AAPM REPORT NO. 133

Alternative Clinical Training Pathways for Medical Physicists

Report of AAPM Task Group 133

August 2008

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Alternative Clinical Medical Physics Training Pathways for Medical Physicists:

Report of AAPM Task Group 133

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I. Introduction

The primary clinical responsibility of the Qualified Medical Physicist is to assure the safe and effective delivery of radiation to achieve a diagnostic or therapeutic result as prescribed in patient care (Medical Physics Scope of Practice)[1]. The patient is the ultimate beneficiary of a medical physicist's effort.

Mechanisms to provide the necessary training and experience to become a qualified medical physicist are the focus of this report. The primary premise is that high-quality patient care is delivered by a team that has met a certain set of clearly defined and well-structured training requirements, and that competency is determined by a peer examination. The training and experience requirements for most non–physician professionals involved in radiologic imaging or radiation therapy, including medical physicists, are being standardized at the national level in congressional bills (CARE [House H.R. 1426] and RadCARE [Senate S2322]). It is incumbent upon us to provide the mechanisms to be certain that medical physicists are properly trained.

There is evidence that 200 to 400 qualified clinical medical physicists are required to join the workforce annually (various surveys). There are currently 21 CAMPEP-accredited residency programs (Commission on Accreditation of Medical Physics Educational Programs, Inc.), with a number in process. With available residency capacity it is currently impossible to produce the requisite number of properly trained individuals through these means only. The profession has resorted to a combination of mechanisms to meet these needs (see Figure 1). It is the charge of

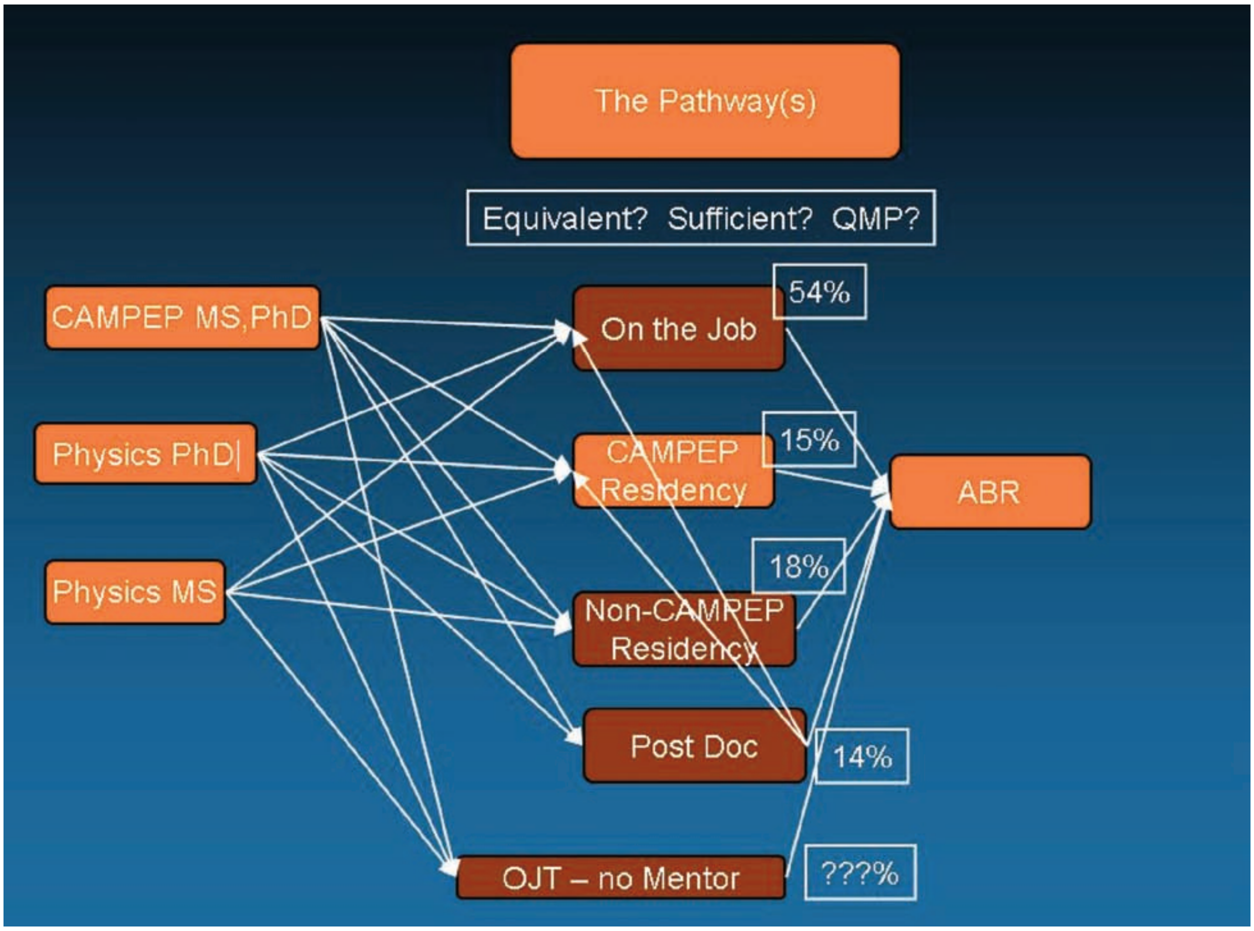

Figure 1. Current pathways to becoming a clinical medical physicist.

this task group to show how such a complex and inconsistent group of pathways can be replaced by an organized, structured pathway for the profession and meet the demand for competent medical physicists.

The background leading to this Task Group 133 report is reviewed. This is followed by a description of the possible training models and the specific focus of TG133. CAMPEP requirements for accreditation in a new program model are discussed, as well as a summary of significant issues for carrying this forward. Results of a Medical Physics Residency Training and Promotion Subcommittee survey related to training methods are then reviewed. Financial issues are briefly presented, and following the summary and recommendations are appendices giving specific examples of necessary essential documents, including a sample self-study document.

II. Background

AAPM President Howard Amols (2004) appointed an *ad hoc* committee to propose mechanisms to bring a substantial number of new, qualified clinical medical physicists into the field. This was prompted by the potential for reduced quality in patient care indicated by dismal certification board passage rates, medical errors, and a demand for qualified medical physicists far exceeding the supply[2]. The report submitted by the committee chaired by Larry Reinstein was accepted by the AAPM Board of Directors (BOD) in July 2005. At the November 2005 AAPM Board meeting, the Education Council (through the Committee on Education of Medical Physicists) directed the subcommittee on residency education programs to form a task group to fully detail possible programs that could be accredited by CAMPEP. The intent was to lessen the burden on institutions in gaining CAMPEP accreditation of training programs, possibly allowing significant growth in qualified medical physicist supply. This should be done without excluding qualified and properly trained individuals and to maximize the successful and proper training of clinical medical physicists. A Point/Counterpoint article in *Medical Physics* concerning this issue indicated that graduates of CAMPEP-accredited residency programs fully pass the American Board of Radiology (ABR) exam on the first attempt at a 95% rate, as compared to the overall ABR average of 53% over the same time period[3]. The ABR has now implemented a requirement that individuals complete a CAMPEP-accredited clinical training program prior to sitting for board certification in medical physics (by 2012)[4].

Quoting from AAPM Report 90[5]:

> *It has never been possible to learn medical physics by unstructured self-study or by observation alone. It is now no longer possible to become a fully competent, qualified medical physicist by on-the-job training, even under the mentorship of a single, experienced medical physicist. Over the past few years, it has become increasingly clear that the training standards and documentation associated with accreditation are needed to properly train individuals to be capable of practicing medical physics independently. It is also clear that high quality training can take place effectively in a hospital setting as well as in an academic environment.*

From the original Reinstein *ad hoc* committee report[2]:

> *At present, the demand for qualified medical physicists far exceeds the supply of individuals graduating from existing CAMPEP accredited residency programs. There are currently 11 independent (10 Therapy, 1 Imaging) accredited residency programs (with an additional half-dozen under consideration). It is estimated that with an average rate of graduation of 5 residents per year per program that approximately 50 accred-*

ited residency programs would be required to support the current demand. The establishment of a fully CAMPEP accredited residency program is a huge undertaking which requires a substantial dedicated and supplemental infrastructure including space, equipment, administrative and clerical personnel, faculty, staff, and hospital or medical school support. Given the magnitude of the undertaking it seems unlikely that such a large number of new residency programs will be established and accredited in time to alleviate this shortage. It is, therefore, urgent that CAMPEP devise guidelines for an alternative, formally structured training mechanism to help assure that an adequate supply of competent clinical medical physicists will be available.

The motions from the *ad hoc* committee report[2], approved by the AAPM Board, represent the foundation of this task group report.

The AAPM fully supports a formal requirement for thorough and proper training of all clinical medical physicists in order to achieve a high standard of safety and quality patient care. AAPM maintains that the proper path for the education and training of clinical medical physicists includes three essential components:

1. *An advanced degree in Medical Physics, Physics, or Physical Science,*
2. *Extensive clinical medical physics training as outlined in AAPM Report #36 (now Report 90)[5] and delivered in a CAMPEP accredited clinical training program, and*
3. *Satisfactory completion of required core didactic medical physics coursework as outlined in AAPM report 79[6] and which can be accomplished in either the first or second component of the training process.*

Consistent with its definition of a Qualified Medical Physicist the AAPM believes that Certification by the ABR or equivalent is evidence of competency for practicing clinical medical physicists. In addition, the AAPM supports the long- term goal that the pathway specified above be considered by the ABR and other Boards as necessary for eligibility to achieve certification in medical physics.

Recognizing that at present the number of CAMPEP accredited clinical training program is insufficient to meet this goal, the AAPM encourages the establishment of additional accredited training programs and urges CAMPEP to develop guidelines and standards which enable the expansion of these CAMPEP accredited programs through the establishment of affiliated clinical training sites incorporating structured mentorships.

AAPM President Mary Martel (2007) published the following comments in the May-June 2007 AAPM Newsletter: “The issue is that medical physics is the only ABR specialty not requiring residency training and this is not acceptable to the American Board of Medical Specialties (for various reasons).” Chairman of the Board Russell Ritenour, in the same newsletter, states: “The American Board of Medical Specialties is putting some pressure on the American Board of Radiology to require applicants to all of its exams to have completed an accredited residency program.” Summarized earlier by Dr. T. A. Brennan: The common premise among all 24 certification boards including the American Board of Radiology and the American Board of Medical Specialties is that “To achieve initial certification, each board requires between 3 and 6 years of training in an accredited training program and a passing score on a rigorous cognitive examination.”[7] Former ABR president W. J. Casarella agrees that the certification exam alone cannot cover every area of practice and that all candidates sitting for the exam must have received proper training in the essentials of practice in an accredited program. “It is the successful completion of the residency itself that is the *sine qua non* (absolute prerequisite) of ABR certification.”[8]

Finally, from Abraham Flexner in his deliberations on the state of American Medicine in 1910, "There is probably no other country in the world in which there is so great a distance and so fatal a difference between the best, the average and the worst"[9]. **This was true for physicians 100 years ago and might be true of medical physics now.**

To further address the critical need, the AAPM BOD passed Professional Policy 19 (March 2007), suggesting that a CAMPEP-accredited clinical residency be required to sit for the ABR exam.

The BOD also directed the Medical Physics Residency Training and Promotion (MPRTP) subcommittee to perform a survey of current training methods throughout North America to better understand how medical physicists are receiving clinical education.

Quoted from the CAMPEP Guidelines for Residency Accreditation, Dec 2006[10]:

> *Options available for clinical residency training:*
>
> - *A formal 2 year residency program at an academic center offering a complete range of treatment techniques and with many, often specialized, qualified medical physicists (QMP). Such a program, if CAMPEP accredited, may serve as a primary site.*
> - *A formal 2 year residency offered at a center with more limited resources but affiliated with a CAMPEP accredited center.*
> - *Incorporation of a residency program in a professional degree where it may replace the research/project component of the more conventional Masters and Doctoral degrees.*
>
> *Clearly to ensure the safety of patients and the quality of the care they receive, it is essential that the knowledge and competence of individuals entering practice via any of these routes is not only consistent but is also of a high standard. The role of CAMPEP in the accreditation of residency programs is to provide assurance to both the entering resident and the prospective employer that a high quality, appropriate educational experience is provided at the accredited institution.[10]*

Key Observations

- Patients deserve the very best quality of care that properly trained and educated medical physicists can facilitate.
- There is a shortage of properly trained clinical medical physicists in the United States.
- The established, accredited training mechanisms available cannot produce the necessary volume of properly trained medical physicists to meet market demands.
- Funding is and will remain an issue.
- Lack of standardized requirements to practice medical physics is and will be an issue (cf. Figure 1).
- An American College of Medical Physics-American Association of Physicists in Medicine (ACMP-AAPM) Medical Physics Scope of Practice document has been promulgated [1]. Guidance for training (AAPM Reports 90 and 79) exists[5,6].
- The CARE and RadCARE congressional bills will require standards for training and education for individuals practicing in medical fields applying radiation.

- ABR would like all candidates to have graduated from a consistent training experience accredited by CAMPEP.
- CAMPEP needs guidance as to what constitutes proper training from an accreditation standpoint.
- American Board of Medical Specialties (ABMS) is putting pressure on ABR to require an accredited residency (with a minimum expected training time).
- The time to act is NOW.

Figure 1 summarizes the issue. There are numerous pathways by which one can enter the practice of medical physics, with the potential of significantly different clinical (and didactic) training regimens. It is impossible for the ABR, an employer, or a patient to know if a given medical physicist has been trained in a structured manner according to AAPM and CAMPEP guidance. This "web" of confusion is a problem for patient care. Further, the numbers listed beside the boxes in Figure 1 represent the percentage of individuals trained by that method as a result of the survey performed by the MPRTP. The data indicate that over half of the survey respondents provide on-the-job (OJT) training! As noted previously, it is necessary to develop a mechanism whereby most or all incoming medical physicists can receive proper, structured clinical training, in an accredited setting and sit for board certification.

III. Charges of TG133

Recognizing that CAMPEP-accredited residency is the standard and based on the above background data, the charges of the Task Group on Alternative Clinical Training Pathways for Medical Physicists are the following:

1. To consider and propose a model or models by which *extensive clinical medical physics training as outlined in AAPM report 36 (revised as Report 90) and delivered in a CAMPEP-accredited clinical training program* can be achieved, increasing dramatically the number of available qualified clinical medical physicists and reducing the burden on the limited number of conventional medical physics residency programs.
2. To ensure that *satisfactory completion of required core didactic medical physics coursework as outlined in AAPM report 79* is also achieved, either in an accredited graduate program or within the structure of the accredited training program(s) proposed in charge No. 1.
3. To provide detail in each training model how the requirements established for accreditation will be achieved, including program funding and expected program time frames. Specifically, the task group will consider:
   a. Current CAMPEP-accredited medical physics residency program structure.
   b. A structured mentorship, affiliated with a core CAMPEP-accredited residency program.
   c. The professional doctoral and/or masters degree in the practice of medical physics.

   d. How an enhanced MS or PhD medical physics graduate program could provide some or all of the necessary clinical training and if not all, how that fits in to the residency and a, b, or c above.

4. Provide recommendations for (CAMPEP) assessment of programs described in charge No. 3, based on the reference structure defined in charges No. 1 and 2.
5. Communicate with other organizations and AAPM committees with interests related to clinical training and competence of practicing medical physicists:
   a. ABR through the ABR physics committee.
   b. CAMPEP, through a liaison.
   c. AAPM licensure and national training standardization (CARE) efforts regarding specifics of training requirements.
6. Review the essential economics issues associated with proper clinical medical physics training.

IV. Potential Training Models

Certain competencies (fully detailed in AAPM reports 79 and 90)[5,6] must be examined and documented in a consistent and high-quality manner to produce uniformly prepared and qualified medical physicists for clinical practice. While a number of mechanisms could exist to meet these requirements, the focus of TG133 is on acquiring the necessary training through a CAMPEP-accredited clinical training program. This provides the highest probability of defining a standard by which all medical physicists will receive clinical training. This also will satisfy the ABR and ABMS requirements of accredited clinical residency completion as a prerequisite to board examination.

The mechanisms that might achieve this goal include:

1. The conventional academic CAMPEP accredited residency.
2. A structured mentorship, affiliated with a primary CAMPEP-accredited residency program. This model could take two possible forms. In the first, the affiliate becomes CAMPEP accredited and connects to a primary program on a limited basis for some materials that are not available in their own program (limited affiliate). The second format would be one where the primary program actually oversees and manages the affiliate program. The affiliate then provides additional training and faculty resources as part of and fully under the auspices of the primary program (dependent affiliate).
3. The professional doctorate degree in the practice of medical physics, perhaps called a doctor of medical physics (DMP). This would be accomplished through existing academic educational systems. Students would pay tuition as with anyone obtaining a professional degree. Numerous other professional degrees exist (PharmD, PhysTherD, etc.), providing context for discussion of a DMP degree. While this could be a long-term solution, to ramp up such a program at the national level with a defined and consensus of curriculum might take a substantial amount of time. The involvement with numerous state and federal educational entities would be needed. (This task group will later recommend a separate group follow the DMP thread in detail.)

4. Enhanced MS or PhD medical physics graduate programs could provide some or all of the necessary accredited clinical training. This mechanism would be possible if the graduate program developed a plan to include all or parts of Report 90 in the curriculum and documented the training. It would be left to the individual programs to adopt or delete clinical experience from their training programs, as clinical training is not currently CAMPEP required for the graduate degree itself. It is the belief of this task group that an individual graduating from a CAMPEP-accredited graduate program with documented clinical training, could count this training toward his/her fulfillment of residency training. These individuals would also have a full complement of Report 79 didactic training documented.

V. Focus of TG133 Report

To create the necessary number of *accredited* training positions, the focus of TG133 is on expanding the number of accredited clinical opportunities for training. This is accomplished by introducing the concept of an affiliation to allow what are now on-the-job training (OJT) facilities and non-residency postdoctoral programs to gain accredited status (see Figure 1). An **affiliate** program would be connected to a **primary** CAMPEP-accredited program for essential material not provided by the affiliated facility. As noted earlier, this could be accomplished with a limited affiliation, where the affiliate would (eventually) independently receive CAMPEP accreditation, only connecting to the primary program for a limited set of needs to complete and to satisfy accreditation requirements. The limited affiliation agreement has a broad application of any case where two or more institutions wish to combine resources to achieve all the necessary goals of accredited medical physics residency training. In each of these cases, it would be expected that each of the entities in the limited affiliation were ultimately CAMPEP accredited individually. If the affiliation is more involved, where the primary program fully manages all the affairs of the program at the primary site and at each affiliate, a dependent affiliation would exist. In the dependent model, the primary site accreditation would extend to any and all dependent affiliates. The primary program would be responsible for managing the entire training program at all sites. In either case, the affiliate program would need to develop a contract with the primary program to make certain all necessary training components are covered (between the affiliate and primary programs) and to document the administrative and financial relationship/obligations between the two. It would be up to the two entities to determine whether the affiliate should become independently CAMPEP accredited, only utilizing the primary for a few necessary rotations, or that the affiliate would rely on the primary program for accreditation and program direction/management. The goal is that all pathways in Figure 1 could become CAMPEP-accredited clinical training opportunities through such a mechanism. Because of widely varying policies and procedures at different institutions, allowing both limited and dependent affiliations provides the largest solution set for success.

Figure 2a indicates how the complex pattern from Figure 1 can be simplified so that no one is left out of the candidate pool. There is only one pathway, regardless of how the individual received initial graduate training. In every case the individual must go through a clinical medical physics residency and then sit for the certification exam. This will be the desired route expected in the United States Department of Health and Human Services text associated with the implementation of the CARE bills.

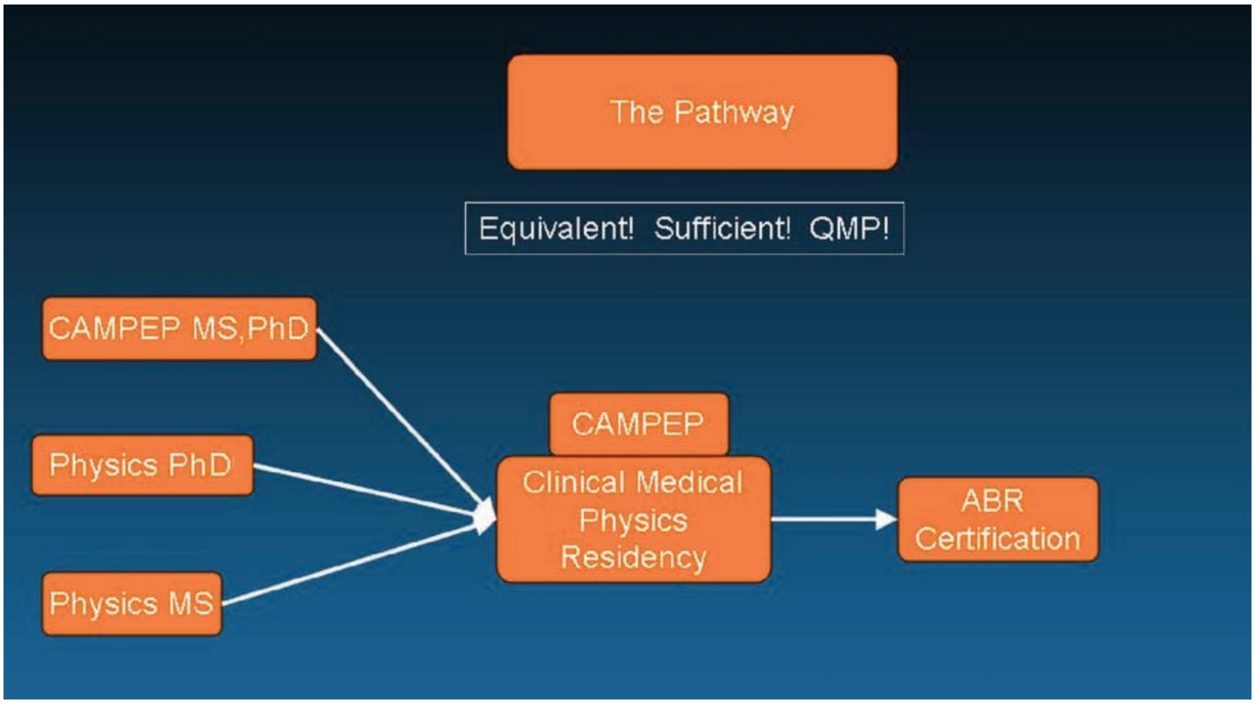

Figure 2a. One equivalent and sufficient pathway for training.

Figure 2b gives further detail about the residency box. Each of the models discussed previously is a component of the box. Equivalent, structured training pathways for clinical medical physicists can be achieved for all entering individuals. The conventional residency and either of the two affiliate residency options both satisfy CAMPEP requirements for accreditation directly. As noted, the amount of material delivered in the affiliate versus the primary program is flexible to the needs of the programs and is clearly defined in contract language and CAMPEP documents. The ABR and AAPM recommendation of having CAMPEP-accredited clinical training as prerequisite for certification is achieved. **It is likely that MS and PhD graduates from CAMPEP-accredited graduate programs would be the preferred candidates for many affiliate residency programs (yellow arrow in Figure 2b), as they would have completed the didactic training requirements of AAPM Report 79 and potentially some clinical experience requirements of Report 90 prior to entering residency.** The pathways shown thus far fully cover OJT and both residency options from Figure 1, which according to the MPRTP survey account for 86% of the total existing pathways. The postdoctoral option should not be neglected and could still be included in either of the models by making certain that the essential material of Report 79 and Report 90 are delivered and documented during the training period (e.g., ~3-yr fellow). (Clearly this is possible at an institution that has both residents and postdoctoral students if they choose to do it.) **This model could assure that all medical physicists pass through structured, accredited training programs prior to sitting for the boards.** In other words, every person entering the field of medical physics with clinical intent/aspirations would have the opportunity to receive accredited clinical training.

It is expected that all of the required materials within AAPM Report 79 (didactic medical physics education)[6] and AAPM Report 90 (clinical medical physics residency training)[5] will be accomplished through a combination of graduate and residency training programs. It is also expected that this will be thoroughly documented. The materials that cannot be covered at

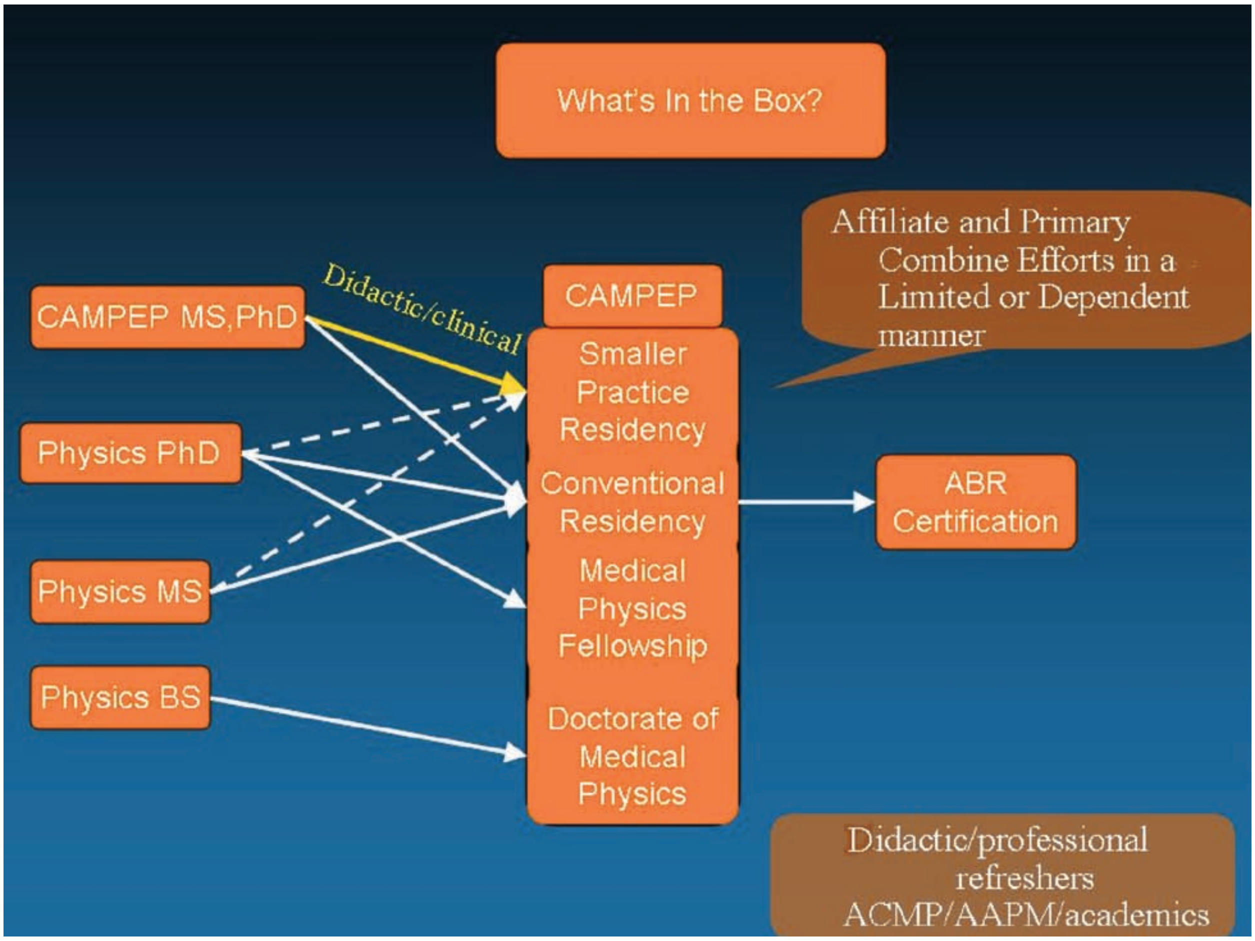

Figure 2b. Detail of the Clinical Residency.

the affiliate shall be covered at the primary site. The necessary elements to provide adequate infrastructure and documentation to receive CAMPEP accreditation are reviewed in detail in sample documents in the appendices.

It is also necessary that didactic medical physics training be accommodated. This likely will either be achieved through a medical physics graduate program (accredited) or within a primary program that offers such training. If some or the entire didactic component is provided during the clinical residency program, it will likely add additional time to the overall resident training program. TG133 will discuss some issues and resolutions to the CAMPEP accreditation application procedure to allow affiliate programs to achieve accredited status, without reducing the quality of medical physics clinical training. These are reviewed in detail in sample documents for affiliation agreements. These, along with a sample CAMPEP accreditation self-study are provided in the appendices as templates, for easy adoption. Appendix A is a sample of the limited affiliate contract. Appendix B is an example of a dependent affiliate contract. The sample CAMPEP self-study document and attachments are given in appendix C and its exhibits A–I.

The DMP option is shown as a pathway following a Bachelor's degree in Figure 2b. While this model requires further development, a 4- to 5-year program, combining a Master of Science medical physics degree with an accredited clinical residency could be appropriate.

The results of the MPRTP survey suggest that the mechanisms shown in Figure 2a,b can succeed and supply the necessary number of properly trained medical physicists to meet demand.

VI. Results of the MPRTP Survey

The AAPM BOD directed the MPRTP to conduct a survey to understand the distribution of current training mechanisms for clinical medical physicists. The survey was distributed electronically May 7, 2007.

Just over 700 individuals were identified as chief, director, or otherwise a leader of a medical physics group. As of May 15, 2007, 120 individuals completed the survey; after dropping duplicates and contributions from outside the United States and Canada, there were 115 surveys completed. The task group recognizes that a shotgun approach is not necessarily complete or demographically accurate and likely represents a bare minimum of existing training "programs."

Demographics

Of respondents, 85% train in therapy, 10% in diagnostic imaging, and 5% in nuclear medicine.

Training Mechanisms/Pathways

Overall, 54% report OJT as their training method, 18% non-accredited residency, 15% postdoctoral, and 13% accredited residency (all 14 current accredited sites).

Why Not Accredited?

Of respondents, 70% suggested that accreditation was too difficult, they did not have all the necessary resources/training or did not even know about CAMPEP accreditation. (TG133 will address all of these issues.) Those individuals with OJT would not have considered normally applying under old CAMPEP application rules.

Would you use TG133 (a well-defined alternate clinical pathway)?

Of the respondents, 72% said they would take advantage of TG133 pathway (over half of these said extra funds would be necessary, and 14% said they would seek accreditation on their own).

Only 11% suggested they would not utilize TG133 or try to seek accreditation in any way at all.

Current and Potential Trainee Production

Currently, 109 individuals per year are being trained in the programs operated by survey respondents. With some extra resources, 130 would be trained. If the TG133 affiliate mechanism were in place, an additional 77 individuals for a total of **207** trained clinical medical physicists would be produced annually and be able to enter the workforce. Of the respondents, 52% said they would not need additional resources (beyond funds).

Funding

The survey indicated that 73% favored funding at the Post Graduate Year, first year (PGY1) residency level. OJT training if paid at PGY1 would make additional funding available for these programs. (Note that PGY levels are nationally established for medical residencies and fellowships and should be consistent for medical physicist residents and fellows as well.)

VII. Economics

Since over 50% of the respondents of the survey suggested that OJT was the mechanism by which they were providing clinical training, the funding for these positions is already in place. A majority of respondents also suggested that the compensation for a resident should be consistent nationwide at the Post Graduate Year level common to current residency programs. This allows additional funding for infrastructure or additional trainees.

AAPM, Radiological Society of North America (RSNA), and American Society for Therapeutic Radiology and Oncology (ASTRO) have all promised funding toward medical physics residencies. The task group feels that this funding should be properly focused to assist existing programs in training additional clinical medical physicists. The task group recommends that MPRTP further specify this.

The Centers for Medicare & Medicaid Services (CMS) have available reimbursement at the hospital level for training of allied health individuals. Documentation is available on the CAMPEP website (http://campep.org/summary.asp). In 2001, Medicare [HCFA (Health Care Financing Administration) at that time, now CMS] applied regulations for Allied Health (Nursing) to Medical Physics Residency programs. The main provisions for receiving payment are CAMPEP accreditation and operation by the providers (hospital). Some institutions have been quite successful in working with their Medicare intermediary to receive payment, typically through the hospital Graduate Medical Education (GME) office. Other facilities may have trouble due to the definition of *provider*. The ideal path would be to have Medical Physics recognized as a medical specialty, though this is unlikely.

VIII. Summary and Recommendations

Patient care is paramount in the practice of medical physics. Properly trained medical physicists are essential to high-quality medical care. The CARE bill requires minimum training and qualifications for individuals to practice medical physics. The ABR certifies medical physicists and desires that all candidates receive consistent training in a CAMPEP-accredited clinical residency program. AAPM supports this desire.

CAMPEP accredits medical physics education programs and desires guidance on what standards and guidelines medical physics clinical training programs should meet. AAPM provides these guidelines in Reports 90, 79, and 133 (this report). Based on the needs and the MPRTP survey, the affiliated clinical residency program (in either affiliation type) may be able to provide the necessary quality training and the number of medical physicists required to meet the ABR 2012 goal. Much of the needed funding is actually in the system now. This provides the necessary bolus of CAMPEP-accredited clinical training to meet the needs for high quality patient care.

TG133 recommends that:

- CAMPEP accept the affiliated accreditation guidelines suggested by TG133 (which may require some flexibility in the affiliated programs; see appendices).
- All clinical training programs—residency, postdoctoral, OJT, graduate—should consider applying for CAMPEP accreditation through this mechanism.
- Existing accredited academic centers agree to affiliate relationships to foster and facilitate standard, high-quality training.
- AAPM, RSNA, ASTRO, and other organizations provide supplemental funding to support faculty/facility enhancements or to defray accreditation costs (probably for existing and newly accredited programs). This task group proposes that MPRTP form a working group to make recommendations.
- Certain didactic content be offered by AAPM and/or ACMP (e.g., radiobiology, anatomy/physiology, clinical oncology, etc.) at refresher courses at national meetings. Further, that on-line education for some of this material should be developed. This task group proposes that MPRTP recommend to its parent committee Education and Training of Medical Physicists (ETC) an action item in this regard.
- Special attention be given to the number of diagnostic imaging and nuclear medicine programs and assistance be given to develop affiliations.
- A working group or task group within MPRTP be formed to address the development of detailed guidelines for the Doctor of Medical Physics programs.
- Time Frame for Implementation: TG133 believes that the affiliate mechanisms for accredited training can be implemented now. By 2008, examples of these programs will have come into existence. To meet the ABR 2012 timeline, residents would have to be entering an accredited program by 2010. Between now and 2010, the affiliate programs and their accreditation will ramp up to provide the necessary training. TG133 believes the process and finances are available to allow this to happen.

It should be noted that individuals enrolled in a CAMPEP-accredited graduate program may enter the ABR process (Part 1) at any time prior to 2014 and be "in process" before 2014, and thus be grandfathered and not have to graduate from residency to sit for the ABR (2014 dictated for CAMPEP graduate program graduates November 2007).

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X. Appendices

The appendices consist of examples of agreements and forms. In every case, commentary is italicized and is not necessarily to be taken as part of the example. The affiliation agreements represent examples only. Legal advice should be consulted prior to an institution's making any legally binding agreements based on these templates.

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Appendix A

Sample Limited Affiliation Agreement

CLINICAL EDUCATION AGREEMENT

This Clinical Education Agreement ("Agreement") shall be effective as of the last date signed below. The parties to this Agreement are ______________________ with an address of ______________________ (collectively, **"Primary"**) and ______________________, a corporation of ______________________ with an address of ____ (**"Affiliate"**).

WHEREAS, Primary desires to provide clinical experiences for residents in Clinical Medical Physics; and

WHEREAS, Affiliate sponsors a graduate medical education program in Clinical Medical Physics (Radiation Oncology) ("Program"); and

WHEREAS, Primary and Affiliate believe their respective programs will be enhanced by Affiliate's residents rotating through Primary's clinical site(s).

NOW, THEREFORE, Primary and Affiliate agree as follows:

1. **Resident Training.**

(a) Primary shall arrange for a six week rotation for Affiliate residents (the "**Residents"**) at its clinical site(s). The rotation will be in compliance with the requirement of the Commission on the Accreditation Medical Physics Education Programs (**"CAMPEP"**). The educational goals and objectives for the rotation are set forth in Exhibit A and Exhibit B hereto, which is incorporated by reference and which may be amended from time to time by Affiliate upon written notice to Primary.

(b) Primary shall provide the clinical facilities and equipment reasonably necessary for the Residents' clinical experiences and allow reasonable use of medical libraries, classrooms and conference rooms, as mutually agreed.

(c) All medical physics services provided by Residents shall be under the direct and exclusive supervision and control of the medical physics staff having practice privileges at Primary. The medical physics staff of the Division of Medical Physics, Department or Radiation Oncology will specifically be responsible for the teaching, supervision and evaluation of the Residents assigned to Primary under this Agreement.

(d) The medical physics staff at Primary will assume administrative responsibility for the Residents while on rotation.

(e) Affiliate agrees to designate for participation in the programs covered by this Agreement only Residents who are in good standing with their respective institutions.

(f) Primary reserves the right to terminate or suspend a Resident's participation in a clinical affiliation provided for under this Agreement when the Resident is unacceptable, in Primary's reasonable discretion, for reasons of health, performance or other good cause related to quality patient care. Primary shall not be arbitrary or discriminatory in the exercise of this right.

(g) Primary assumes full responsibility for the care of its patients. It is understood that individual patient care is not covered, supervised or paid for by Affiliate and Affiliate does not derive direct revenue from patient care activity at Primary.

(h) Affiliate shall ensure that its faculty and Residents meet minimum health standards. Upon request, Affiliate shall provide Primary with a current health status report for each of its Residents prior to beginning the rotation through Primary. The health status report may include, without limitation, (1) proof of immunity or immunization for measles, mumps and rubella, (2) proof of current diphtheria/tetanus immunization, (3) proof of immunity or immunization for varicella, (4) documentation of TB screen, (5) documentation of Hepatitis B antibody screen or signed declination statement, (6) date of last complete physical exam and (7) when appropriate for the specific rotation, documentation of completed background studies and drug screening. The costs for pre-rotation screenings (including criminal background reports and drug tests) are the responsibility of the Residents and/or Affiliate.

(i) Affiliate shall ensure that each Resident maintains health insurance throughout the entire term of their training at Primary. Affiliate agrees to provide Primary with evidence of each Resident's health insurance coverage prior to such Resident's participation in the training at Primary. Resident shall be furnished emergency medical care and treatment, if needed, while on duty at Primary with the associated expense to be the responsibility of the Resident.

2. Policies and Procedures Governing Residents. Residents enrolled in the program rotation covered by this Agreement will be governed in accordance with the policies and procedures established through Affiliate's residency programs. Residents shall also follow applicable Affiliate policies and procedures while completing their rotation.

3. Stipend and Additional Costs.

(a) Affiliate shall provide stipend and medical benefits to its Residents in accordance with its own policies and procedures.

(b) Primary will not provide a stipend either in the form of pay or in kind to the Residents for services provided under this Agreement.

(c) Comment: Fees to primary for affiliate may be considered: if so, the following may be indicated:

a. AFFILIATE shall pay a fee of $XXXX per year to Primary. This fee shall cover all costs related to training provided by Primary, including but not limited to internet coursework, time commitments by Primary professors and staff, and laboratory or other on-site work needed on the Primary campus.

4. Insurance.

(a) Host Institution will provide and maintain insurance as described below:

(i) Professional liability insurance (or comparable coverage under a program of self-insurance) providing coverage on an "occurrence basis" for occurrences during the term of this Agreement with limits no less than $1 million per occurrence and $3 million aggregate.

(ii) Comprehensive general liability insurance (or comparable coverage under a program of self-insurance) providing coverage on an "occurrence basis" for occurrences during the term of this Agreement with limits no less than $1 million per occurrence and $3 million annual aggregate.

All such insurance shall be provided by carriers reasonably acceptable to Affiliate, and shall not be modified or terminated except upon thirty (30) days prior written notice to Affiliate. Prior to assignment of any Residents pursuant to this Agreement, Primary will provide Affiliate with a certificate of insurance evidencing the above-stated coverage.

In the event any "claims-made" policy is procured to meet the insurance requirements hereunder, "tail" coverage shall also be procured for a period of four years after termination of such policy.

Each party is solely responsible for any of its own claims, causes of action, liabilities or the like that may arise out of this Agreement. Furthermore, neither party shall compensate the other party for any of the foregoing. The terms of this section shall survive expiration or termination of this Agreement.

5. Independent Contractors. Each party is a separate and independent institution, and this Agreement shall not be deemed to create a relationship of agency, employment, or partnership between or among them. Each party understands and agrees that this Agreement establishes a bona fide training relationship and that the agents or employees of each respective party are not employees or agents of the other party.

6. Term. This Agreement shall be effective as of the last date signed below, shall continue for one (1) year and is automatically renewed for subsequent one year terms unless terminated by either party by written notice provided at least ninety (90) days prior to the commencement of the ensuring year term.

7. Termination. Either party may terminate this Agreement for any reason by giving at least ninety (90) days written notice to the other party.

8. Amendments. This Agreement may be amended from time to time in writing by the written agreement of the parties.

9. Notices. Whenever written notice is required or permitted to be given by a party to the other, such notice shall have been deemed to have been sufficiently given if personally delivered or deposited in the United States Mail in a properly stamped envelope, certified or registered mail, return receipt requested, addressed to:

For Primary	For Affiliate
____	____
____	____
____	____
____	

With copy to:

Legal Contract Administration
Primary ______________________
____

10. Health Insurance Portability and Accountability Act.

(a) For purposes of compliance with the Health Insurance Portability and Accountability Act and associated privacy regulations (**"HIPAA"**), Residents shall be considered part of Primary's work force as that term is defined in HIPAA to include trainees and students. Primary shall provide the necessary training specific to HIPAA.

(b) Both parties will permit, on reasonable request, the inspection of clinical and related facilities by the other party and government agencies charged with the responsibility for accreditation of the Graduate Medical School Program. It is understood that both parties will authorize CAMPEP to access identified medical information to the extent required for the purposes of accreditation.

11. Use of Name. No party shall use the name, logo, or likeness of another party, or another party's employee or agent, in any publicity or advertising material without such other party's express prior written consent; however, the existence and scope of the programs available via this Agreement may be made known to Residents as a means of assistance in completing their training requirements.

12. Assignment. No party has the right or the power to assign this Agreement, in whole or in party, without the prior written consent of the other parties, and any purported assignment in contravention of this provision shall be null and void.

13. Governing Law. This Agreement shall be construed in accordance with the law of the State of ______________________ .

14. Enforceability and Waiver. The invalidity or unenforceability of any term or provision of this Agreement shall in no way affect the validity or enforceability of any other term or provision. The waiver by a party of a breach of any provision of this Agreement shall not operate as or be construed as a waiver of any subsequent breach thereof.

15. Non-exclusive Agreement. Each party may enter into similar agreements with other training institutions, provided that such agreements do not materially interfere with the ability of each party to carry out its obligations hereunder.

16. Compliance with Laws. Each party shall comply with all federal, state and local laws and regulations applicable to their respective operations, including, but not limited to, those dealing with employment opportunity, immigration and affirmative action such as 42 U.S.C. Sec. 2000 (e) et seq., The Civil Rights Act of 1964, Sections 503 and 504 of the Rehabilitation Act of 1973, Section 402 of the Vietnam Era Veterans' Readjustment Assistance Act of 1974, the Immigration Reform Act of 1986, the Americans with Disabilities Act of 1990 and any amendments and applicable regulations pertaining thereto.

17. Indemnification. Each party (the "Indemnifying Party") shall indemnify, hold harmless and defend the other (the "Indemnified Party") from and against any third party claim and any loss, cost, liability or expense of a third party claim (including costs and reasonable fees of attorneys and other professionals) which the Indemnified Party suffers resulting from such third party claim that is directly attributable to the Indemnifying Party's gross negligence or willful misconduct in its performance of this Agreement. The terms of this section shall survive expiration of this Agreement.

18. Entire Agreement. This Agreement represents the entire agreement between the parties with respect to the subject matter hereof.

19. Authority. The persons signing this Agreement warrant that they have full authority to do so and that their signatures shall bind the parties for which they sign.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the respective dates written below.

PRIMARY CLINIC ______________________	**(Insert name of Affiliate)**
By: ______________________	By: ______________________
Name: ______________________	Name: ______________________
Title: ______________________	Title: ______________________
Date: ______________________	Date: ______________________

By: ______________________

Name: ______________________

Title: ______________________

Date: ______________________

Sample Limited Affiliation Agreement

Exhibit A

ROTATION GOALS AND OBJECTIVES

As stated in AAPM report 90, "The objective of the radiation oncology physics residency training program is to educate and to train physicists to a competency level sufficient to practice radiation oncology physics independently." That statement summarizes the goal of both the Affiliate Program and the Primary Program in forming a partnership to support a radiation oncology physics resident at affiliate.

The Primary medical physics residency program is accredited by the Commission on Accreditation of Medical Physics Educational Programs (CAMPEP). There are very specific training guidelines required for CAMPEP accreditation, which are essentially the recommendations listed in AAPM Report 90. Additionally, a medical physics resident shall have didactic training as detailed in AAPM Report 79.

Those aspects of residency training required for CAMPEP accreditation which cannot be met solely at affiliate, and for which it is desired for the resident to gain through a rotation at Primary are:

Intra-operative radiation therapy
Total skin electron therapy
Interstitial brachytherapy (LDR and/or HDR)
Prostate seed brachytherapy

Details of the rotation topics are given in the outline below. (*Comment: THESE ARE NOT ABLE TO BE DONE AT THE AFFILIATE AND ARE NEEDED TO BE DONE AT PRIMARY.*)

A. Intraoperative radiation therapy
   I. Treatment planning and delivery
   II. Shielding/architectural considerations
   III. Calibration and Quality Assurance
B. Total skin electron therapy
   I. Treatment planning and delivery
   II. Treatment techniques and patient assist devices
   III. Patient specific dosimetry
   IV. Shielding/architectural considerations
C. Interstitial brachytherapy (LDR and/or HDR)
   I. Dose delivery mechanisms
   II. Radionuclide charact**eristics**
   III. Treatment planning
   IV. Treatment delivery
   V. Quality Assurance of LDR and HDR equipment and processes
   VI. Radiation safety aspects
D. Prostate seed brachytherapy
   I. Radionuclide characteristics and selection
   II. Treatment planning
   III. Implant procedure
   IV. Imaging aspects
   V. Radiation safety aspects

Sample Limited Affiliation Agreement

Exhibit B

CLINICAL PHYSICS EDUCATIONAL ACTIVITIES

Opportunities to participate in clinical physics educational activities will be extended to the affiliate residents when practical. These include clinical physics conferences, lectures and in-services. These may be done by video or teleconference capability and will be arranged by the respective mentors.

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Appendix B

Sample Contract for Medical Physicist Residency Position Affiliation

AGREEMENT

This agreement is made this ______ day of ______ , 2008, by and between ________________ , a corporation of ________________ (hereinafter referred to as “Affiliate”), and ________________ , a corporation not for profit of ________________ (hereinafter referred to as “Primary”).

WITNESSETH:

WHEREAS, Primary wishes to place a radiation physicist resident in Affiliate for the duration of the residency; and

WHEREAS, Affiliate is able and qualified to accept the appointment of a resident; and

WHEREAS, Affiliate desires to provide such services to Primary as an Affiliated residency training site in accordance with the specific terms and conditions hereinafter set forth.

NOW, THEREFORE, in consideration of the premises and of the mutual covenants and promises herein contained and for other good and valuable consideration, it is agreed as follows:

1. **Responsibilities of Affiliate.**
Comment: The employment status of the resident could be at either primary or Affiliate and agreed to in this contract. Even the amount of time the individual is at each program site should be specified.
The resident shall be an employee of Affiliate and will enjoy the benefits of a full time employee. In addition, Affiliate will provide clinical radiation oncology physics training in conjunction with Primary per the terms in the attached accreditation documents *(CAMPEP self-study, etc.)*. In addition:

- The policies, rules, and regulations that apply to Affiliate employees shall apply to the resident.
- Affiliate will pay the full salary of the resident, and will set the salary level.
- Affiliate will provide a recognized primary mentor for the resident. This position shall be filled by a person certified by the ABR in Therapeutic Radiological Physics (or equivalent).
- With the agreement of the resident and Affiliate, the resident may gain permanent employment with Affiliate at the conclusion of the residency, or two years after the start date of the residency, whichever comes first.
- Provide the resident with professional and medical education opportunities, such as meetings and conferences. An allowance of five business days and $1500 per year shall be available for such activities.
- Affiliate may, but is not obligated to, provide funding for moving expenses.
- Affiliate will provide typical work-related supplies (e.g., paper, pens, work computer (including software, internet access), physics equipment).

2. Responsibilities of Primary.

- Provide assistance/sponsorship in the process of CAMPEP accreditation/acceptance of the Affiliated residency position.
- Primary will provide access to training staff not available in Affiliate (e.g., radiobiologists, radio-pharmacists).
- Primary will provide access to their library and journal resources, both through Internet accounts and on-site, to the resident and training staff at Affiliate.
- Primary will provide access (live or recorded) to patient conferences, physics conferences, and Primary staff conferences where resident attendance is required.

3. Responsibilities of the Resident.

- The resident shall be responsible for all standard living costs (room, board, transportation) while in the residency position.
- The resident shall be responsible for all costs associated with required visits to the Primary campus.
- The resident shall be responsible for all sply costs associated with residency coursework (e.g., paper, pens, home computer (including software and Internet access), presentation materials)

Comment: By agreement, Primary or Affiliate could fund some or all of these costs.

4. Fees and Associated Costs.

- Affiliate shall pay a fee of $XXXX per year to Primary. This fee shall cover all costs related to training provided by Primary, including but not limited to Internet coursework, time commitments by Primary professors and staff, and laboratory or other on-site work needed on the Primary campus.

5. Terms and Conditions.

The residency position shall begin on _____________ (date).

The residency may be terminated only by Primary. With sufficient justification, Affiliate has the right to refuse access to Affiliate facilities and terminate employment with Affiliate. This decision is the sole right of Affiliate. Upon termination by Affiliate, Primary would have the right to continue the residency training at the Primary campus, or to terminate the position.

The selection of the person to fill the Affiliated residency position at Affiliate will be a cooperative project of Affiliate and Primary. Either party may refuse the selection of a candidate to the residency position. Both parties shall agree to the final selection. Recruitment for the position may be performed by either party, but all applicants must formally apply for the residency position through Primary.

This agreement, which shall be governed and applied solely under the laws of the States of _____________ and_____________ , shall not be altered or modified except in writing duly executed by the parties hereto.

Comments: Many of the exact details of how and where and by whom the resident is trained must be specified in the self-study document. Which rotations are done at Affiliate and which at primary? Who are the rotation mentors, etc. See appendix C.

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Appendix C

Sample/Template CAMPEP Application Self-Study: TG133

Whether the affiliation is limited or dependent, the Primary medical physics residency program is already accredited by the Commission on Accreditation of Medical Physics Educational Programs (CAMPEP). There are very specific training guidelines required for CAMPEP accreditation, which are essentially the recommendations listed in AAPM Report 90. Additionally, a medical physics resident shall have didactic training as detailed in AAPM Report 79. The Self-Study is the significant document in an application for CAMPEP accreditation and indicates how all necessary training, administration and documentation are carried out in the program, including specifics for any affiliations. Regardless of the affiliation agreement or exact training model, the expected training is complete and consistent (per the description in TG133 main text).

This outline/template/sample is based directly on the current version of the CAMPEP guidelines for clinical residency accreditation describing the self-study.[1] Pages 10–18 provide a detailed description of each required component. Reading the self-study description and following the example below will make the application process and the management of the residency program straightforward.

Comments in italics are inserted where further explanation is warranted.

I. PROGRAM GOAL AND OBJECTIVES

Clinical training of medical physicists in medical physics (radiation oncology, diagnostic imaging or nuclear medicine) in preparation for ABR certification and independent practice in medical physics.

Comment: The essential expectation in a residency program is that the resident shall be assigned full-time to clinical education duties. For a minimum 24-month program, full time commitment to the residency training would be necessary. There may be situations where some clinical duties may be required, and these serve to expand clinical experience. They may however cause the program time to be extended. In any case, the key factor is that all necessary training is accomplished and documented.

II. PROGRAM EVOLUTION AND HISTORY

Comment: The evolution and history should refer to the entire entity requesting accreditation. In the case of affiliation, the type of affiliation and history of relationship should be stated as well as the training history each of the primary and affiliate program.

A. History of Primary–Affiliate Program Relationship

The relationship between the Affiliate and Primary programs is based on the limited affiliation model of AAPM Task Group 133. A contract for a limited set of rotations necessary to provide complete training has been developed and signed (date) (and attached). *Comment: What is written and included here will depend on whether the affiliation is limited or dependent.*

B. History of Primary Program

The primary program at ________________ began in 1998 and has graduated seven residents since that time. This program was accredited by CAMPEP in 2003. The current program director is ________________ .

C. History of Affiliate Program Training
The Affiliate institution opened its first clinical practice in 2001. To date, no formally documented clinical residency training has occurred. However, within this practice (and within practices in the same organization), junior physicists have been trained over the years. The affiliate is striving to provide the highest quality training in an accredited environment and has thus created a residency position on its staff, for the purpose of accomplishing this goal.
Comment: Any training history would be appropriate to list here. The history of the clinical practice would also be of use.

III. PROGRAM STRUCTURE AND GOVERNANCE

Comment: The specific response here will be based on the type of program, conventional, primary, A. limited affiliation, B. dependent affiliation.

A. Program Organizational Structure—*for a limited affiliate*
1. The residency position is funded and exists entirely within the affiliate program.
Comment: Some guidance and review by primary could be discussed here.
2. The essential management of the program resides within the Affiliate, with limited ties to the primary program for specific rotations and educational needs (see for example Appendix A, Exhibits A and B).
3. The affiliate residency program resides within the Department of Radiation Oncology in ___________ hospital.
4. The primary residency program resides within the Graduate School of Medical Education in the Department of Radiation Oncology at ___________ institution.

Comment: Additional administrative structural details should be filled in here for 3 and 4 above. This should include reporting structure for the affiliate program director. If faculty appointments for affiliate exist at primary or vice versa, these should be listed here. Many of these details will be in the affiliate contract language (Appendix A) and can be referenced if attached.

B. Program Organizational Structure—*for a dependent affiliate*
1. The residency position and Affiliate Program is developed through and administered by the Primary Program.
2. The primary mentor at the Affiliate Program shall be ___________, who assumes responsibility for all aspects of the residency position at the Affiliate, under guidance and supervision from the primary program director.
3. The primary residency program resides within the Graduate School of Medical Education in the Department of Radiation Oncology at ___________ institution.
4. The affiliate residency program resides within the Department of Radiation Oncology in ___________ hospital.

Comment: Additional administrative structural details should be filled in here for 3 and 4. This could include reporting structure for the primary and affiliate program leaders. If faculty appointments for affiliate exist at primary or vice versa, these should be listed here. (These may also be detailed in Appendix B)

C. Program Director
1. The Primary Program Director is ___________. ___________ directs the medical physics clinical group.
2. The Affiliate Program Director/primary mentor is ___________ .

IV. CURRICULUM

A. Requirements for Completion

1. The clinical training objectives are those set forth by AAPM Report 90 and CAMPEP requirements. These will be completed and documented for successful completion of the program. They are engaged in an orderly fashion as outlined in Exhibit A.

   Comment: This is a sample training schedule, which can take many forms. For individuals who require more didactic training and/or are doing concomitant research, the program schedule will be spread over a longer time period. For affiliate programs, the schedule should indicate which rotations are occurring at the affiliate and which occur at the primary site.

2. The program training length may be 2 or more years (but not to exceed 5 years). Evaluation of the resident with respect to residency completion is content and competency based. However, depending on whether the incoming trainee has completed a full set of didactic medical physics training, additional work may be required. In addition, if the individual is expected to participate in research, the competencies described in Report 90 must still be accomplished and will require additional time. For a graduate of a medical physics MS or PhD program, it is expected that all requirements should be fulfilled in 2 years.

   Comment: The time limit of 5 years is to protect the trainee from not being abused for low-pay clinical duties.

B. Design and Content

1. The schedule for residency training is to guarantee that the objectives of AAPM Report 90 are met. Specific objectives for this residency program are shown in Appendix C, Exhibits B1 and B2).

   Comment: These again are samples, adapted from existing programs. Details from one site to another will differ substantially. For the rotation objectives, contacting existing program directors will be greatly beneficial for further details. How the training is shared between affiliate and primary should be clearly indicated.

2. Conferences, seminars, etc., are available to the resident and are summarized in Appendix C, Exhibit C.

   Comment: These may all be at the primary or affiliate site, or at times at one or the other. In any case, mechanisms for the resident to have access to these educational resources should be described. Virtual attendance would be acceptable if audience interaction is preserved.

3. If a resident is absent from a large number of the above scheduled activities (especially during the first year), the primary mentor will investigate and encourage better attendance.

C. Sample Training Plans

1. Objectives, consistent with AAPM Report 90 and CAMPEP requirements are detailed in Appendix C, Exhibits B1 and B2.
2. Quarterly and Rotation Oral Evaluation forms are attached as Appendix C, Exhibits D1 and D2.

   Comment: These are blank, but are simple templates to be used or modified.

3. Didactic education, as necessary, is delivered through:
   Comment: Whichever of these is needed, should be coordinated through the program. If the resident is at an affiliate location and requires some of these, the mechanism by which it is delivered must be specified. Below is a list of possible didactic solutions. It is likely that a nearby graduate program can also provide some of these and that there may be on-line resources useful as well.
   (a) Anatomy for Therapy Students: Offered annually, given by anatomy instructor, one- or two-semester course. (Contact Radiation Therapy (RTT) program director.)
   (b) Radiation Biology: Offered biannually, two-week intensive course with a consultant expert radiobiologist (scheduled departmentally).
   (c) Radiation Oncology Physics for residents: year-long course taught to medical and physics residents by the medical physics faculty.
   (d) Radiation Oncology physics graduate-level courses.
   (e) Basic Radiological Physics graduate course.
   (f) Clinical Radiation Oncology: Annual two-semester course taught by clinical M.D. staff in a site-specific manner in the radiation therapist training program. (Contact RTT program director.)
   (g) Oncology Core Curriculum: A weekly lecture primarily for medical residents. The physics resident should attend those sessions specific to radiation oncology.
   (h) Imaging Physics for Radiology Residents: Course includes basic physics for each imaging modality. (Contact Radiology Physics director.)

D. Evaluation of the Program and Curriculum
1. The program and curriculum are reviewed at least annually by the medical physics program executive committee. Minutes from these meetings summarize changes and commentary on the program.
2. Residents are asked to provide a written evaluation of a specific rotation following the oral exam for that rotation. They are also asked to review the program on an annual basis. Although difficult at times, these documents are considered anonymous and confidential. Further, the program director(s) meet with the residents annually to receive direct feedback on program improvements. A sample of these evaluation documents is attached as Appendix C, Exhibit E.

Comment: Some institutions have internal reviews that can be documented here as well.

3. The Affiliate Program will be given a full review on a yearly basis. This review will:
   (a) Evaluate the effectiveness of the clinical education.
   (b) Evaluate the resources available for clinical education.
   (c) Assure that resident education goals are being met.
   (d) Assure that policies of the Primary Program are being implemented.

Comment: Some description of evaluation of the affiliate portion of the program should be given and No. 3 is a sample.

V. RESIDENTS

A. Admissions
1. Potential applicants are given:
   (a) Description of the program.
   (b) Material routinely provided by the institution.

(c) An official application to be filled out.

(d) AAPM documents on medical physics and access to Report 90.

Comment: Specific documents such as these can be attached as an appendix to the self-study and will differ between institutions and by type of affiliation if one exists. A tally of applicants to the program per CAMPEP guidelines should be kept as an appendix. Affiliate programs may be more restrictive in their applications, only accepting, for example, individuals who have completed CAMPEP-accredited graduate degrees.

2. Admissions Committee is composed of (*list of faculty at primary and as necessary from affiliate program involved in applicant review/decision*). Interview evaluation is carried out during a 1-day interview and documented on an interview form Appendix C, Exhibit F.

B. Recruitment Efforts: Advertisements for qualified individuals are posted in American Institute of Physics (AIP) and AAPM materials.

Comment: If an affiliate program, the sharing of responsibility of the primary and affiliate in terms of application processing should be discussed.

C. Enrollment

Comment: Specific number of trainees at each site should be listed.

D. Evaluation of Resident Progress

1. Resident progress documentation was discussed in IV.C.2 above. In those evaluations panels consist of faculty involved in the rotation or the program and additional guest examiners from the clinical staff who were involved in the training of the resident. The questions/discussion and evaluation of the resident are documented on the forms Exhibits D1 and D2. A minimum of three examiners is necessary for an exam to begin.

Comment: The number needed may be a variable depending on the size of the program.

2. Residents are evaluated quarterly and at the end of each rotation, formally. They are also continuously monitored by their primary mentor in weekly meetings.
3. The failing resident must be assessed and offered assistance as soon as possible. Usually, the first sign of unsatisfactory performance is reviewed with the resident by the primary mentor and a period of heightened awareness is initiated. This typically would begin if an unsatisfactory grade was received on a quarterly evaluation, for example. If improvement is not noted in the near future (by the next quarterly evaluation), probationary status may be used.

Comment: Since each institution has its own employee probation/disciplinary process, the most appropriate version of this process should be explicitly stated/attached to the self-study. Accredited programs could share examples if desirable. In the affiliated programs a clear understanding is necessary as to how probation and discipline are to be carried out between the primary and affiliate organization.

E. New Resident Orientation: Orientation shall include:

1. Program requirements and expectations.
2. Policies and procedures.
3. Environmental health and radiation safety.
4. Additional department specific orientation. An outline is shown in Appendix C, Exhibit G.

Comment: This will vary by institution, but should include institutional orientation as well as department and physics orientation.

F. Safety

It is the institutional policy to provide a safe working environment for its employees and educational program participants. The resident will take part in general safety training during orientation. Further, yearly radiation safety courses are conducted and the residents are required to attend. The standard programs through the institution will be used. Specifics for both the primary and affiliate institution will be given as necessary. This includes radiation monitoring.

VI. PROGRAM ADMINISTRATION

A. Structure within Hospital or Medical Center

Comment: This may/will be different for a conventional or primary program versus an affiliate program, whether limited or dependent. In either case, the hierarchy of administrative reporting should be shown. From the CAMPEP guidelines: "For a single-institution applicant, the roles of the program director, the medical director, the residency steering committee, and any appropriate institutional committees should be stated. For programs that consist of multiple institutions and departments, the role and commitment of each component institution and department shall be explained. In particular the roles and responsibilities of individuals in each participating institution as regards the residency program shall be specified."

B. Role of the Program Director

The Program Director is ______________, who has overall responsibility for the management and administration of the residency program. The program director report to ______________, within the Department of ______________.

Comment: Depending on if an affiliation exists, there may be mentors at the affiliates, named in the primary program self-study (for dependent affiliates). For limited affiliations, there would be a program director on site at the affiliate; however, the relationship with the primary program personnel/director should be specified.

C. Committees and Meetings

The committees responsible for the administration of the clinical medical physics residency program are the Medical Physics Education Program Executive Committee (members…), the Department Education Committee (members…) (or Department Administrative committee). The Program Executive Committee meets at least monthly with documented minutes.

Comment: Specific relationships between primary and affiliates should be described in these committees. Specific attention to how communication between affiliates and primary will be maintained and documentation kept clear and organized. Examples of how this is done might be useful to show. This could be done for example by periodic updates from affiliate back to primary (may be different for dependent versus limited). In a limited affiliation, the affiliate may have its own executive committee with a liaison relationship to the primary. In the case of the dependent affiliation, it might be likely that only one executive committee would exist at the primary site and membership on the committee from each affiliate would be expected.

D. Records Available for Review

1. The maintenance of training records shall be consistent with procedures as outlined by CAMPEP requirements.

2. All records pertaining to residency education committee minutes, resident applications, and resident activities will be retained and made readily available. These include:
   (a) Medical Physics Residency Education committee minutes
      (i) for administrative activities
      (ii) applicant selection activities
      (iii) oral examination activities and results
   (b) Resident applications
      (i) application forms
      (ii) transcripts
      (iii) candidate interview evaluations
   (c) Residents
      (i) training schedules
      (ii) rotation objectives and expectations
      (iii) rotation evaluations
      (iv) examination results
      (v) oral examination evaluations

VII. RESOURCES

A. Staff
   1. See Appendix C, Exhibit H for a full listing of program physicist and dosimetrist staff, including curriculum vitae (CVs).

   Comment: This list will need to be complete for an affiliate program; if limited, then the primary program faculty who will be involved in limited rotation(s) should be listed; if for dependent, then the affiliate program faculty should be listed on the primary roster, with appropriate appointments as necessary.

   2. The number of Board Certified physicists is ______________. The faculty physicist to trainee ratio is ______________.

   Comment: Some use of the primary might be necessary to substantiate both of these (or even other qualified individuals within the institution) to provide a sufficient ratio. Faculty should be considered anyone who is teaching residents (mentors) and not necessarily be based on academic appointment held at an institution.

   3. In the event of the loss of the primary mentor, another board-certified physicist from the program would become the primary mentor.

   Comment: If this is an affiliate program, it would be done in coordination with the primary.

B. Finances
   1. Resident salary will be consistent with appropriate postgraduate training year, national levels. Benefits will be provided and matched similarly.

   Comment: Any specifics associated with an affiliate agreement will be specified in the contractual documents (appendices A and B). It may be specified here who exactly is funding the trainee.

   2. The resident will have time and funding for attending professional conferences.
   3. The resident will have funding allotted for professional dues and journal subscriptions.

   Comment: For affiliate agreements, specifics related to costs incurred by the resident related to rotations at primary should be listed.

C. Facility
   1. Description and availability of clinical facilities. See Appendix C, Exhibit I.
   Comment: This is simply a list of available facilities. In an affiliate situation, this could list combined resources, but it should be clear when the resident has access to which facility and which resources at each.
   2. Specific minimum residency program requirements listed in Report 90 (Epilogue) will be met by a combination of resources at the Primary Program and Affiliate Program sites (through a limited or dependent affiliation).
   3. Library hardcopy and on-line access will be accessible to the residents.

VIII. FUTURE PLANS

A. Summary of Strengths and Needs
Comment: These are self-defined strength and growth areas. It is okay to be candid.
   1. The greatest strength of the Program is ____________________________________.
   2. The greatest need is ____.

B. Further Development and Improvements
   1. Goal 1:
   2. Goal 2:
   3. Goal 3:

Reference

1. Clark, B., et al. CAMPEP Guidelines for Accreditation of Residency Education Programs in Medical Physics. http://www.campep.org, 2006.

Appendix C, Exhibit A   Sample Master Rotation

page 1

Clinical Physics Rotations (in months)   TG133

Trainee NAM

		2005						2006												2007					
Rotation	**Mentor(s)**	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Orientation	Faculty	NAM																							
Dosimetric systems acceptance testing/ commissioning/ QA	Faculty		NAM																						
on call physicist (POD) / Plan Check	Faculty			NAM																					
Treatment machine QA	Faculty	NAM																							
Shielding / room design	Faculty													NAM											
Radiation safety	Faculty											NAM													
Treatment machine ATP, survey, commissioning (see note 1)	Faculty							NAM																	
Treatment machine calibration (TG51)	Faculty							NAM																	
Simulator acceptance testing and QA (Fluoro)B	Faculty									NAM															
Simulator acceptance testing and QA (CT-sim3)B	Faculty											NAM													
External beam treatment planning	Faculty					NAM																			
TPS commissioning	Faculty												NAM												
MU calculations(2 months)	Faculty				NAM	NAM																			
IMRT Planning (2 months and follows ExBeam Tx Planning	Faculty										NAM														
IMRT QA (1 month and follows IMRT planning)	Faculty												NAM												
Special applications (777370,diodes, EPID) before POD	Faculty													NAM											
Stereotactic (Gamma knife / SRT, see note 2)	Faculty														NAM										
IORT	Faculty																	NAM							
Brachytherapy: sources/ calibrations/ safety/ regulations	Faculty															NAM									
Satellite practice rotation	Faculty														NAM										

(1) If a machine is not installed in this time period, then a "mock" ATP & commissioning will be done during the next annual QA in January.
(2) During rotation period, expectations include at least two complete SRT cases, gamma knife QA and annual (2 pp), and 6 patient coverage days on gamma knife.

Rotation window
Didactic instruction
Observation prior to rotation/participation
Responsible window
Responsible and Teaching

page 2

Labs

Generic Template

		2005						2006												2007												2008					
Labs	**Mentor(s)**	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
QA-Linac sessions 1-5	faculty	P1-4	P2	P5	P5																																
QA_Simluator sessions 1-4	faculty	P1,3																	P2,4																		
POD	faculty			P																																	
PlanCheck	faculty			P																																	

P represents didactic or hands on session

Classroom courses (if required)   taken

Anatomy
Clinical Oncology
Dx Imaging
Radiologic Physics

Appendix C, Exhibit B1

SAMPLE ROTATION OBJECTIVES FOR THE RADIATION ONCOLOGY CLINICAL MEDICAL PHYSICS RESIDENCY

Comment: This is ONE example based on an accredited program. There are many variables and methods of meeting Report 90 and CAMPEP guidelines. Treat this as a guide/example.

I. General Objectives

A. Resident is expected to become competent in all areas related to the safe and efficacious use of ionizing radiation as relates to simulation, planning, and treatment of human disease. This is accomplished in part through routine evaluated clinical rotations.

B. Resident is expected to complete structured rotations that include written summaries/reports and/or presentations at the completion of the rotation. Evaluations will occur throughout each rotation in one-to-one and group settings.

C. Resident will present, review, and defend his/her knowledge of a given rotation in an oral-based session with the residency program faculty.

D. Quarterly evaluations will be based on the results of ongoing evaluations and rotation end oral evaluations.

E. Resident is expected to obtain an appropriate mastery of the physical principles (e.g., interactions of radiation in matter, radionuclide decay therapy) associated with the use of radiation in treatment of human malignancy.

F. Resident is responsible for obtaining a level of training in anatomy, computer technology, and diagnostic imaging appropriate for a position as a Radiation Oncology Clinical Physicist. This is primarily accomplished during the clinical dosimetric treatment planning rotation and didactic courses on these topics.

G. Resident will demonstrate knowledge sufficient to ensure she/he can manage the radiation safety aspects of a Radiation Oncology practice.

H. Resident is expected to attend Radiation Oncology Department conferences and Radiation Physics Division meetings and medical physics journal club.

I. Resident will understand the potential uses of and hazards associated with ionizing radiation and high-voltage electronics as used in the practice of radiation oncology.

J. Radiobiological principles of the use of radiation will be understood by the Resident, through both didactic and practical training.

II. Dosimetric Systems

A. Ion Chamber

1. Principles of operation: Resident will be able to describe the theory of operation of an electrometer/ion chamber system. [References: Khan (2003) and Van Dyk (1999).]

2. Uses of cylindrical and parallel plate ion chambers: Resident will learn which tasks are appropriate for various detectors. Detector geometry and size are to be considered.
3. Calibration: Resident will be able to describe the various correction factors required to use an ion chamber as an absolute dosimeter. [References: Khan (2003), Van Dyk (1999), AAPM TG-21 (1983), and AAPM TG-51 (1999)]
4. Commissioning measurements: Resident will perform commissioning measurements to parameterize the operation of a cylindrical ion chamber. The Resident will develop a list of measurements, perform them, and present and interpret the data.

B. Film

1. Principles of operation: Resident will be able to describe the process by which an image is formed on a film, and explain how the system can be used as a dosimeter. [References: Khan (2003) and Van Dyk (1999)]
2. Applications of film: Resident will be able to describe various clinical applications for which film is well suited (and for which it is inappropriate). The discussion will include films of various sensitivities and radiochromic film.
3. Measurements: Resident will be familiar with methods for converting grayscale film images into dose maps. The film scanner and computer software will be used to create an H&D curve and to measure a dose distribution with film. Uses of electronic portal imaging devices (EPIDs) for measurements will also be reviewed.

C. Diodes

1. Principles of operation: Resident will be able to describe the theory of operation of a diode system. [References: Khan (2003) and Van Dyk (1999)]
2. Applications: Resident will describe clinical application of photon and electron diodes.
3. Measurements: Resident will calibrate a photon and an electron diode.

D. TLD

1. Principles of operation: Resident will be able to describe the theory of operation of a thermoluminescent dosimeter (TLD). [References: Khan (2003) and Van Dyk (1999)]
2. Resident will describe clinical application of a TLD system and discuss possible TLD replacement technologies generally available.

III. POD and Plan Check

On call, Physicist of the Day (POD) and PlanCheck are separate clinical duties; however, the Resident/Fellow is examined on both at the same time. Therefore, for the purposes of training, they are considered to be part of the same rotation.

A. POD

1. The POD is the on-call physicist from 7:00 a.m.–5:00 p.m. During the rotation, the Resident will be assigned to shadow the POD for an entire day. The Resident may be excused for a short period of time if there is a conflict (e.g., Resident needs to go to a lecture). However, if the Resident knows that there will be several conflicts, she/he should reschedule the POD training day. As the Resident becomes more familiar with POD duties, the Resident may be asked to carry the POD pager.
2. One of the primary responsibilities of the POD is to be available to help maintain hardware and software operations (linear accelerators, simulators, planning systems, and associated computers) in the clinic. Therapists and dosimetrists will call the POD using a dedicated pager, and the POD is expected to answer the pager during this time period and coordinate fixing the problem. In some cases, the POD may be able to fix the problem themselves; in other cases, the POD may have to ask for assistance. If the POD calls for assistance (e.g., from x-ray maintenance), the POD should remain on the scene (unless called elsewhere) until the problem has been resolved.
3. The POD is responsible for signing off on the morning quality assurance (QA) that is done on each treatment machine and simulator. The Resident will be familiar with any QA software. The Resident should have previously observed morning QA during some of the introductory labs and rotations, so he/she should be familiar with the tests that are done. The Resident should become familiar with the different action levels for the QA tests, and know what needs to be done if a test result is outside of the normal tolerance.
4. The POD is responsible for the weekly chart check for a subset of the patients on treatment. The Resident will be shown how to determine what subset of patient charts needs to be checked, and how the results of the chart check are recorded. The POD physicist will review the chart check procedure with the Resident, and the Resident will be asked to independently review a sample of the treatment charts for a given day. If the Resident finds a problem or sees something unfamiliar in the chart, the Resident will discuss this with the POD before any action is taken. The POD is responsible for independently checking the treatment chart and reviewing any additional findings with the Resident.
5. The POD physicist is not expected to be able to fix all problems for which they may be called. However, they should be able to fix some of the more common problems, and know where to look to find answers to less common problems (e.g., documents on department shared drive, log books, service data base). They can also call on other physicists or the service/vendor support to help if needed.

B. PlanCheck

1. The PlanCheck physicist is responsible for checking treatment plans coming out of dosimetry on a given day. It is standard procedure that all treatment plans are to be signed off by a physicist prior to the patient's first treatment. On any given day, all plans that are completed by dosimetry prior to 4:00 p.m. are the responsibility of the PlanCheck physicist. During the rotation, the Resident will be assigned to shadow the PlanCheck physicist for an entire day. The Resident may be excused for a short period of time if there is a conflict (e.g., Resident needs to go to a lecture).

However, if the Resident knows that there will be several conflicts, he/she should reschedule the PlanCheck training day.

2. When the Resident is first scheduled for PlanCheck, he/she will most likely not have had the external beam treatment planning rotation. Therefore, much of the treatment planning output will be unfamiliar. The PlanCheck physicist or primary mentor and the Resident should go through at least one treatment plan together, going through all of the items that need to be checked. The Resident should become familiar with the current PlanCheck checklist (found in the physics documentation) and how to log errors that are found. After going through a few different types of plans, the PlanCheck physicist will choose a treatment plan that the Resident can plan check using the checklist as a guide. After discussing their findings with the PlanCheck physicist, the PlanCheck physicist will independently check the treatment plan and discuss any differences in findings with the Resident.
3. As the Resident advances in the rotation, he/she will be expected to be able to check treatment plans more independently, discussing any unusual findings with the PlanCheck physicist. If possible, the Resident should attempt to check all plans that are completed on a given day. The exception to this is when a treatment plan is completed on short notice, where there would be a risk of the patient treatment being delayed if the PlanCheck physicist does not have time to complete checking the treatment plan. The PlanCheck physicist is responsible for independently checking the treatment chart and review findings with the Resident.

C. Credentialing Examination

1. After approximately 12 months (18 months for fellows with research responsibilities), the Resident will be examined for both POD and PlanCheck, with the intention of determining if the Resident should be credentialed to take on those clinical duties independently. For POD, the Resident will be expected to know what the POD duties are, how to fix minor problems, and how/where to seek assistance for other problems. For PlanCheck, the Resident is expected to be able to describe the process for checking a treatment plan, explain each of the checklist items, and describe some common problems that she/he has seen, and how they were dealt with.
2. After the successful conclusion of the credentialing examination, the Resident shall be included in the clinical rotation for both POD and PlanCheck for the remainder of the residency (fellowship). In each quarter, the Resident will be scheduled for approximately 4 POD days and 4 PlanCheck days.

IV. External Beam QA

The primary purpose of the treatment machine QA rotation is to become familiar with daily, weekly, and monthly QA of a medical linear accelerator (linac). The rotation consists of four parts, as described below.

A. In phase 1 (approximately 1 month), the Resident is expected to attend lectures on Linear Accelerator Operation and the overall QA program, participate in QA labs designed to familiarize the Resident with safe operation of the linear accelerators, including startup and shutdown procedures, use of service mode, and observation of therapist daily QA. After learning how to operate the linear accelerator, the Resident should perform the daily QA procedure independently and demonstrate the daily QC tests to the medical physicist responsible for the linear accelerator.

B. In phase 2 (approximately 3 months), the Resident will be assigned to a linear accelerator, and will observe (and participate as determined appropriate by the responsible medical physicist, mentor) weekly and monthly QA on that linear accelerator. The Resident should become familiar with AAPM guidelines, as well as any applicable state and/or federal regulations for QA of linear accelerators.

C. In phase 3 (approximately 6 months), the Resident will perform weekly and monthly QA under the mentor's supervision. In the beginning, the mentor will directly observe the Resident performing the QA. As this phase progresses, the mentor will allow the Resident to perform more independently, while reviewing the Resident's results and maintaining responsibility for the QA of that linear accelerator. Near the end of phase 3, the Resident will be credentialed to take responsibility for QA of a linear accelerator independently. The Resident will be expected to be able to describe all aspects of daily, weekly, and monthly QA on the linear accelerator. If a hypothetical problem is found, the Resident is expected to be able to describe the steps that need to be taken to determine if the problem is a result of machine and/or measurement variance, and what may need to be done before the machine is returned to safe operation in the clinic. Assuming successful completion of the credentialing examination, the Resident will proceed to phase 4.

D. In phase 4, the Resident is assigned to a linear accelerator as co-owner, to do regular weekly, monthly, and annual QA on a linear accelerator for the remainder of their residency. The other co-owner physicist will be a senior member of the physics staff that can monitor the Resident's work and help as needed. The Resident is expected to be able to perform the regularly scheduled QA independently.

V. Shielding and Room Design

A. Residents are expected to be able to design treatment room shielding adequate to ensure that environmental levels of radiation do not exceed those permitted by applicable state and federal regulations. This will be done for an appropriate photon beam, including x-ray and neutron shielding requirements.

B. The concept of ALARA (as low as reasonably achievable), cost vs. benefit in this context will be understood.

C. The Resident will understand the current formalism for determining adequate shielding, including all input parameters. The trade-offs between materials, machine placement, restricted areas, and occupancy will all be reviewed.

D. Room penetrations, mazes, and shielding doors will be discussed.

E. The Resident will perform a full set of calculations for a given real or hypothetical room shielding scenario.

F. The Resident will become familiar with shielding for brachytherapy applications, including HDR (high-dose rate) and a hot lab.

G. Pertinent references include:
- NCRP Report 151, Structural Shielding Design and Evaluation for Megavoltage X- and Gamma-Ray Radiotherapy Facilities (Dec 2005)

- Various ACMP and AAPM refresher course slides/handouts on file in your department
- NCRP Report 116, Limitation of Exposure to Ionizing Radiation (1993)
- NCRP Report 107, Implementation of the Principle of As Low As Reasonably Achievable (ALARA) for Medical and Dental Personnel (1990)
- NCRP Report 40, Protection Against Radiation from Brachytherapy Sources (1972)

VI. Radiation Safety

A. The Resident is expected to know appropriate institutional, state, and federal regulations pertaining to the use, storage, transport, and patient and personnel safety relating to ionizing radiation.

B. Resident will participate in at least two annual room surveys (as required by state regulations) of conducting a set of measurements around a linear accelerator vault and its subsequent analyses in order to sustain the claim that no levels are expected to exceed those permitted by applicable state and federal regulations. This will include an understanding of neutron measurements and typical instruments or devices used for measurement.

C. Resident will know how to calibrate and use a survey meter for the expressed purpose of assessing environmental levels of radiation.

D. A knowledge of setting up and running a safety monitoring program for personnel will be demonstrated by the Resident.

E. The Resident must be able to manage the ordering, receipt assay, and disposal of all sources he/she expects to use or would have responsibility for as a Radiation Safety Officer (RSO).

F. The management of patients containing radionuclides must be understood and demonstrated.

G. The Resident should become familiar with radiation area designation and monitoring, as well as event reporting guidelines and regulations.

VII. Treatment Machine ATP, Survey, Commissioning

A. Resident will complete an Acceptance Test Protocol (ATP) for a linear accelerator capable of producing photons and electron treatment beams.

B. The Resident will understand the commissioning process and will be involved in obtaining all radiation beam measurements needed to calculate monitor units as well as provide data for entry into associated treatment planning systems. This will be done for both photon beams and electron beams.

C. The Resident will learn to calibrate all electron and photon beams on a linear accelerator according to the current AAPM protocol (section VIII). They will also be responsible for learning the calibration procedures for low energy x-ray treatment units available in the clinic.

D. Add-on technology such as Electronic Portal Imaging Device (EPID) acceptance and commissioning will be understood and practiced by the Resident.

E. The Resident is expected to familiarize him/herself with troubleshooting treatment machine related problems (hardware and software) and develop the ability to provide reasonable problem solving to the treatment staff.

VIII. Treatment Machine Calibration

A. The Resident will review the TG51 (or current AAPM protocol) calibration protocol [AAPM TG-51 (1999)] and the TG-21 calibration protocol [(AAPM TG-21 (1983). The Resident will be able to describe the TG-51 protocol, and the fundamental differences between the former and current calibration protocols.
B. The Resident will calibrate a linear accelerator (all energies, photons and electrons) independently, but near the time of annual QA of the linear accelerator, using full protocol procedures as if it were a new accelerator beam being calibrated for the first time. The calibration will include an ion chamber intercomparison. The results of the Resident's calibration will be compared to the results from the annual QA.
C. The Resident will be evaluated using an oral examination. The Resident will be expected to describe how to calibrate a linear accelerator beam (electron and/or photon) using the current TG-51 protocol, and how that differs from the previous TG-21 protocol. Results from the Resident's calibration will be presented and discussed in comparison to the annual QA.

IX. Simulator Acceptance Testing and QA (Fluoro)

A. **Basic fundamentals:** The Resident should review basic fluoroscopic imaging concepts during the didactic portion of the rotation, and be prepared to discuss fundamentals of fluoroscopic image acquisition. This should include x-ray tube operation, focal spot, source-to-image distance, heat loading, heel effect, the principles of operation of the imaging detector, and how all of the above affect the image quality.
B. **Simulator operations:** The Resident will learn basic simulator operations through labs and review of the user manual. They should demonstrate familiarity and understanding of all imaging parameters as well as all basic X-ray operations; including tube warm-up, shutdown/start-up, and routine simulation procedures. (*Recommended review material:* “Simulator” Reference Guide)
C. **Simulator QA and commissioning:** Commissioning and quality assurance skills will be developed by the Resident.
   1. *Simulator QA recommendations vs. regulations:* The Resident should become familiar with and be able to discuss AAPM recommendations, state regulations, as well as the program for Simulator QA (daily and monthly QA, commissioning) (*Recommended review material:* State Regulations, Department QA program).
   2. *Simulator daily and monthly QA:* The Resident must obtain a level of skills and knowledge that permits him/her to understand and perform daily and monthly QA tests, as well as troubleshoot problems detected with those tests or reported by users. The Resident will observe monthly QA sessions and perform at least two monthly QA sessions under supervision. Once successfully credentialed, the Resident will independently perform monthly QA on a simulator.

3. *Simulator annual QA:* The Resident is expected to observe annual simulator QA, and to demonstrate during the final oral rotation review an understanding of the types of tests that are performed on an annual basis.
4. *Simulator commissioning:* The Resident is expected to either participate in the commissioning of a simulator if one is installed during the course of the rotation, or to create an outline of all simulator commissioning tests and to perform a subset of each type of test. The Resident should be prepared to demonstrate understanding of simulator commissioning tests during the final oral rotation review.

D. **Simulation software functionality:** The Resident is expected to learn how to perform and support software associated with fluoroscopic simulation.

The Resident should become familiar with and be able to demonstrate during the final oral rotation review an understanding of the functionality and support of the software utilized during simulation, and how the information generated is incorporated into treatment planning and delivery. (*Recommended review material:* Simulation, Instructions for use.)

E. **Clinical procedures:** The Resident should become familiar with both basic and advanced simulation procedures, and be prepared to discuss during the final oral rotation review how fluoroscopic simulation with current tools differs from methods using virtual simulation. The Resident should also be familiar with how the simulator can be used for cone-beam CT (computed tomography), including the effect of the cone-beam CT filters.

F. **Evaluation:** The Resident will be evaluated by an oral examination at the end of the rotation. The Resident must be able to demonstrate an appropriate level of familiarity with the above objectives in order to complete the examination successfully.

X. Simulator Acceptance Testing and QA (CT)

A. **Basic fundamentals:** The Resident should review basic CT imaging concepts during the didactic portion of the rotation, and be prepared to discuss fundamentals of CT image acquisition as well as differences between diagnostic and RT (radiotherapy) scanners during the rotation evaluation. (*Recommended review material:* Bushberg on-line institutional or national learning tools.)

B. **CT operations:** The Resident will learn basic CT operations through labs and review of the user manual, and should demonstrate familiarity and understanding during a mid-rotation Operations & QA credentialing session of all scanning parameters as well as all basic CT operations, including tube warm-up, shutdown/restart, and routine scanning procedures. (*Recommended review material:* CT User Manual)

C. CT QA and commissioning: Commissioning and quality assurance skills will be developed by the Resident.

1. *CT QA recommendations vs. regulations:* The Resident should become familiar with and be able to discuss AAPM recommendations, state regulations, as well as our program for CT QA during the mid-rotation credentialing (daily and monthly QA) and final oral rotation review (QA and commissioning). (Recommended review material: TG-66 [AAPM TG-66 (2003)], State Regulations, Department QA program.)

2. *CT daily and monthly QA:* The Resident will obtain a level of skills and knowledge that permits him/her to understand and perform daily and monthly QA tests, as well as troubleshoot problems detected with those tests. The Resident will observe monthly QA sessions and perform at least two monthly QA sessions under supervision before scheduling a mid-rotation Operations & QA credentialing examination, during which the Resident will demonstrate knowledge and experience with daily and monthly QA as well as CT operations described above. Once successfully credentialed, the Resident will independently perform monthly QA on a CT simulator.
3. *CT semiannual QA:* The Resident is expected to observe semiannual CT QA, and to demonstrate during the final oral rotation review an understanding of the types of tests that are performed on a semiannual basis.
4. *CT commissioning:* The Resident is expected to either participate in the commissioning of a CT simulator if one is installed during the course of the rotation, or to create an outline of all CT commissioning tests and to perform a subset of each type of test. The Resident should be prepared to demonstrate understanding of CT commissioning tests during the final oral rotation review.

D. **Virtual simulation software:** The Resident is expected to learn how to perform and support software associated with virtual simulation.

1. *Virtual simulation software functionality:* The Resident should become familiar with and be able to demonstrate during the final oral rotation review an understanding of the functionality and support of the various software packages utilized during virtual simulation, and how the information generated is incorporated into treatment planning and delivery. (Recommended review material: virtual simulation, fusion, and 4D software user manuals, internal How-To documentation)
2. *Virtual simulation software commissioning/QA:* The Resident should review recommendations for commissioning and QA in the noted reading materials, should outline a program for commissioning and/or QA of virtual simulation, and be prepared to discuss recommendations during the final oral rotation review. [Recommended review material: IAEA 430, TG-53 (AAPM TG-53 (1998)]

E. **Clinical procedures:** The Resident should become familiar with both basic and advanced virtual simulation procedures (multi-field isocentric breast and cranio-spinal axis), and be prepared to discuss during the final oral rotation review how virtual simulation with current tools differs from previous methods using fluoroscopic simulators.

XI. External Beam Treatment Planning

The rotation is divided into four general areas, including (1) orientation, (2) CT-simulation competencies, (3) mock treatment plans, and (4) clinical treatment plans. Objectives for each area are outlined below. As much as possible, the Resident should be immersed in the external beam treatment planning rotation, spending at least 60% of normal working hours working in dosimetry for a total of 6 weeks. While some after-hours work is allowable, working primarily after-hours is discouraged so that the Resident can take advantage of available dosimetrist expertise. It is the responsibility of the primary mentor as well as the Resident to ensure that all areas are covered adequately.

A. **Orientation:** A dosimetrist mentor will be assigned to the Resident for the duration of the rotation, although the assigned dosimetrist may change as the rotation progresses. The Resident's primary mentor will orient the new Resident to general dosimetry procedures including data flow procedures, image retrieval and transfer, and treatment planning systems. The orientation is expected to last no more than 1–2 days.

B. **CT-simulation software:** The Resident will be shown how to use the CT-simulation software to prepare the CT-simulation data for transfer to the treatment planning system. This will include, but is not limited to, the following tasks. The Resident should be able to look at both plane films as well as sectional images and identify relevant normal structures as well as the general appearance of cancer (an anatomy class is taken during the first year of residency). Competency in using the CT-simulation software should be demonstrated by the end of the first week of the rotation.
   1. Using the automatic tools for creating the external contour or internal anatomy (such as lung or spinal cord).
   2. Verifying couch removal and SSD (source-to-skin distance).
   3. Verifying that no unintended changes to the planned isocenter have occurred between the CT-simulation and the transfer to the treatment planning system.
   4. Verifying treatment unit and energy match physician's instructions.
   5. Creating automatic block apertures based on target volumes, and conversion of the aperture to a multileaf collimator (MLC) setting.
   6. Creating and printing reference digitally reconstructed radiograph (DRR) images.
   7. Transfering treatment and/or image information to the treatment planning and/or record & verify systems, as appropriate.

C. **Mock treatment plans:** After completion of the CT-simulation section, the Resident will proceed to developing "mock" treatment plans for single-field, parallel-opposed, and three-field beam arrangements. During this section, the Resident will become more familiar with the treatment planning system without the time pressure of a clinical treatment plan. The effects of energy, wedging, and beam-weighting should be investigated as appropriate. If an appropriate clinical case is available and treatment planning time constraints are reasonable, a clinical case may be substituted. However, it is expected that once the clinical plan is completed, the Resident will use a copy of the plan to investigate changing treatment planning parameters. All mock treatment plans should be completed by the end of the third week of the rotation.

D. **Clinical treatment plans:** Once the Resident is sufficiently proficient in the use of the treatment planning software, clinical cases should be planned for the following sites. In some cases (e.g., conventional head and neck), an appropriate clinical case may not be available during the time period of the rotation. In that case, an appropriate "mock" case or a previously planned clinical case may be substituted. The Resident should monitor upcoming cases so that most of the desired treatment sites can be accomplished with clinical treatment plans.
   - Breast
   - Prostate
   - Lung
   - Head and Neck [conventional, non-IMRT (intensity-modulated radiation therapy)]
   - Pancreas
   - Pelvis/Endometrial
   - Esophagus

- Sarcoma extremity
- Hodgkin's disease (including "Mantle" field treatment technique)
- 3-D brain
- Craniospinal axis central nervous system (CNS)

E. Throughout the rotation, the dosimetry mentor shall complete the Dosimetry Evaluation documenting the competency of the Resident in the following areas. Any additional comments from dosimetry will be noted.
   1. General dosimetry knowledge: has in-depth understanding of the abilities/limitations of dosimetry.
   2. Technical skills: able to complete dosimetry plans with minimal supervision.
   3. Interpretation of information: able to discern and optimize treatment plans.
   4. Communication/presentation of data: able to transmit information to therapist (written and verbal).
   5. Completion of skills log: has well-rounded experience; completed all required skills.
   6. The final element of the external-beam treatment planning rotation is an oral examination. The examiners will include physics faculty as well as dosimetrists familiar with the Resident's work. The Resident should be prepared to discuss the overall treatment planning process, and at least three treatment plans that he/she had personally completed. The Resident should know standard approaches for treatment planning at the various sites, as well as reasons for deviating from standard approaches.
   7. The Resident will be familiar with the linear-quadratic model and be able to estimate if tolerance threshold doses may be exceeded from treatmentplanning information.

XII. TPS Commissioning

A. The Resident will be able to perform acceptance testing of both the hardware and software for a Treatment Planning System (TPS).
B. The Resident will learn and perform commissioning of at least one clinical photon beam and/or electron beam in the TPS.
C. The Resident will understand and be able to perform monthly QA on the TPS.
D. The Resident will understand the various algorithms and their limitations within clinical TPS.
E. The Resident will become familiar with DICOM RT (Digital Imaging and Communications in Medicine Radiotherapy) communication.

XIII. MU Calculation

A. The Resident will understand the formalism for manual monitor unit (MU) calculations and its implementation in the clinic and in commercial MU calculation programs.
B. The Resident will understand the current standard (AAPM) methodology and parameters for calculating monitor units for photon and electron fields under SAD (source-to-axis distance) and SSD (source-to skin distance) conditions.

C. The Resident will provide a comparison of MU output from the current treatment planning system(s) with the formalism in 1. above. This will be done for a number of clinical cases under various conditions
D. The Resident will demonstrate understanding of how the MU second check is performed for each modality in the practice.
E. The Resident will have an understanding of specification, acceptance testing, commissioning, and clinical implementation of an MU program.
F. *Primary references:* AAPM TG-71 (Formalism for MU Calculations), Various treatment planning physics manuals (defining formalism used in TPS), Kahn (2003). Any in-house software and documentation for this purpose.

XIV. IMRT

A. IMRT Planning
   1. **Principles of IMRT:** The Resident will be familiar with the history of IMRT, as well as the various commercially available systems for its planning and delivery. [Reference: IMRT CWG (2001)]
   2. **Theory of inverse planning:** The Resident will learn how the clinical planning system optimizes a treatment plan. He/she will be familiar with the inputs to the cost function, how it is calculated, and be familiar with the interplay between sometimes competing objectives.
   3. **Special contouring techniques for IMRT:** The Resident will be able to convert “clinical” contours into inputs suitable for optimization. Target volumes are made unique and sometimes subdivided for various goals. Non-anatomical volumes are added to the patient anatomy, and margins are added to normal tissues. (Reference: ICRU 62)
   4. **Dose calculation and plan evaluation:** The Resident will learn how the planning system calculates dose distributions from optimal fluence maps. He/she will evaluate treatment plans with respect to dose heterogeneity, plan complexity, and susceptibility to setup variations.
   5. **Practical training:** The Resident will plan a number of practice cases under the guidance of a physics mentor (a prostate and a head & neck) and then move to dosimetry to plan a number of live patient cases. The live cases will also involve the development of verification plans, documentation, and import to the record and verify system.
      (a) Practice cases: one prostate, one head & neck.
      (b) Live cases: two prostates, two head & neck, two “other.”

B. IMRT QA
   1. **IMRT QA overview:** The Resident will be able to describe the elements of systemic and patient-specific IMRT QA. He will be able to indicate which features of an IMRT plan must be validated before treatment and how they are tested within the clinic’s QA program [References: AAPM report 82 (IMRT QA), Low et al. (1998)]

2. **IMRT QA techniques:** The Resident will become proficient in each of the IMRT QA systems used in the clinic and will be able to describe the strengths and weaknesses of each technique. He/she will be able to cite the specific reason for each test, know its thresholds for passage or failure, and know how to proceed if a plan fails QA.
   (a) Ion Chamber Measurements
   - Selection of dose measurement points
   - Setting up Excel sheet for measurements
   - Delivering IMRT plan to phantom

   (b) EPID Portal Dosimetry
   - Generation of portal dose images
   - Dosimetric calibration of EPID
   - Measuring portal dose images
   - Evaluation techniques (profiles, isodose, gamma)

   (c) Film Dosimetry
   - Techniques, RIT analysis, etc.
   - Strengths and weaknesses compared to EPID

   (d) MU calculation
   - When MU calculation is appropriate

   (e) Matrix array
   - Strengths and weaknesses compared to film and EPID
3. **Practical Experience:** Resident will spend at least 2 weeks functioning as IMRT QA physicist, practicing all aspects of routine IMRT QA.

XV. Special Applications

Comment: Some of the very specialized procedures are considered electives and the specific implementation of all rotations will be the responsibility of the individual institution.

A. For total body irradiation (TBI) the Resident will be able to perform acceptance testing, commissioning, treatment planning, treatment support, quality assurance, and other appropriate duties in support of offering this special procedure to a patient.

B. For total skin electron therapy (TSET) the Resident will be able to perform acceptance testing, commissioning, treatment planning, treatment support, quality assurance, and other appropriate duties in support of offering this special procedure to a patient.

C. For small-field conformal (SFC)—also known as stereotactic radiotherapy—the Resident will be able to perform acceptance testing, commissioning, treatment planning, treatment support, quality assurance, and other appropriate duties in support of offering this special procedure to a patient.

D. For special shielding/dosimetry, the Resident will be able to perform dose estimation, treatment support, quality assurance and other appropriate duties in support of offering Special Dosimetry support for a patient treatment.

E. IORT (intraoperative radiation therapy): For intraoperative electron beam therapy (IOEBT) the Resident will be able to perform acceptance testing, commissioning, treatment planning, treatment support, quality assurance, and other appropriate duties in support of offering this special procedure to a patient. [Reference: Palta et al. (1995)]

F. After all of the special applications have been covered, the Resident will have a mini-oral examination during the next scheduled quarterly review. The examination will cover aspects of all four special applications. The examination may be spread over two quarterly evaluations depending on how the rotation is scheduled.

XVI. Stereotactic (Gamma Knife)

A. **Basic fundamentals:** The Resident should review basic stereotactic radiosurgery principals, with emphasis placed on application of Gamma Knife (GK) radiosurgery. The Resident should be prepared to discuss fundamentals of treatment planning, treatment delivery, and quality assurance. [Recommended review material: Khan, Chapter 21 (2003), AAPM Report 54 (1995)]

B. **Gamma Knife operations:** The Resident will learn basic GK operations through observation and self-study. Special emphasis should be placed on emergency procedures and regulatory adherence. (Recommended review material: GK User Manual)

C. **GK QA recommendations vs. regulations:** The Resident should become familiar with and be able to discuss AAPM recommendations, state and federal regulations, as well as the institution's program for GK QA. (10CFR35, State Regulations, Department QA program)

D. **GK daily and monthly QA:** The Resident will obtain a level of skills and knowledge that permits him/her to understand and perform daily and monthly QA tests, as well as troubleshoot problems detected with those tests and reported by users. The Resident will observe monthly QA sessions and perform at least one monthly QA session under supervision.

E. **GK annual QA:** The Resident is expected to observe (or simulate) an annual GK QA, and to demonstrate an understanding of the types of tests that are performed on an annual basis during the final oral rotation review.

F. **GK commissioning:** The Resident is expected to either participate in the commissioning of a GK unit or or to create an outline of all GK commissioning tests and to perform a subset of each type of test. The Resident should be prepared to demonstrate understanding of GK commissioning tests during the final oral rotation review.

G. **Treatment planning software:** The Resident should know how to import the relevant imaging studies into the Gamma Plan treatment planning software and how to create a treatment plan. This includes creation of target and avoidance structures, display of isodose lines, plan renormalization and dose-volume histogram (DVH) analysis.

H. **Safety analysis:** The Resident should construct an independent safety analysis. This consists of a description of the imaging, planning, and treatment processes with descriptions of failure modes and suggested QA responses/procedures.

I. **Clinical procedures:** The Resident should observe and participate in at least six clinical treatment days and be able to describe the target volumes and organs at risk (OARs) associated with at least three different clinical treatment sites.

XVII. Brachytherapy

A. The Resident will be familiar with procedures, hardware, and isotopes used for the treatment of the most common anatomic sites treated with sealed-source radionuclide therapy.
B. The physical characteristics, assay, handling, licensing, and disposal (if applicable) of brachytherapy sources will be learned by the Resident.
C. The Resident must be able to quality assure the computer system used to generate information utilized to plan and treat patients with radionuclide sources.
D. The Resident should be able to show competence in physics and dosimetric services in support of the clinical use of sealed radionuclide sources in the treatment of the following. If a case does not occur or is now extremely uncommon, then the Resident should perform a mock treatment; or the requirement may be waived at the discretion of the Rotation Supervisor.
   - Biliary duct: intraluminal
   - Eye plaque
   - Permanent lung implants: planar
   - Permanent prostate seed implants: volume interstitial
E. The Resident should be able to show competence in physics and dosimetric services in support of the HDR clinical treatments of the following. If a case does not occur or is now extremely uncommon, then the Resident should perform a mock treatment; or the requirement may be waived at the discretion of the Rotation Supervisor.
   - Vaginal cylinder HDR.
   - Tandem and Ring – Fletcher Suit – HDR.
   - Interstitial HDR.
   - Planar intraoperative HDR (IOHDR).
F. The Resident should observe and actively participate in as many brachytherapy cases as reasonably possible such that they gain sufficient experience and confidence to do the case themselves. Because some cases do not occur very often, the Resident is expected to place a higher priority on the attendance of brachytherapy cases.
G. The Resident should be able to perform all aspects of the LDR and HDR QA independently (although the Resident will not be asked to do so if it not within regulations). The Resident should participate in a minimum of two source exchanges.
H. The Resident will be familiar with federal, state, and local regulatory documents related to sealed-source therapy.
I. References include: AAPM TG-43 (1995) and updates, TG-60 (1999), TG-56 (1998), etc. The Brachytherapy AAPM summer school text (AAPM Monograph 31) is also an excellent reference to consult. There are also many excellent text books on brachytherapy [e.g., Kahn (2003)].

XVIII. Satellite Practice Rotation

A. Following POD, PlanCheck, and machine QA credentialing, the Resident will be scheduled to share in providing physics support at one of the satellite clinics. The intention of this rotation is to provide experience with a different (smaller) practice, while still having the safety net of having a number of physicists at the main center that can be called on for assistance. A primary mentor for this rotation will be assigned, based on the regional site being covered.

B. The Resident will be evaluated on this rotation as part of his/her quarterly evaluations. Feedback from the primary mentor, as well as the on-site personnel (dosimetrists, therapists, physicians) will be used to determine if the Resident is performing satisfactorily.

References

AAPM Monograph No. 31. *Brachytherapy Physics, Second Edition.* B. R. Thomadsen, M. J. Rivard, and W. M. Butler (eds.). Joint AAPM/American Brachytherapy Society Summer School. Madison, WI: Medical Physics Publishing, 2005.

AAPM Report No. 82. (2003). Ezzell, G. A., J. M. Galvin, D. Low, J. R. Palta, I. Rosen, M. B. Sharpe, P. Xia, Y. Xiao, L. Xing, and C. X. Yu. "Guidance document on delivery. Treatment planning, and clinical imlementation of IMRT: Report of the IMRT subcommittee of the AAPM radiation therapy committee." *Med Phys* 30(8):2089–2115.

AAPM Report No. 84. (2004). Rivard, M. J., B. M. Coursey, L. A. DeWerd, W. F. Hanson, M. S. Huq, G. S. Ibbott, M. G. Mitch, R. Nath, and J. F. Williamson. "Update of AAPM Task Group No. 43 report: A revised AAPM protocol for brachytherapy dose calculations." *Med Phys* 31(3):633–674.

AAPM Report No. 89. (2005). J. F. Williamson, W. Butler, L. A. DeWerd, M. S. Huq, G. S. Ibbott, Z. Li, M. G. Mitch, R. Nath, M. J. Rivard, and D. Todor. "Recommendations of the American Association of Physicists in Medicine regarding the impact of implementing the 2004 task group 43 report on dose specification for 103Pd and 125I interstitial brachytherapy." *Med Phys* 32(5):1424–1439.

AAPM TG-21. (1983). No authors listed. "A protocol for the determination of absorbed dose from high-energy photon and electron beams." *Med Phys* 10(6):741–771.

AAPM TG-42. (1995). AAPM Report No. 54. Stereotactic Radiosurgery. Report of Radiation Therapy Committee TG-42. Woodbury, NY: American Institute of Physics, 1995.

AAPM TG-43. (1995). Nath, R., L. L. Anderson, G. Luxton, K. A. Weaver, J. F. Williamson, and A. S. Meigooni. "Dosimetry of interstitial brachytherapy sources. Recomendations of the AAPM Radiation Therapy Committee Task Group No. 43." *Med Phys* 22(2):209–234. Also available as AAPM Report No. 51.

AAPM TG-51. (1999). Almond, P. R., P. J. Biggs, B. M. Coursey, W. F. Hanson, M. S. Huq, R. Nath, and D. W. Rogers. "AAPM's TG-51 protocol for clinical reference dosimetry of high-energy photon and electron beams." *Med Phys* 26(9):1847–1870. Also available as AAPM Report 67.

AAPM TG-53. (1998). Fraass B., K. Doppke, M. Hunt, G. Kutcher, G. Starkschall, R. Stern, and J. Van Dyk. "American Association of Physicists in Medicine Radiation Therapy Committee Task Group 53: Quality assurance for clinical radiotherapy treatment planning." *Med Phys* 25(10):1773–1829. Also available as AAPM Report 62.

AAPM TG-56. (1998). Nath, R., L. L. Anderson, J. A. Meli, A. J. Olch, J. A. Stitt, and J. F. Williamson. "Code of Practice for Brachytherapy Physics." Report of Radiation Therapy Committee Task Group 56. *Med Phys* 24(10): 1557–1598. Also available as AAPM Report No. 59.

AAPM TG-60. (1999). Nath, R, et al. "Intravascular brachytherapy physics: Report of the AAPM Radiation Therapy Committee Task Group No. 60." *Med Phys* 26(2):119–152. Also available as AAPM Report No. 66.

AAPM TG-66. (2003). Mutic, S., J. R. Palta, E. K. Butker, I. J. Das, M. S. Huq, L. N. Loo, B. J. Salter, C. H. McCollough, J. Van Dyk; AAPM Radiation Therapy Committee Task Group No. 66. "Quality assurance for computed-tomography simulators and the computed-tomography-simulation process: Report of the AAPM Radiation Therapy Committee Task Group No. 66." *Med Phys* 30(10):2762–2792. Also available as AAPM Report 83.

AAPM TG-71. Formalism for Monitor Unit Calculations. Draft Report.

IAEA TRS 430. Commissioning and Quality Assurance of Computerized Planning Systems for Radiation Treatment of Cancer. Technical Reports Series (TRS) No. 430. Vienna, Austria: International Atomic Energy Agency, 2004.

ICRU Report 62. Prescribing, Recording and Reporting Photon Beam Therapy. Supplement to ICRU Report 50 (1993). Bethesda, MD: International Commission on Radiation Units and Measurements, 1999.

IMRT CWG (2001). Intensity Modulated Radiation Therapy Collaborative Working Group. "Intensity-modulated radiotherapy: Current status and issues of interest." *Int J Radiat Oncol Biol Phys* 51(4):880–914.

Khan, F. M. The Physics of Radiation Therapy, 3rd edition. Philadelphia: Lippincott Williams & Wilkins, 2003.

Low, D. A., W. B. Harms, S. Mutic, and J. A. Purdy. (1998). "A technique for the quantitative evaluation of dose distributions." M*ed Phys* 25:656–661.

NCRP Report 40. Protection Against Radiation from Brachytherapy Sources. Bethesda, MD: National Council on Radiation Protection and Measurements, 1972.

NCRP Report 107. Implementation of the Principle of As Low As Reasonably Achievable (ALARA) for Medical and Dental Personnel. Bethesda, MD: National Council on Radiation Protection and Measurements, 1990.

NCRP Report 116. Limitation of Exposure to Ionizing Radiation. Bethesda, MD: National Council on Radiation Protection and Measurements, 1993.

NCRP Report 151. Structural Shielding Design and Evaluation for Megavoltage X- and Gamma-Ray Radiotherapy Facilities. Bethesda, MD: National Council on Radiation Protection and Measurements, 2005.

Palta, J. R., P. J. Biggs, J. D. Hazle, M. S. Huq, R. A. Dahl, T. G. Ochran, J. Soen, R. R. Dobelbower Jr., and E. C. McCullough. (1995). "Intraoperative electron beam radiation therapy: Technique, dosimetry, and dose specification: Report of task force 48 of the radiation therapy committee, American Association of Physicists in Medicine." *Int J Radiat Oncol Biol Phys* 33(3):725–746.

10CFR35. *Code of Federal Regulations,* title 10, sec. 35: Medical Use of Byproduct Material. Nuclear Regulatory Commission (NRC). Washington, DC: U.S. Government Printing Office.

Van Dyk, J. (ed.). *The Modern Technology of Radiation Oncology.* Madison, WI: Medical Physics Publishing, 1999.

Recommended Review Material

Various ACMP and AAPM refresher course slides/handouts on file.
Simulation, Instructions for Use
Simulator Reference Guide
State and Federal Regulations
Department QA Program
On-line Institutional or National Learning Tools (Bushberg)
Virtual Simulation, Fusion, and 4-D Software User Manuals
Internal How-To Documentation
Treatment Planning Physics Manuals
Gamma Knife User Manuals

Appendix C, Exhibit B2

SAMPLE IMAGING PHYSICS RESIDENCY PROGRAM ROTATION GUIDE

Comment: This is ONE example based on an extraction from an accredited program. There are many variables and methods of meeting Report 90 and CAMPEP guidelines. Treat this as a guide/example.

INTRODUCTION

This document contains the outline for the residency rotations. It is used by the Clinical Coordinator(s) and Resident to ensure the important aspects of Diagnostic Imaging Physics particular to each imaging modality, and several special applications are addressed. It provides basic guidance, recommended activities, and minimum relevant references.

In addition to the clinical activities outlined within, the resident is expected to work with at least one faculty member on a clinically applicable research project of reasonable duration and depth. The Resident is expected to produce at least one abstract that will be submitted to a regional or national meeting. The Resident is also expected to submit a manuscript for publication to a peer-reviewed journal during the second year of residency.

Research Imaging Seminars and Trainee/Junior Faculty Seminars are conducted within the Department of Imaging Physics. The Resident is expected to attend at least two seminars per month. Attendance is documented via a sign-in sheet.

During the second residency year, the Resident may be afforded the opportunity to assist in the teaching of graduate students during the Introductory Diagnostic Imaging Rotation course for the Medical Physics Program.

The Resident is expected to present two scientific lectures per year. This requirement may be satisfied by presenting abstracts accepted to scientific meetings and by presenting during the summer Trainee and Junior Faculty Seminar series.

The first week of residency normally consists of the following:

- Institutional Orientation
- Acquiring/requesting ID badge, keys, pager, and badge access
- Setting up the workspace, PC, and phone
- Residency program orientation with Clinical Coordinator

INTRODUCTORY CLINICAL OBSERVATIONS

Goals and Objectives

This is an initial rotation that is intended to introduce the Resident to the clinical imaging environment, the types of technologist quality control, and the regulations pertaining to use of radiation machines. This rotation is of 4 to 5 weeks' duration and includes approximately one week in each of the following:

- General Radiography
- Angiography/Fluoroscopy

- CT
- MRI (magnetic resonance imaging)
- Breast Imaging

The Resident will meet the lead technologists, area managers, technologists, radiologists, physics faculty, physics technologists, and associated personnel in each area. They will also learn the layout of the Diagnostic Imaging department and the types of imaging procedures performed routinely within the division.

Resources

Bushberg, J.T., J. A. Seibert, E. M. Leidholdt Jr., and J. M. Boone. *The Essential Physics of Diagnostic Imaging,* 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 2001.

1999 American College of Radiology. Mammography Quality Control Manual. Committee on Quality Assurance in Mammography.

Contact List (see Residency Document—Introduction)

Institutional and National Introductory Diagnostic Imaging Physics Rotation Courses and websites.

General Radiography

At the end of this segment, the Resident should be able to give typical clinical values for several imaging parameters in routine radiographic imaging (kVp, SID, number of views, beam direction through patient, etc.) and a brief description of the weekly quality control (QC) procedure. The Resident will also be able to describe how to wear the personnel radiation monitor.

Angiography/Fluoroscopy

At the end of this segment, the Resident should be able to sketch three different standard fluoroscopic imaging system configurations (C-arm, for example), describe the patient positioning, give the maximum permissible skin entrance exposure rate, list several tests that are performed to comply with state regulations, and list several of the imaging parameters that can be varied for each system (such as patient to image intensifier distance, kVp, etc.).

CT

At the end of this segment, the Resident should be able to briefly describe the daily QC, list the kVp used most frequently in CT imaging, give the definition of pitch and effective mAs, and provide a general description of image formation in CT.

Mammography

Upon completion of this segment, the Resident should be able to explain the major differences between general radiographic and dedicated mammographic x-ray imaging systems, list several of the technologist QC tests for mammography, briefly describe a typical screening mammogram, provide several imaging parameters, and give an overview of the reading room viewing conditions.

MRI

At the end of this segment, the Resident should be able to explain several MRI safety considerations for patients and personnel, be able to describe some fundamental differences between MRI and x-ray imaging, list some coils used in MR imaging, briefly describe the basics of MR image contrast and 2-D image localization (slice selection and frequency and phase encoding), at least for spin-echo imaging, and summarize the daily QC tests.

QC OF MONITORS, FILM PROCESSORS, AND LASER/THERMAL PRINTERS

Goals and Objectives

- Perform QC tests on diagnostic display devices including film processors, wet and dry process laser printers, and electronic displays
- Establish baselines and action limits
- Evaluate a darkroom according to MQSA (Mammography Quality Standards Act)
- Understand the use of the SMPTE (Society of Motion Picture and Television Engineers) test pattern in assessing display quality
- Identify and isolate common artifacts from processors, laser printers, and electronic displays

Year 1

The resident is to assist with the following:

- Darkroom fog and integrity tests (see quarterly mammography tests)
- Processor quality control (daily) and fixer retention (quarterly)
- Regular QC rounds of processors and printers
- Recording and evaluation of processor and printer QC data
- Monitor QC tests and adjustments
- Service calls and follow-up for processors, printers, and monitors

Year 2

The resident is to assist with the following:

- Troubleshooting of equipment performance or image quality issues
- Configuration and acceptance testing of new printers or monitors. (If a new unit is not available, the acceptance tests may be performed for an existing unit.)

Applicable Regulations/References

QC of Monitors, Film Processors, and Laser/Thermal Printers

Required References

American College of Radiology. Mammography Quality Control Manual. Committee on Quality Assurance in Mammography. 1999, (pp. 134–136, 149–165, 249–257).

AAPM Online Report No. 3. Samei, E., et al. Assessment of Display Performance for Medical Imaging Systems. Imaging Informatics Subcommittee Task Group 18; 154 pp.

Seibert, J. A. "Film Digitizers and Laser Printers" in *Practical Digital Imaging and PACS.* J. A. Seibert, L. Filipow, and K. Andriole (eds.) AAPM Medical Physics Monograph No. 25. Madison, WI: Medical Physics Publishing,1999.

Wagner, L. K. "Acceptance Testing and QC of Film Transport and Processing Systems" in *Specification, Acceptance Testing and Quality Control of Diagnostic X-ray Imaging Equipment.* J. A. Seibert, G. T. Barnes, and R. G. Gould (eds.). Medical Physics Monograph No. 20. Proceedings of the AAPM 1994 Summer School. Woodbury, NY: American Institute of Physics, 1994.

Additional References

AAPM Report No. 57. (1996). Recommended Nomenclature for Physical Quantities in Medical Applications of Light. Report of General Medical Physics Committee Task Group 2. Woodbury, NY: American Institute of Physics.

Haus, A. (ed.). *Advances in Film Processing Systems, Technology, and Quality Control in Medical Imaging.* Madison, WI: Medical Physics Publishing, 2001.

Section on Processors, Printers, Monitors

Section on PACS (for monitor QC)

Section on Visual Perception

Kodak Health Imaging Support: Service Bulletin http://www.kodak.com/US/en/health/support/service/30.shtml.

GENERAL RADIOGRAPHY

Goals and Objectives

- Understand the principles of image formation with screen-film, Computed Radiography (CR) or Digital Radiography (DR) systems
- To understand image quality in static 2-D projection imaging
- Learn to perform and evaluate QC testing

Year 1

At a minimum, the resident is to assist with the following:

- Annual compliance testing two units (no more than one portable can be applied toward this requirement)
- Entrance skin dose calculation at least once, preferably twice
- Fetal dose calculation and risk estimate
- Acceptance test at least one general radiography unit (portables do not apply toward this requirement). If a new unit is not available, the acceptance tests may be performed for an existing unit
- Assist with shielding calculation or evaluation, if available

Year 2

The resident is to perform each of the following with minimal supervision:

- Annual compliance test
- Shielding calculation for at least one general radiographic room (a rad/fluoro room can be substituted)

- Shielding inspections for at least one general radiographic room (a rad/fluoro room can be substituted)
- Patient dose calculation, fetal dose calculation, and risk estimate
- The resident is to assist with the following: Troubleshooting of equipment performance or image quality issues

Applicable Regulations/References

Required References

AAPM Report 74. (2002). Quality Control in Diagnostic Radiology. Report of Task Group 12, Diagnostic X-ray Imaging Committee. Madison, WI: Medical Physics Publishing.

Sprawls, P. "Digital Imaging Concepts and Applications" in *The Expanding Role of Medical Physics in Diagnostic Imaging,* G. D. Frey and P. Sprawls (eds.). Madison, WI: Advanced Medical Publishing, pp. 17–36, 1997.

NCRP Report 116. Limitations of Exposure to Ionizing Radiations. Bethesda, MD: National Council on Radiation Protection and Measurements, 1993.

State Regulations for Control of Radiation

Additional References

AAPM Report 14. (1985). Performance Specifications and Acceptance Testing for X-Ray Generators and Automatic Exposure Control Devices. R. P. Rossi, P. J. Lin, K. Strauss, and R. P. Rauch. Woodbury, NY: American Institute of Physics.

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AAPM Report 31. (1990). Standardized Methods for Measuring Diagnostic X-ray Exposures. Report of Diagnostic X-ray Imaging Committee Task Group 8. Woodbury, NY: American Institute of Physics.

Kitts, E. L. "Recent Advances in Screen-Film Systems" in *The Expanding Role of Medical Physics in Diagnostic Imaging.* G. D. Frey and P. Sprawls (eds.). Madison, WI: Advanced Medical Publishing, pp. 153–181, 1997.

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NCRP Report 147. Structural Shielding Design for Medical X-ray Imaging Facilities. Bethesda, MD: National Council on Radiation Protection and Measurements, 2004.

Title 10, Code of Federal Regulations, Part 20, Standards for Protection against Radiation, Nuclear Regulatory Commission, Washington, D.C.: U. S. Government Printing Office.

Title 21, Code of Federal Regulations, Part 1020, Food and Drug Administration (FDA), Washington, D.C.: U. S. Government Printing Office.

http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfCFR/CFRSearch.cfm

United Nations Scientific Committee on the Effects of Atomic Radiation, Genetic and Somatic Effects of Ionizing Radiation. 1988 Report to the General Assembly, New York, 1988.

Wagner, L., R. Lester, and L. Saldana. *Exposure of the Pregnant Patient to Diagnostic Radiations: A Guide to Medical Management.* 2nd ed. Madison, WI: Medical Physics Publishing, 1997.

Shielding for Diagnostic X-rays

The supporting data for the approaches and recommendations provided in NCRP Report 147 are based upon many of these publications.

Archer, B. R., J. I. Thorny, and S. C. Bushong. (1983). "Diagnostic x-ray shielding design based on an empirical model of photon attenuation." *Health Phys* 44:507–517.

Archer, B. R., T. R. Fewell, B. J. Conway, and P. W. Quinn. (1994). "Attenuation properties of diagnostic x-ray shielding materials." *Med Phys* 21:1499–1507.

Dixon, R. L. (1994). "On the primary barrier in diagnostic x-ray shielding." *Med Phys* 21:1785–1794.

Dixon, R. L., and D. J. Simpkin. (1998). "Primary shielding barriers for diagnostic x-ray facilities: A new model." *Health Phys* 74:181–189.

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Simpkin, D. J. (1994). "Diagnostic X-ray shielding calculations for effective dose equivalent (abstract)." *Med Phys* 21:893 .

Simpkin, D. J. (1995). "Transmission data for shielding diagnostic x-ray facilities." *Health Phys* 68:704–709.

Simpkin, D. J. "Regulations and Standards: Radiation Rrotection" in *RSNA Categorical Course in Physics 1995: Physical and Technical Aspects of Interventional Radiology.* Oak Brook, IL: RSNA,1995.

Simpkin, D. J. (1996). "Evaluation of NCRP Report 49: Assumptions on workloads and use factors in diagnostic radiology facilities." *Med Phys* 23:577–584.

Simpkin, D. J., R. L. and Dixon. (1998). "Secondary barriers for diagnostic x-ray facilities: Scatter and leakage revisited." *Health Phys* 74:350–365.

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Simpkin, D. J. "Radiation Shielding for Cardiac Angiography Laboratories" in *RSNA Categorical Course in Physics: Cardiac Catheterization Imaging.* (Oak Brook, IL: RSNA, 1998.

Trout, E. D., and J. P. Kelly. (1972). "Scattered radiation from a tissue-equivalent phantom for x-rays from 50 to 300 kVp." *Radiology* 104:161–169.

ANGIOGRAPHY AND FLUOROSCOPY

Goals and Objectives

- Understand the principles of image formation with fluoroscopic systems utilizing image intensifiers and/or digital (flat-panel) image receptors
- Understand the theory of operation and the clinical uses of transmission ion chambers and other dosimetry devices in fluoro applications [such as PEMNET® (Patient

Exposure Monitoring Network), MOSFET (metal oxide semiconductors–field effect transistor), etc.]
- Operate several different fluoroscopy systems for purposes of quality control testing
- Learn the radiation safety concerns for patients, personnel, and public
- Discuss the interactions of the variable imaging parameters associated with the fluoroscopic configurations and their impact on patient dose and image quality
- Understand the imaging and patient dose concerns with special procedures, including: last-image hold, road-mapping, serial (radiographic) imaging, digital subtraction imaging, rotational fluoro acquisitions, etc.
- Estimate patient entrance skin dose as well as fetal dose from a variety of fluoroscopic procedures
- Perform and evaluate QC testing

Year 1

The resident is to assist with the following:
- Annual compliance testing of at least two units having different configurations (i.e., portable C-arm, general purpose, interventional, cysto)
- Shielding calculation for at least one fluoro or interventional room
- Shielding inspections for at least one fluoro or interventional room
- Entrance skin dose calculation for at least two different procedures (one general and one interventional)
- Fetal dose calculation and risk estimate
- Acceptance test at least one and preferably two fluoro or interventional units. If a new unit is not available, the acceptance tests may be performed for an existing unit.

Year 2

The resident is to perform each of the following with minimal supervision:
- Annual compliance test
- Shielding calculations
- Patient dose calculation, fetal dose calculation, and risk estimate

The resident is to assist with the following:
- Troubleshooting of equipment performance or image quality issues
- Assist with teaching of labs during diagnostic imaging rotations for graduate medical physics students

Applicable Regulations/References

Required References

See Required References for General Radiography section.

FDA recommendations Sep 1994, Sep 1995.

AAPM Report No. 70. (2001). Cardiac Catheterization Equipment Performance, Report of Task Group 17 of Diagnostic X-ray Imaging Committee. Madison, WI: Medical Physics Publishing.

Wagner, L. K., and B. J. Archer. *Minimizing Risks from Fluoroscopic X-rays: Bioeffects, Instrumentation, and Examination,* 2nd edition. No city given: R.M. Partnership, 1998.

NCRP Report 116. Limitations of Exposure to Ionizing Radiations. Bethesda, MD: National Council on Radiation Protection and Measurements, 1993.

Additional References

See Additional References for General Radiography section.

AAPM Report No. 58. (1998). Managing the Use of Fluoroscopy in Medical Institutions. Report of Radiation Protection Committee Task Group 6. Madison, WI: Medical Physics Publishing.

Balter, S., and T. Shope (eds.). Syllabus: A Categorical Course in Physics. Physical and Technical Aspects of Angiography and Interventional Radiology. Presented at 81st Radiological Society of North America (RSNA), 26 Nov–1 Dec 1995.

MAMMOGRAPHY

Goals and Objectives

- To appreciate the differences between general radiography and mammography
- To observe the technologist and radiologist at work in a mammography environment
- To become familiar with the Technologist QC program
- To perform and document an annual inspection of a mammography unit
- To understand MQSA and its effect on the role of the physicist in mammography
- To become familiar with mammography references, regulations, and guidance documentation
- To calculate the shielding required for a mammography room
- To calculate the average glandular dose for a mammogram
- To appreciate the differences that digital mammography is bringing to mammographic imaging

Year 1

The resident is to assist with the following:

- Annual compliance testing of at least two screen-film mammography units
- Annual compliance testing of at least four full-field digital mammography units
- Annual compliance testing of the prone stereo biopsy unit
- Shielding calculation for at least one unit
- Screen speed uniformity and artifact testing
- Evaluation of view boxes and viewing conditions
- Attend at least one quarterly mammography QC review meeting

Year 2

The resident is to perform at least one of the following with minimal supervision:

- Annual compliance testing of at least 4 mammography units
- Screen speed uniformity and artifact testing
- Evaluation of view boxes and viewing conditions

The resident is to assist with the following:

- Troubleshooting of QC problems in mammography.

Applicable Regulations/References

Required References

American College of Radiology. Mammography Quality Control Manual—1999, Committee on Quality Assurance in Mammography, Hendrick, E. et al. (eds.) Reston, VA: ACR, 1999.

Bushberg, J. T., J. A. Seibert, E. M. Leidholdt, and J. M. Boone. "Chapter 8: Mammography" in *The Essential Physics of Medical Imaging,* 2nd ed. Philadelphia: Lippincott Williams and Wilkins, 2002.

Food and Drug Administration Web Site for Mammography: http://www.fda.gov/cdrh/mammography/index.html.

NCRP Report 147. Structural Shielding Design for Medical X-ray Imaging Facilities. Bethesda, MD: National Council on Radiation Protection and Measurements, 2004.

Nickoloff, E. L., and E. M. Donnelly. (1988). "Use of gypsum drywall as shielding material for mammography." *Health Phys* 54:465–468.

Simpkin, D. "Scatter radiation intensities about mammography units." (1996). *Health Phys* 70:238–244.

Simpkin, D. (1987). "Shielding requirements for mammography." *Health Phys* 53(3):267–279.

Wu, X. "Breast dosimetry in screen film mammography" in *Screen Film Mammography: Imaging Considerations and Medical Physics Responsibilities.* G. T. Barnes and G. D. Frey (eds.). Madison, WI: Medical Physics Publishing, pp. 159–175, 1991.

Additional References

AAPM Report No. 29 (1990). Equipment Requirements and Quality Control for Mammography. New York, NY: American Institute of Physics.

American College of Radiology. Stereotactic Breast Biopsy Quality Control Manual. Hendrick E. et al. (eds.). Reston, VA: ACR, 1999.

American College of Radiology website: http://www.acr.org.

Dixon, R., P. Butler, and W. Sobol (eds.). *Accreditation Programs and the Medical Physicist.* Proceedings of AAPM 2001 Summer School. AAPM Monograph No. 27. Madison WI: Medical Physics Publishing, 2001.

Haus, A. (ed.). Advances in Film Processing Systems, Technology and Quality Control in Medical Imaging. Madison WI: Medical Physics Publishing, 2001.

Haus, A., and S. Jaskulski. *The Basics of Film Processing in Medical Imaging.* Madison, WI: Medical Physics Publishing, 1997.

MA-AAPM Symposium Proceedings. Emerging Issues in Mammography. Charlottesville, VA, 20–21 Sep 1996.

NCRP Report 116. Limitations of Exposure to Ionizing Radiations. Bethesda, MD: National Council on Radiation Protection and Measurements, 1993.

SE-AAPM Symposium Proceedings: Quality Control in Digital Mammography. Memphis, TN; 2–3 April 1998.

Stanton L., T. Villafana, J. L. Day, and D. A. Lightfoot. (1984). "Dosage evaluation in mammography." *Radiology* 150:577–584.

Wu, X., E. L. Gingold, G. T. Barnes, and D. M. Tucker. (1994). "Normalized average glandular dose in Mo/Rh and Rh/Rh target filter mammography." *Radiology* 193:83–89.

COMPUTED TOMOGRAPHY

Goals and Objectives

Year 1

The resident is to assist with the following:

- Acceptance test at least one and preferably two CT scanners. If a new unit is not available, the acceptance tests may be performed for an existing unit
- Annual compliance testing of at least one and preferably two CT scanners
- Shielding calculation for at least one and preferably two scanners

- Shielding inspections for at least one scanner (optional for CT)
- Dose calculation at least once, preferably twice
- Fetal dose calculation and risk estimate

Year 2

The resident is to perform the following with minimal supervision:

- Annual compliance test
- Shielding calculations
- Patient dose calculation, fetal dose calculation and risk estimate

Applicable Regulations/References

Required References

AAPM Report No. 39. Specification and Acceptance Testing of Computed Tomography Scanners. Report of Task Group 2 of the Diagnostic X-ray Imaging Committee. New York: American Institute of Physics, 1993.

State Regulations for Control of Radiation

Additional References

Seibert, J.A. G. T. Barnes, and R. G. Gould (eds.). *Specification, Acceptance Testing and Quality Control of Diagnostic X-ray Imaging Equipment.* J. A. Seibert, Proceedings of the 1991 AAPM Summer School. AAPM Monograph 20. Woodbury, NY: American Institute of Physics, pp. 801–936, 1994.

Gould, R. "CT Overview and Basics." pp. 801–832.

Mattson, R. "CT Design Considerations and Specifications." pp. 833–862.

Loo, L.-N. D. "CT Acceptance Testing." pp. 863–898.

Rothenberg, L. "CT Dose Assessment." pp. 899–936.

SE-AAPM Spring Symposium 2000. Spiral and Multi-slice CT: Physical Principles and Medical Physicist Responsibilities, 16–17 March 2000, Asheville, NC.

NUCLEAR MEDICINE AND PET

Goals and Objectives

Year 1

The resident is to assist with the following:

- Acceptance test at least one nuclear medicine camera. If a new unit is not available, the acceptance tests may be performed for an existing unit
- Annual compliance testing of at least two nuclear medicine cameras (one of which should include SPECT (single photon emission computed tomography) testing)
- Annual compliance testing of the PET (positron emission tomography) unit
- Shielding calculation
- Shielding inspection
- Dose calculation at least once, preferably twice
- Fetal dose calculation and risk estimate

Year 2

The resident is to perform the following with minimal supervision:

- Annual compliance test
- Shielding calculations
- Patient dose calculation, fetal dose calculation and risk estimate

The resident is to assist with the following:

- Troubleshooting image quality or equipment performance issues

Applicable Regulations/References

Required References

AAPM Report No. 6. Scintillation Camera Acceptance Testing and Performance Evaluation. Report of the Nuclear Medicine Committee. New York: American Institute of Physics, 1980.

AAPM Report No. 52 (1995). "Quantitation of SPECT performance." Report of Nuclear Medicine Committee Task Group 4. *Med Phys* 22(4):401–409.

Bushberg, J. T., J. A. Seibert, E. M. Leidholdt, and J. M. Boone. Chapter 8 "Mammography" in *The Essential Physics of Medical Imaging,* 2nd ed. Philadelphia: Lippincott Williams and Wilkins, 2002.

Graham, S. "Quality Assurance of Anger Cameras" in *Physics of Nuclear Medicine: Recent Advances.* D. Rao, R. Chandra, and M. Graham (eds.). Proceedings of the AAPM 1983 Summer School. AAPM Monograph No. 10. New York: American Institute of Physics, 1984.

Additional References

AAPM Report No. 71 (2001). A Primer for Radioimmunotherapy and Radionuclide Therapy. Report of Nuclear Medicine Committee Task Group 7. Madison, WI: Medical Physics Publishing.

NEMA Standards Publication NU 1-2001 (Draft): Performance Measurements of Scintillation Cameras. Rosslyn, VA: National Electrical Manufacturers Association.

NEMA Standards Publication NU 2-2001: Performance Measurements of Positron Emission Tomographies. Rosslyn, VA: National Electrical Manufacturers Association.

Rao, D., R. Chandra, and M. Graham (eds.). *Physics of Nuclear Medicine: Recent Advances.* Proceedings of the AAPM 1983 Summer School. AAPM Monograph No. 10. New York: American Institute of Physics, 1984.

State Regulations for Radioactive Materials

ULTRASOUND

Goals and Objectives

Year 1

The resident is to assist with the following:

- Acceptance test at least one unit. If a new unit is not available, the acceptance tests may be performed for an existing unit.
- Annual compliance testing two units

Year 2

The resident is to perform the following with minimal supervision:

- Annual compliance test

The resident is to assist with the following:

- Troubleshooting of equipment performance or image quality issues.

Applicable Regulations/References

Required References

Bushberg, J. T., J. A. Seibert, E. M. Leidholdt, and J. M. Boone. Chapter 8 "Mammography" in *The Essential Physics of Medical Imaging,* 2nd ed. Philadelphia: Lippincott Williams and Wilkins, 2002.

Goodsitt, M. M., P. L. Carson, S. Witt, D. L. Hykes, and J. M. Kofler Jr. (1998). "Real-time B-mode ultrasound quality control test procedures: Report of AAPM Ultrasound Task Group No. 1." *Med Phys* 25(8):1385–1406.

RESIDENCY ROTATION: MAGNETIC RESONANCE IMAGING

Goals and Objectives

Year 1

The resident is to assist with the following:

- Acceptance test one MRI system. If a new unit is not available, the acceptance tests may be performed for an existing unit
- ACR annual testing of two units
- Review siting considerations, participate in site planning (if available)

Year 2

The resident is to perform each of the following with minimal supervision:

- Annual survey

The resident is to assist with the following:

- Troubleshooting of equipment performance or image quality issues

References

MRI Basics

Bushberg, J. T., J. A. Seibert, E. M. Leidholdt, and J. M. Boone. Chapter 14: "Nuclear Magnetic Resonance" and Chapter 15: "Magnetic Resonance Imaging (MRI)" in *The Essential Physics of Medical Imaging.* 2nd ed. Philadelphia: Lippincott Williams and Wilkins, pp. 373–467, 2002).

Elster, A. D., and J. H. Burdette. *Questions and Answers in Magnetic Resonance Imaging.* 2nd edition. St. Louis: Mosby, 2001.

General

Bernstein, M. A., F. King Kevin, and X J. Zhou. *Handbook of MRI Pulse Sequences.* Burlington, MA: Elsevier Academic Press, 2004.

Clarke, G. D. "Rationale and Implementation of the ACR MRI Accreditation Program's Required Phantom Tests" in *Accreditation Programs and the Medical Physicist.* R. Dixon, P. Butler, and W. Sobol (eds.). Proceedings of the AAPM 2001 Summer School. AAPM Monograph No. 27. Madison WI: Medical Physics Publishing, 2001.

Haacke, E. M., R. W. Brown, M. R. Thompson, and R. Venkatesan. *Magnetic Resonance Imaging: Physical Principles and Sequence Design.* New York: Wiley-Liss, 1999.

Runge, V. M., W. R. Nitz, S. H. Schmeets, W. H. Faulkner, and N. K. Desai. *The Physics of Clinical MR Taught Through Images.* New York: Thieme, 2005.

Sobol, W. "MRI Physics of the QC Program" in *Accreditation Programs and the Medical Physicist.* R. Dixon, P. Butler, and W. Sobol (eds.). Proceedings of the AAPM 2001 Summer School. AAPM Monograph No. 27. Madison WI: Medical Physics Publishing, pp. 81–100, 2001.

Wehrli, F. W., D. Shaw, and J. B. Kneeland. *Biomedical Magnetic Resonance Imaging: Principles, Methodology and Applications.* New York: VCH Publishers, 1988.

Zhuo, J., and R. P. Gullapalli. (2006). "AAPM/RSNA Physics tutorial for residents: MR artifacts, safety, and quality control." *Radiographics* 26:275–297.

MRI Safety

ACR MR Safety white paper and update: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/WhitePaperonMRSafetyCombinedPapersof2002and2004Doc11.aspx.

FDA Document: Criteria for Significant Risk Investigations of Magnetic Resonance Diagnostic Devices: http://www.users.on.net/~vision/safety/ACRWP-comments-FGS-JVC.pdf.

Kanal, E. (ed.). MR Safety; Magnetic Resonance Imaging Clinics of North America: Vol 6, No. 4, 1998.

Kanal, E. MR Safety website: http://www.radiology.upmc.edu/MRsafety/.
http://www.fda.gov/cdrh/safety/mrisafety.html.
http://www.imrser.org/.
http://www.magneticresonancesafetytesting.com/.

Shellock, Frank. MRI Safety website: http://www.mrisafety.com.

Shellock, F. G., and J. V. Crues. (2004). "MR procedures: Biologic effects, safety, and patient care." *Radiology* 232(3):835–652.

Shellock, F. G., and E. Kanal. *Magnetic Resonance: Bioeffects, Safety, and Patient Management.* Philadelphia: Lippincott Williams and Wilkins, 1996.

MR Acceptance Testing and Quality Control

AAPM Report No. 20. Site Planning for Magnetic Resonance Imaging Systems. Report of Nuclear Magnetic Resonance Committee Task Group 2. New York, American Institute of Physics, 1986.

AAPM Task Group 1. (2005 Draft not yet published.) Jackson, E. F., et al. Acceptance Testing and Quality Assurance Procedures for Magnetic Resonance Imaging Facilities (MR Task Group 1).

Och, J. G., G. D. Clarke, W. T. Sobol, C. W. Rosen, and S. K. Mun. (1992). "Acceptance testing of magnetic resonance imaging systems: Report of AAPM nuclear magnetic resonance Task Group No. 6." *Med Phys* 19 (1):217–229.

Price, R. R. L. Axel, T. Morgan, R. Newman, W. Perman, N. Schneiders, M. Selikson, M. Wood, and S. R. Thomas. (1990). "Quality assurance methods and phantoms for magnetic resonance imaging: Report of AAPM nuclear magnetic resonance Task Group No. 1." *Med Phys* 17(2):287–295.

ACR Accreditation in MRI

American College of Radiology (ACR) website: MRI Accreditation Program ACR Accreditation Program Requirements; Phantom Test Guidance for the ACR MRI Accreditation Program. http://www.acr.org.

MRI Artifacts (Applicable Web Sites)

Website Tutorials (Applicable Web Sites)

Proton MR Spectroscopy

Drost, D. J., W. R. Riddle, and G. D. Clarke. (2002). "Proton magnetic resonance spectroscopy in the brain: Report of AAPM MR Task Group #9." *Med Phys* 29(9):2177–2197.

REGIONAL HOSPITAL CARDIOVASCULAR ROTATION

Contact: Dr. ________________ .

Make scheduling arrangements for this section of the rotation through Program Director.

- Cardiac Catheterization laboratories, eleven laboratories, with a variety of equipment and the full range of diagnostic and interventional procedures
- Observe range of cath procedures
- Observe intravascular radiation therapy for prevention of restenosis and assess the radiation safety issues
- Assist in the medical physicists performance evaluation of several cardiac cath labs
- Review the performance and the quality control procedures for flat panel digital fluoroscopy systems (GE Innova 2000)
- Review the preventative maintenance and the quality control programs of the cath labs by the Biomedical Engineering department
- Review patient and staff doses in an adult cardiac catheterization laboratory

REGIONAL HOSPITAL CARDIOVASCULAR NUCLEAR MEDICINE

- Observe the quality control protocol for cardiac SPECT cameras
- Observe treadmill and pharmacologic radionuclide stress testing
- Review SPECT acquisition and processing options on Marconi and ADAC SPECT systems
- Attend interpretation session with nuclear medicine physicians and cardiologists
- Observe echocardiography studies on representative patients
- Review patient and staff doses in cardiovascular nuclear medicine

REGIONAL HOSPITAL CARDIAC CATH LAB AND NUCLEAR MEDICINE

- Observe the diagnostic and interventional pediatric cardiology catheterization procedures
- Review patient and staff doses in a pediatric cardiac cath laboratory
- Observe gamma camera quality control protocols and representative pediatric nuclear medicine procedures
- Review pediatric radiopharmaceuticals dosage schedule and patient absorbed doses

Appendix C, Exhibit C

Sample Summary of Conferences
Clinical Medical Physics Residency

1. Physics Journal club is once every 2 months. The residents will attend this meeting and under the mentorship of the medical physics faculty, a physics resident will present an article in journal club on a rotating basis.
2. Monday Morning plan review/QA conference. This treatment planning conference is an essential conference and the resident will attend at least 3 times per month.
3. Tuesday Physics rounds: Special topics, Raphex reviews, in-services are scheduled during these sessions. Attendance is required.
4. Thursday new patient conference: Resident will attend 1 to 2 times per month.
5. Friday morbidity and mortality conference: Attendance is required.
6. Physics Section and dosimetry meetings: Attendance is required.
7. Visiting professor lectures in both radiation oncology and radiation physics, attendance required
8. Others.

Appendix C, Exhibit D1

Sample Medical Physics Residency Evaluation – Oral Exam

Resident____ Date_______________________

Topic________Ext Beam Tx Planning / MU CALC_______________

Rotation Mentor: ____

Oral Examiners

- ☐ Faculty A
- ☐ Faculty B
- ☐ Faculty C
- ☐ Guest Examiner A
- ☐ Guest Examiner B

Comments

____

____

____

____

____

Satisfactory Unsatisfactory

Signed____

Faculty Member

Appendix C, Exhibit D2

Picture can go here

SAMPLE QUARTERLY EVALUATION

Institution _________________________

Clinical Medical Physics Residency/Fellowship

Department of Radiation Oncology

Name: Trainee Name

Rotation Dates: 9/30/2006 thru 12/29/2006
Fall 2006

Internal ID: ##########

Program Start Date: 7/2/05

Training Elements	S	U	UE
Clinical Rotation Performance			
Technical Skills/Judgment			
Fund of Knowledge			
Team Relationships/ Maturity			
Research			
Overall			

Evaluation Criteria
S Satisfactory
U Unsatisfactory
UE Unable to evaluate

Current Rotation(s) –

Didactic Instruction –

Research/Clinical Projects –

Mentor's Signature ______________________________________ **Date** ___________

Resident's Signature ____________________________________ **Date** ___________

Program Director _______________________________________ **Date** ___________

Appendix C, Exhibit E

Sample Rotation and Program Evaluations

ROTATION EVALUATION

Procedures:

This form is to be completed by the physics resident upon completion of each rotation. Fill out the form below. Return it to the Physics Residents' Advocate (currently John Doe, M.D.) who will compile the results and present them to the Chief of Radiological Physics and the Physics Residency Program Director. Reasonable efforts to retain anonymity will be made.

Rotation: ________________________

Please comment on the following issues regarding your recently completed rotation:

Time allotted

Overlapping/conflicting responsibilities

Availability/Quality/Appropriateness of didactic material (e.g., text books, etc..)

Availability/Quality/Appropriateness of documentation of written procedures

Quality/availability of rotation mentor

Quality/availability of primary mentor

Other: (Interaction with physicians, opportunities for attending seminars, case conferences, meetings…)

Other: Issues that I would like addressed

Other comments

ANNUAL PROGRAM EVALUATION

Procedures:

This form is to be completed by each Physics Resident/Fellow annually and is designed to gather feedback on the Clinic Radiation Therapy Medical Physics Residency Program in general. Return it to the Physics Residents' Advocate (currently Dr. John Doe), who will compile the results and present them to the Chief of Radiological Physics and the Physics Residency Program Director. Reasonable efforts to retain anonymity will be made.

Please comment on:

Your primary mentor in terms of his/her availability, professionalism, etc…

Working hours reasonable

Space (Is your office/lab space adequate?)

Accessibility of equipment/machines?

Physician accessibility

Course work (Time allotted, appropriateness)

Ability to attend meetings

Administrative support (availability)

Resident Evaluation of Physics Faculty:

Appendix C, Exhibit F

Sample Clinical Medical Physics Residency Candidate Evaluation Form

Name of Candidate: ____

Date of Interview: ____

Scores:

________Interest, reasons for candidacy for this residency
________Knowledge of Radiation Oncology Medical Physics
________Technical skill set including experimental experience
________Application (references, transcripts, etc.)
________Communication and interaction skills
________Initiative and Productivity

Scale
1 = outstanding
2 = excellent
3 = good
4 = satisfactory
5 = unacceptable

Overall Score: __________

Comments:
____
____
____
____
____

Interviewer Name: ____

Interviewer Signature: ____________________________ **Date:** __________

Appendix C, Exhibit G

Sample Medical Physics Residency Orientation

July 2–3	Institutional Orientation
July 5	Program Director introduction to program and details of program
July 6	Treatment Machine A (Staff A)
July 9	Treatment Machine E
July 10	Treatment Machine G (a.m.)
July 11	Simulation 2 (CT Sim)
July 12th	Block Shop (a.m.)
July 13th	Simulation I (conventional) (p.m.)
July 12th and 13th	Dosimetry, external beam/HDR (Staff B)

Comment: This should also include tours and introduction to physics and other staff, locations of all critical items in the department, etc. This will vary from institution to institution.

Appendix C, Exhibit H

Sample Faculty List

Key Department Faculty
Radiation Oncology Clinical Medical Physics Residency

Physics Faculty	Faculty Rank	Board Certification	Year Appointed
Faculty 1	Professor	ABMP (1994)	1998
Faculty 2	Assoc. Professor	ABR(1990)	1992
Faculty 3	Instructor	----	2002
Faculty 4	Staff	CMD (2000)	1995
Faculty 5	Affiliate	ABR(2001)	1999

C.V. of each faculty should be attached.

Appendix C, Exhibit I

Sample Description and Availability of Clinical Facilities

Comment: This should list the primary and any affiliate resources clearly, with details under each heading area.

PRIMARY Facilities

External Beam Treatments NNNN pts/yr

Simulators

Treatment Planning Systems

Brachytherapy Resources

Dosimetry Resources

Informatics

AFFILIATE Facilities   NMMM patients per year

AFFILIATE-location 1

External Beam Treatments NNNN pts/yr

Simulators

Treatment Planning Systems

Brachytherapy Resources

Dosimetry Resources

Informatics

AFFILIATE-location 2

External Beam Treatments NNNN pts/yr

Simulators

Treatment Planning Systems

Brachytherapy Resources

Dosimetry Resources

Informatics