whose membership will be of benefit to the activities of the group. The
invitation for such physicists to join the group rests with the full members of the group. In the first instance the period of appointment will be for 3 years although the invitation to remain on the group may be repeated.

4. The number of invited members will not normally exceed five.

Officers
1. The Chairman, Vice-Chairman and the Secretary of the Group shall be elected by the full members of the Group.

2. The Chairman, Vice-Chairman and the Secretary of the Group shall be elected to hold office for a period of three years and shall not be eligible for immediate re-election.

Meetings
1. The quorum for a meeting shall be 8 full members and shall include either the Chairman or Secretary of the Group.

2. Only full members may vote. Resolutions are considered passed if there is a two-thirds majority.

3. The Group will normally meet twice a year, but the Chairman may also call an Extraordinary meeting if necessary.

4. The minutes of the meetings will be presented to the Director of the NHSBSP. The minutes will also be sent to the National QA Coordinating Groups for Radiology, Radiography and Equipment.

Administrative Support
1) The IPEM will administer the monies related to the activities of the Group and will provide administrative support for meetings including mammography training meetings organised by or on behalf of the Group.

2) The IPEM will be reimbursed by the NHSBSP for expenditure on meetings and other administrative costs.