Medical Physics Board Exam Notebook

Orals Section

2006

Dear Candidate,

Thanks for your $35.00 purchase of the SCCAAPM's study guide for the ABR. For official information, see http://www.theabr.org

The notebook has been assembled for physicists preparing to take the Radiologic Physics section of ABR examination. Included are general requirements for candidates, example questions and comments from previous candidates. It is intended to serve as a study guide for those preparing to take the examination. There is no guarantee that any of these questions will be asked on future exams. It is updated annually.

The format of this document is unchanged changed from last year. It is in electronic .PDF format. Please note that a few documents are quite old and their quality is poor. We have decided to include them anyways. The information is in chronological order, i.e. the latest information is at the end of the documents.

We would like to thank those who have contributed their notes over the many years of this project and request that future exam takers help to perpetuate this notebook.

Alex Li & Tim Paul
SCCAAPM

January 17, 2006

amination will again have three examiners, one for each of the three categories. If the candidates pass two examinations, a conditional pass will be awarded, and only the failed examination need be repeated.

Requirements for Eligibility

Candidates must be certified by the American Board of Radiology in radiology or diagnostic radiology.

For the first five years, candidates will be required to have a minimum of one year of full-time training in pediatric radiology following the completion of their residency training and must have completed at least one year of practice or additional training in the subspecialty. If a candidate has not completed a fellowship, the individual must have at least five years of practice with a minimum of one third of that time devoted to pediatric radiology. (The one-third time requirement will be based on a 45-hour work week. Fifteen hours per week devoted exclusively to pediatric radiology satisfies the requirement.) This encompasses actual performance and interpretation of examinations and procedures as well as time devoted to consultation with referring physicians, attendance at related conferences, and pre- and postprocedure visits with patients. The chief of service must attest to this experience.

The next examination will be given November 6 and 7, 1995.

By the year 2000, all candidates will be required to have successfully completed a one-year fellowship in an ACGME-accredited program followed by one year of practice in pediatric radiology. ■

CAQ in Vascular/ Interventional Radiology

by William J. Casarella, MD

The ABR has successfully implemented procedures to issue certificates of added qualifications (CAQs) in vascular/interventional radiology. Final approval was obtained from the American Board of Medical Specialties in March 1994, and the first examinations were held in November 1994 in Louisville, KY. They were designed to certify a small number of senior individuals who will become examiners and to evaluate the test material that had been recorded on video discs.

Applications have been received from about 700 radiologists, and they will be processed as soon as possible. The first examination was held on February 26–28, 1995, and it will be repeated in the fall of 1995. After the current large group of qualified applicants have been certified, the examination will be given annually.

The examination consists of three separate 30-minute components. They are vascular diagnosis, vascular/interventional radiology, and nonvascular/interventional radiology. Candidates will be shown a series of cases selected from a bank of about 400 recorded on a video disc similar to that used for the oral Board format for the residents' examination. Evaluation of the candidates' performance will be made by the panel of three examiners who will have independently conducted the three examinations.

Eligibility for the CAQs is based on the candidate's ability to demonstrate his/her experience as a complete vascular/interventional radiologist. Documentation of performance of 500 individual cases that include a broad spectrum of procedures is essential. Performance of 25 angioplasties and 15 nephrostomies is required to comply with SCVIR/ACR guidelines on training in interventional radiology. Candidates must spend at least one third of their time in vascular/interventional radiology. By the year 2000 only individuals who have completed an accredited fellowship will be eligible.

The purpose of the CAQ examination is to certify experts and to improve training in vascular/interventional radiology. It is not intended to exclude general radiologists but should recognize those individuals who have subspecialized and have achieved a high level of experience and competence in their field. ■

Ready...Set...Go!

How to Prepare for the Oral Board Examination: The 20 Most Important Things to Know or Do

by Melvyn H. Schreiber, MD

It has been said that older people tend to give good advice when they can no longer serve as bad examples. Acting on the possibility that we might get some really good advice about taking the oral examination of the American Board of Radiology from the people who give it, we sought comments from members of the board of trustees. Trustees routinely examine twice a year, in June and again in November at the time of the oral examination for persons who conditioned three or fewer categories during the summer examinations. Some of them examine more often than that, considering the upcoming CAQ examinations in neuroradiology, vascular/interventional

radiology, and pediatric radiology.

We received many replies to our invitation to give helpful advice to candidates preparing for the oral examination, and I have summarized, interpreted, and edited them to produce the following exhortations and guidance.

Several respondents emphasized the importance of beginning preparation for the Board examination from the start of residency training. Read diligently, attend conferences regularly and attentively, concentrate on learning the material during clinical rotations, and you should be well-prepared to take the oral examinations without much cramming at the end. The idea is to prevent fourth-year hysteria or even severe anxiety by developing progressively the competence required to perform creditably as a diagnostic radiologist. The idea, after all, is not merely to pass the Board examination but to prepare for a lifetime of practice. Everyone agrees that graduates of accredited American or Canadian medical schools taking the examination for the first time are highly likely to pass, particularly if the candidate has worked hard during residency training and gotten average or better evaluations.

Continuing a reasonable pace of learning during the fourth year is advisable rather than wasting time worrying about the impending examination and absenting yourself from the activities of the department, retreating to the library or elsewhere for private study. Many candidates consider it necessary to attend one or more board preparation courses, and giving these courses has become a popular activity for academic radiology departments. No reliable figures exist to gauge the usefulness of these exercises, and several trustees believe them to be of limited value. Still, it's undoubtedly comforting to have the whole subject encompassed in a few days, especially if a syllabus is provided. That gives the illusion of carrying under your arm the whole of what you must know to overcome this final barrier to the practice of radiology. But it's an illusion. Several trustees remarked that review sessions and mock boards for fourth-year residents are probably more helpful and are certainly sufficient.

Now to the examination itself. The following is a distillation of advice from a number of trustees (every one of whom, at one time or another, took and passed this test):

1. Give some thought to travel. If you are coming from a long distance, arrive a day or two in advance to allow the effects of jet lag to diminish.

2. Try to relax, put your mind at ease, and get some sleep. By the time you get to Louisville, the die is cast. You are there to display your knowledge and judgment, not to ruin your already frazzled constitution by cramming just before the examination.

3. Don't bring your library to the examination. It's an unnecessary burden on your lumbosacral area and your nervous system. If you need a textual security blanket, bring a thin one.

4. If anxiety wakes you much too early on the morning of the test, and you know you won't get back to sleep, **get up and get going.** An early morning walk or run will get the juices flowing and the endorphins secreting and probably help a lot to put you at ease when the whistle finally blows and you are handed the ball.

5. Believe it or not, **the examiners want you to pass.** They are there to be sure you demonstrate an acceptable level of competence, not to see if you can hit a home run every time. Some examiners are sweeter than others, it is true, but not one of them is out to get you.

6. The whole idea is to see if you can recognize an abnormality, properly describe it, and synthesize the findings into a reasonable diagnosis. Differential diagnosis is important but should not become a fetish. **A long and exhaustive list of irrelevant differential diagnostic possibilities is a sure sign of rote learning.** What the examiner really wants to know is whether you can think sensibly about a diagnostic problem.

7. Try not to dance around too much. Convoluted, nondefinitive answers give the appearance of insecurity and ignorance. If you don't know the answer, say so and get on to the next case where you may do much better. Above all, avoid creative observation (seeing things that are not there or offering answers not based on observation or fact).

8. Don't play mind games with the examiner. It's a waste of time trying to guess what the examiner wants to hear. Describe what you see, say what it means, and tell the diagnosis. Recommend additional studies or ask for additional information only when you have made the most of the material presented to you up to that point.

9. Be logical and rational. Analyze and deduce instead of blindly following some preconceived algorithm. Be decisive, and be prepared to defend your position. Overconfidence and cockiness will ruin your presentation.

10. Plain films and other simple studies are frequently all you will get. **Do the best you can with what you have before you.** If you can only function with a CT, MRI, or ultrasound study, you are in deep trouble.

11. Speak up. Don't mumble. Some of the older examiners are a little hard of hearing.

12. Look at the images, think about them, and then speak. Several examiners remarked that the most difficult problem they encounter with candidates is seeing them spot anything that looks a little bit curious and then going on and on about this irrelevant finding for five minutes, never really examining the images carefully enough to detect what is really wrong.

13. Don't pander to the examiner, and don't expect

him/her to provide more than minimal encouragement. Instead of looking at the examiner for support, look at the images for clues.

14. Put behind you the last case you saw and the last examination you took. **Concentrate on the case at hand.**

15. If you think you did poorly with an examiner, forget it. Go on to the next examination and do your best. The examiners discuss your performance at the end of the day, and if you did poorly with one examiner and well with everyone else, perhaps it was partly due to your interaction with an examiner with whom you did not click. That's taken into consideration. Worrying about what you did with the first examiner will only keep you from concentrating on the next examination (where you may do poorly) when you actually performed well with the first examiner.

16. An atypical example of a common entity occurs more frequently than a typical example of a rare entity. Write that down.

17. Dress conservatively and neatly. Bathe. Comb your hair. Don't distract the examiner with outlandish costumes or other curious sights.

18. Everyone consulted gave this advice: behave during the examination as you would if you were consulted by a junior colleague at the view box at home. The more your behavior differs from your usual approach to radiological diagnosis, the less likely you are to produce an acceptable performance. Remember, it's a lot easier than your daily job. There are no normals, and you know in what area you are working.

19. Finally, never, never give up. Even if you think you have booted it thoroughly, go on to the next question and to the next examination, and give it all you've got. You are the poorest judge of your performance on the last case or the last examination. Candidates frequently remark that they are surprised to find they passed a subject they thought they did poorly in.

20. When it's over, let it go. The worst reality is not nearly as bad as the imagined one. Get something to eat, and relax. If you came to the Board examination prepared to spend your life practicing radiology competently, you surely passed. ■

1995 Physics Examination Committee Members

Physics Advisory Committee
Ed Chaney, Chair; Krish Banerjee; Libby Brateman; Robert Dixon; Phil Heintz; Dave Marsden; Doug Shearer

Oral Examination
Phil Heintz, Chair; Libby Brateman; David Gooden; Doug Shearer

Written Part 1
Linc Hubbard, Chair; James Ehrhardt; Dave Marsden

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Richard Morin, Chair; Robert Dixon; Anthony Seibert

Therapy Part 2
Robert Barish, Chair; Peter Biggs; Timothy Schultheiss

Nuc Part 2
Steve Graham, Chair; Guy Simmons; Jon Trueblood

Written Examination Coordination
Krish Banerjee, Chair; Gary Barnes; Dave Marsden

Additional information can be obtained by requesting a copy of the Booklet of Information for Examination in Radiological Physics from the American Board of Radiology, 5255 E. Williams Circle, Suite 6800, Tucson, AZ 85711.

Physics Update Report to ABR Diplomates

BY ED CHANEY, PHD

New Physics Trustees Elected

At the 1994 winter meeting, the ABR board of trustees elected two prominent AAPM members to fill the new physics trustee positions that were approved by the ABR board of trustees and ABR-sponsoring organizations last year. William R. Hendee, PhD, and Guy Simmons, PhD, were elected by the trustees from a roster of nominees submitted by President Ravi Nath on behalf of the AAPM. Dr. Hendee is a professor and dean of the graduate school at the Medical College of Wisconsin. He is a past president of the AAPM and a recipient of the Coolidge Award. Dr. Simmons is a professor in the Department of Radiology at the University of Kentucky College of Medicine and is AAPM president-elect. Both are active in educating and training medical physicists and in ABR certification activities. The new trustees will take office July 1, 1995.

Physics Examination Update

Qualifications for admission to the physics examination and the structure of the examination have changed over the past several years. The following summary is presented for the benefit of diplomates who are not familiar with current procedures.

The ABR issues certificates to physicists practicing diagnostic radiological physics, therapeutic radiological physics, medical nuclear physics, any two of the preceding specialties, and the combination of all three specialties, radiological physics. Candidates must possess an appropriate master's or doctoral degree. For examination in one specialty, a candidate must have three years' experience in an approved

Some Questions in Clinical Radiation Physics
asked by examiner Dr. Childs at Cincinnati, June, 1966

I The Oxygen Effect

1. Discuss the principles and applications of the effect.

2. Precisely how is the oxygen tension raised?

3. Why isn't breathing oxygen by mask useful?

4. Why isn't everyone who can afford to do so rushing to get into high pressure oxygen work?

5. Have the treatment results reported in the literature had good experimental control?

6. What effect does the intervening steel or plastic have on the position of the build up peak at the skin? How far from the pressure vessel walls must the skin be in order to retain original build up pattern?

7. What do you personally think of high pressure oxygen radiotherapy?

II Interaction of ionizing radiations and tissue. Discuss all the factors you can think of which influence the effects of radiation on tissue. I mentioned most of the subjects in the following list; he asked about a few of them explicitily.

(a) Dose
(b) Fractionation
(c) Volume irradiated
(d) Type of radiation, its energy and L.E.T.
(e) Type of interaction - function of radiation and absorber
(f) Type of tissue - bone, muscle, fat
(g) General features of variation of absorption coefficients as a function of energy and atomic number. Does this have any bearing on diagnostic x-ray?
(h) Oxygen effect (already discussed)
(i) Chemical radiation sensitizers - 5FU, etc.
(j) Chemical protectors - how do they work?
(k) What is the order-of-magnitude duration of hot radicals
(l) Relative radiation sensitivity of the organ
(m) Division rate (mitotic index)
(n) What is the law of Bergonie-Trapideau?

III Ethics - Professional Attitude

1. How and where would you start if a doctor wanted to try out a brand new idea for a diagnostic radioisotope test? Assume the isotope had never been used before and the metabolism of the proposed tagged compound had never been investigated, as far as you knew.

2. Literature search is negative. What then?

3. In work with experimental animals is organ analysis sufficient? (Answer: One must be careful to always determine blood activity levels and correct for it in organs containing significant blood)

4. How do you determine effective and biological half-lives?

5. When you have found the critical organ and the pertinent half-lives, how do you calculate the dose?

6. Can data on metabolic pathways in experimental animals, e.g. guinea pigs and rabbits, be relied on to apply 100% to humans?

7. Animal studies and dose calculations seem to show no unusual hazard from the procedure. What about doing such an experimental procedure on children?

8. What do you tell the patient on whom you propose to try out this new procedure? Can you <u>guarantee</u> that it will not have any harmful effect on him?

9. What should the physicist advise the doctor concerning legal liability re the radiation risk?

10. Even though the formal legal liability may rest entirely on the doctor, what is the physicist's responsibility in this area?

These questions are recalled from memory, of course, and very likely are not listed in the order in which they were asked. Subject area II (interaction of radiation with matter) was actually developed in general back and forth discussion form rather than in the manner which might be assumed from my long list of "separate" topics.

The examiner was courteous and patient. He used two or three minutes for friendly small talk before actually starting the examination.

HIGH ENERGY ACCELERATORS

Describe the operation of a betatron. How is this machine used to produce x-rays?

Describe the operation of a linear accelerator.

Describe the operation of a Van der Graaff generator.

How does one control the "quality" (wavelength and uniformity of field) of a beam of x-rays produced by a betatron?

Compare the x-ray spectrum from a betatron operating at 22 Mev with the spectrum from a Cobalt-60 unit.

Discuss the relative importance of exit dose for each of the following: A high energy unit (betatron, Van der graaf, linear accelerator), a Co-60 unit, a 250 KVP unit.

You are a newly appointed Chief of the Division of Radiation Therapy and have a choice of installing one high energy unit: a betatron, linear accelerator, Co-60 unit. What are some of the considerations you must evaluate before making a selection?

How would you measure "dose" with a betatron?

Some betatrons are capable of delivering a beam of electrons as well as a beam of x-rays. If the unit were operating at 22 Mev and you were treating a large deep seated tumor (say 10 cm at depth) which modality would you prefer? Why?

Compare the following factors for an x-ray beam from a betatron operating at 22 Mev with a beam from a Co-60 unit

a) Skin dose
b) Depth dose
c) Definition of beam
d) Bone absorption
e) Uniformity of field

Compare a G-M counter with an ionization chamber with regard to sensitivity, ability to measure exposure rate.

Discuss the relative merits of the photographic and gaseous ionization methods of measuring x-ray dose rates. Explain how a dose rate meter can be calibrated.

Describe a Wilson cloud chamber. What is it used for?

Describe a Bubble Chamber. What is it used for?

Describe in detail the Victoreen Condenser Ionization instrument.

If you are going to measure the output from an x-ray machine with cones, where is the ionization chamber placed to obtain the output at the bottom of the cone?

What is meant by a thimble ionization chamber? How does it compare with the extrapolation ionization chamber?

Describe the Free Air Ionization Chamber? What requirements must be met in measuring the true ionization current?

In checking a nuclear counter, a source was counted three times by preset time method for five minutes each time. The following total counts were observed:

9120
8900
9350

these results agree with expectations for properly functioning equipment? If you think that these results indicate that something is wrong with the equipment, what will you do?

You receive a scintillation counter on approval. How will you determine whether it performs satisfactorily (what will you check and what radiation source will you need to use?)

What does the term "energy dependence" mean with regard to a radiation detecting system?

What is the principle of the operation of a condenser ionization chamber measuring instrument?

What determines the necessary separation of the electrodes in a free air ionization chamber?

What kind of radiation measuring instrument would you use to measure stray radiation levels near a radium safe? near a fluoroscope?

What is ionization? Discuss the importance of this phenomenon in radiation measurement.

What is a Monitor Ionization Chamber on an X-ray therapy machine?

How would you experimentally determine the optimum wall thickness for a thimble ionization chamber to be used for the measurement of radiation from a Co-60 teletherapy unit? How would you calculate this thickness?

A standard free air chamber has a diaphram area of 2/3 square cm and a collecting electrode 3 cm long. If 150 e.s.u. are collected in 5 minutes what are the R/min? At what distance from the target is this exposure rate determined?

Describe and discuss how a Geiger counter functions.

Define "resolving time" and classify the Geiger counter, proportional counter and photomultiplier tube (scintillation counter) with respect to this characteristic.

Compare the advantages and disadvantages of the Geiger counter to the scintillation counter.

In the definition of the roentgen, what is "associated corpuscular emission"?

Why is a 250 R thimble chamber with a thick wall likely to be not as accurate as a 25 R thimble chamber with a thick wall for measuring dose rates from a Cobalt-60 source?

Is there any objection to leaving the cap off the contact end of the chamber tube of the Victoreen Condenser R- Meter when (a) it is stored in the case, and (b) it is being used for making a measurement?

How might you use photographic films to determine depth dose curves, and what are the sources of error?

Can biological material be used to measure dose? Discuss.

Explain what is meant by the term "effective wavelength". Compare the effective wavelength in an x-ray beam from a pulsating x-ray machine to that from a constant potential machine.

Discuss the factors which are important in choosing material for an x-ray target.

Describe a rotating anode x-ray tube. What are its advantages over a stationary t

What are some of the methods used to dissipate heat in diagnostic x-ray tubes?

Describe the following and describe how one can influence each:
contrast, detail, distortion, fog.

What are the factors which influence unsharpness of an x-ray film?

Approximately how much filtration is usually found in diagnostic units? Why this much and not more or less?

Discuss how an intensifying screen in a film cassette works.

What is the physical reason for choosing iodinated compounds as contrast agents?

What is meant by the term "film speed" in radiography? What is the most important method of increasing speed in recording radiographic images?

Why are image intensifiers desirable in fluoroscopy? If the gain of an image intensifier is infinitely large, would it be possible to reduce the x-ray exposure dose rate to an infinitely small level? Discuss.

What are the advantages and disadvantages of high KV radiography?

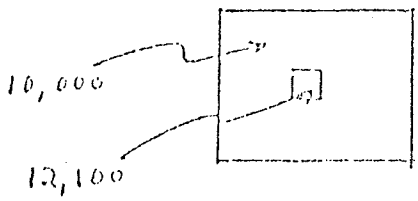
On entering a new department you find the following factors in use for A-P pelvic exposure in 20 cm thick adults:

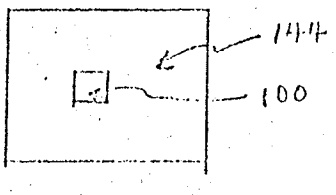
focal film distance: 30"
Bucky grid ratio: 16 to 1
Detail screens
54 KVP
300 MAS
0.5 mm AL added filtration
Kodak Royal Blue film

What changes, if any, would you make in these factors?

How would you measure focal spot size and shape? How would you determine whether your x-ray machine was full wave rectified or half wave rectified?

Illustrated below are two fluorescent screens with the image of a square object. The number of light photons striking the retina from each square cm of surface is shown. What is the percent contrast for A? For B? What is the light fluxation for A? For B? In which situation is the perception of the object the easiest? Why





Name the factors required to obtain an optimum roentgenograph and discuss each one. (By an optimum roentgenograph is meant one containing the most information in the recorded shadow).

What is meant by the penumbra of an x-ray beam? What are the factors which control its magnitude?

Discuss the processes by which x-rays are generated when high energy electrons strike the target of an x-ray tube.

Explain the term "line focus" of an x-ray tube. Why are x-ray tube targets shaped this way?

An object 2 cm long is 100 cm from the focal spot of an x-ray tube and 10 cm from the film. How big will the shadow be on the film?

A 150 KV x-ray beam strikes a patient. By what mechanism will these rays be absorbed in the patient?

What is meant by "intensification factor" of an intensifying screen?

Discuss the advantages of intensifying screens and also the disadvantages.

Draw an x-ray tube and identify the different parts. Explain the function of each.

Discuss briefly the factors which affect the contrast and sharpness of a radiograph.

Describe the process of absorption of x-rays by matter. Illustrate your answer by considering the absorption of low and high energy x-rays by varying materials, such as soft tissue and lead.

What is an x-ray tube rating chart and why should it always be available in the radiographic room?

What methods can be used in roentgenography to reduce scattered radiation from reaching the film?

What is the relationship between the gamma (or contrast) of a film and its latitude?

What is the grid ratio? Discuss the importance and use of grids.

Describe how one would obtain the HVL of an x-ray beam.

What is meant by the quality of an x-ray beam? In the operation of an x-ray machine how can the quality be influenced?

Can the quality of an x-ray beam by influenced by the choice of target material? Why

What is meant by coefficient of absorption? coefficient of mass absorption? What is meant by discontinuities in the mass absorption coefficient?

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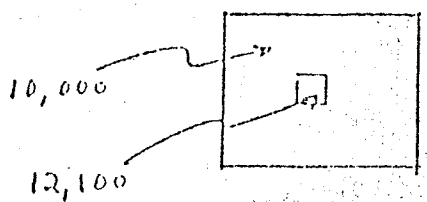
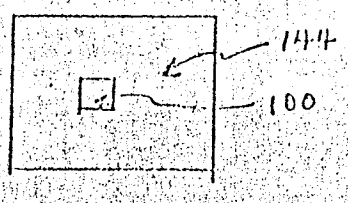
Illustrated below are two fluorescent screens with the image of a square object. The number of light photons striking the retina from each square cm of surface is shown. What is the percent contrast for A? For B? What is the light fluxation for A? For B? In which situation is the perception of the object the easiest? Wh





Name the factors required to obtain an optimum roentgenograph and discuss each one. (By an optimum roentgenograph is meant one containing the most information in the recorded shadow).

What is meant by the penumbra of an x-ray beam? What are the factors which control its magnitude?

Discuss the processes by which x-rays are generated when high energy electrons strike the target of an x-ray tube.

Explain the term "line focus" of an x-ray tube. Why are x-ray tube targets shaped this way?

An object 2 cm long is 100 cm from the focal spot of an x-ray tube and 10 cm from the film. How big will the shadow be on the film?

A 150 KV x-ray beam strikes a patient. By what mechanism will these rays be absorbed in the patient?

What is meant by "intensification factor" of an intensifying screen?

Discuss the advantages of intensifying screens and also the disadvantages.

Draw an x-ray tube and identify the different parts. Explain the function of each.

Discuss briefly the factors which affect the contrast and sharpness of a radiograph.

Describe the process of absorption of x-rays by matter. Illustrate your answer by considering the absorption of low and high energy x-rays by varying materials, such as soft tissue and lead.

What is an x-ray tube rating chart and why should it always be available in the radiographic room?

What methods can be used in roentgenography to reduce scattered radiation from reaching the film?

What is the relationship between the gamma (or contrast) of a film and its latitude?

What is the grid ratio? Discuss the importance and use of grids.

Describe how one would obtain the HVL of an x-ray beam.

What is meant by the quality of an x-ray beam? In the operation of an x-ray machine how can the quality be influenced?

Can the quality of an x-ray beam by influenced by the choice of target material? Why?

What is meant by coefficient of absorption? coefficient of mass absorption? What is meant by discontinuities in the mass absorption coefficient?

1966

Memorandum

Schaffer

1. # Radiological Physics

6-4-66

Dr. Childs- (put you at ease-more like a casual conversation than question & answers)

1. What would you do if you saw a resident setting up a child for therapy treatment and was doing something completely wrong?

ANS: We as free moral agents are responsible morally and legally for acting according to our best knowledge. We should attempt to correct the wrong tactfully, if this did not give satisfactory results, report the incident to a superior that has direct control over the intern.

2. Do you think it would be proper to conduct an experiment to produce some normal values of teeth or jaw development by taking full mouth x-rays of 1,000 children?

ANS: Discussed somatic and genetic dangers as well as some dental equipment that may over-radiate.

2a. Speaking of both somatic and genetic damage what is DNA?

ANS: A large molecule made up of carbon, hydrogen, oxygen, nitrogen and perhaps smaller amounts of sulfer, sodium, chlorine and other elements we incidentally find in proteins. The molecular weights is in the order of many thousands. It is found in the nucleus of both somatic and sex cells. It has been postulated that this molecule has the ability to reproduce itself. A model produced by some biochemist a few years ago won the chemistry Nobel prize. It has a spiral appearance.

2b. What has DNA to do with either type of cell damage?

ANS: Radiation may ionize an atome in the molecule with the result of splitting, polymerizing or other chemical effect that will cause a mutation in the cells of this mother cell. This may mean a recessive abnormal trait produced in the progeny of a radiated parent.

2c. What would this mean in terms of somatic cells?

ANS: Somatic cells may devide into a new type of cell and, as postulated by Warburg, may become a rapid devide type with a reduced, fermentation type of metabolism and rapidly replace or impede normal tissue function and thus be termed as a malignant neoplasm.

3. Discuss the reason why the practice of hyperoxygenation of patients is being done during radiation treatments.

ANS: This is done to attempt to increase the radiosensitivity of the radiated tissue. It has been shown by reducing oxygen tension the tissue becomes more radioresistent.

3a. Have you ever thought that just because reduced oxygenation shows radioresistence that increased oxygenation above the normal o2 tension might not increase radiosensitivity. In fact, I would now surmise it would not.

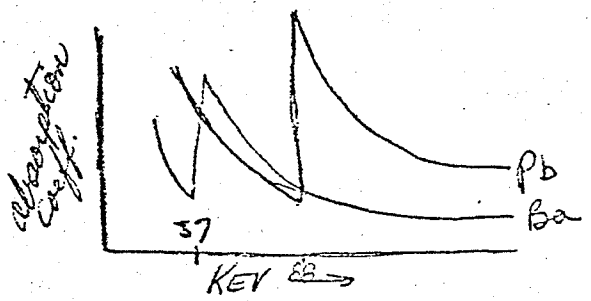
Dr. Keriakes- (Did not put you nearly so much at ease)

1. What opaque media do you use in diagnostic department?
ANS: Barium and iodine compounds.

1a. If I gave you a lead compund would you prefer to use it instead?
ANS: Lead compunds are very toxic.

1b. If I guaranteed that this would not be toxic would you us it?
ANS: It probably would give a shadow greater than tissue, but depending on the Kv of your machine, you might be right at the point of the K edge where P.E. absorption could be very low.

1c. Draw the absorption curves of barium and lead.
ANS:

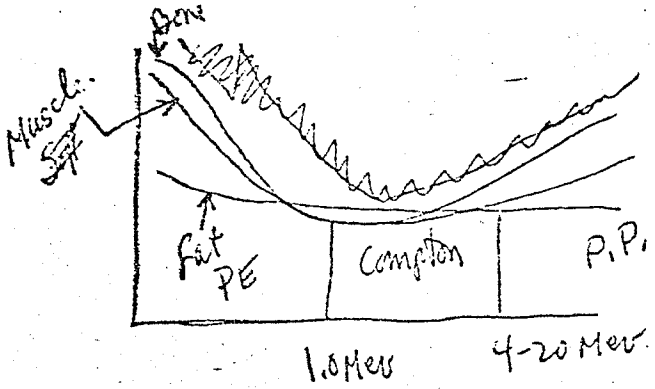


1d. What causes this K edge?
ANS: This edge coincides with the binding energy of the K electrons. Since photoelectric absorption is the knocking out of the K electrons, the photon must excede the binding energy of the K electron and the cross section of this process is greatest when the photon energy is equal or very slightly greater that the binding energy.

2. What is the relationship of the P.E. absorption to ~~Z~~?
ANS: The absorption increases with increased z with the relationship of about ~~Z~~ 3.

3. What is the relationship of absorption of ~~Z~~ to other absorption coefficients?
ANS: Comption scatter is independent of Z but is dependent of number of electrons in any given volume, therefore it is more closely proportional to density.

4. Draw the curves for the total absorption coefficients for various biological tissues. — total attenuation ?
ANS:



kVp

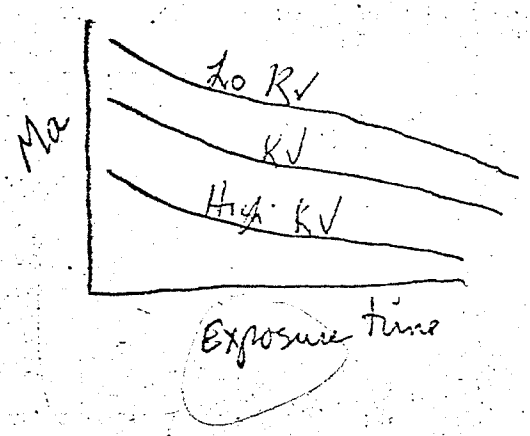
13

5. Discuss the heat capacity of a diagnostic tube.
ANS: The heat capacity of the tube is measured in heat units, products of the applied Kv times the Mas. The cooling rate is given as heat units per minute.

6. How is the heat dissipated?
ANS: Mostly by conduction because the vacuum insulates against any radiation of heat. The heat is conducted into the copper block that backs up the tungsten. The heat is initially spread over a larger surface area if the target rotates. It is conducted down the stem of the target to the stator and exits thru the tube to a metal ballast that has a fan blowing air over it.

7. Describe tube damage by heat.
ANS: The target may partially melt, pit and degas by overheat, occasionally mechanical damage such as warping or cracking the envelop might occur.

8. Draw the way the limit of a diagnostic tube is usually presented.
ANS:



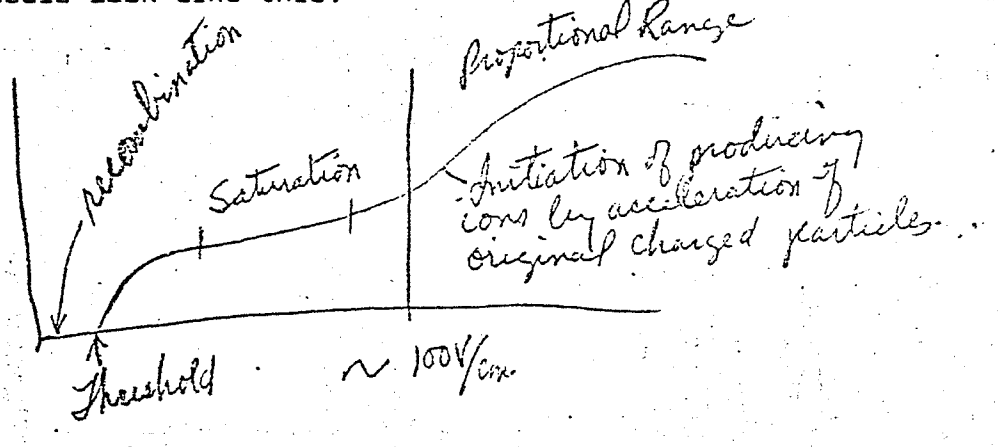
Dr. Williams- (put you very much at ease)

✓ 1. What would you do if your boss was a little eccentric and wanted to inject some untested isotope medicine into patients to prove some theory he has?

ANS: I would first set up an animal program and sacrifice test animals serially, locate the isotope, determine its biological T½ in various organs. Knowing the chemical and the isotope, I might be able to predict its metabolism, but it would also be necessary to determine the dosage it gives total body and specific organs. (He went on to describe to me an interesting experience where he found that the carrier was toxic chemically.)

(2.) Suppose you had a chamber designed that could collect ions, what is the voltage relationship to the reading?

ANS: If I had a device which was essentually a "can" with a wire going through it with a voltage applied, the signal to voltage per cm. would look like this:



(Williams stopped me before I got to G-M range)

✓ 3. How would you measure the activity of very low energy beta?

ANS: Either a gas flow counter using G-M principle (4 11) or a liquid scintillation counter.

✓ 4. Could you measure a beta spectrum with a G-M tube?

ANS: No, the G-M tube gives an "all or nome" response. The avalanche cannot be related to the initiating radiation.

✓ 5. Where do the beta particles originate when counting x rays with a G-M tube?

ANS: Mainly in the envelope. Very few would orginate in the gas itself.

✓ 6. On what instrument would you quantitively measure P-32?
ANS: A thin windowed G-M tube.
✓ 6(a) Do you think you would tally all the counts?
ANS: By far the greater portion, exluding those lost by geometry or self absorption. The G-M tube is nearly 100% efficient in this case.
✓ 6(b) Will you lose any betas that cannot penetrate the mica window?
ANS: A very minor quantity, I should guess 1-2%.
✓ 6(c) How could you be sure?
ANS: I could add some thin filters and extrapolate to no filtration.

? → 7. Last year an intern (during his board exam) pointed out that handbook #76 shows x mm. lead as the HVL for making a cone to decrease the primary beam to the "legal" 5%, but the same handbook shows Y mm. lead for the attenuation of the primary beam against the wall. There is a disparity of X3 in the two figures, why? (He added it took himself several days of thought to justify the difference and he just wondered what I could come up with at the spur of the moment.) (I hoped this might have been a "bonus" question.) ?

ANS: It might be because the beam strikes the cone at such an angle that it actually travels through much more material than if the HVL were measured normal to the surface.

7(b) He said the HVL would be considered normal to the beam not the surface of the cone. Besides, the disagreement is in the other direction.

ANS: The cones attenuation is to a given 5% whereby the walls attenuation is probably much greater, therefore, since the absorption curve for x-ray is not a straight line the HVL listed was the 1o-15th are greater level.

Dr. Webster- (Heavy English accent. I was not at ease because of forewarning.)

1. A card was given that read "If you were given some P 32 and another matter to make up an "infinitely" thick applicator, give the dose that would be given to a surface lesion. (After reading the card Dr. Webster added-you may chose the medium of the block, but I do not want the dose described in principles but in actual numbers of rads or roentgens !)

ANS: The material I would choose would be a plastic with an absorption similar to soft tissue. An inner block of the applicator would receive a rad dosage of:

$$\frac{3.7\times10^{7}\ \text{mc/gm} \times \bar{E}_{\beta} \times \frac{\text{ergs}}{\text{Mev}}}{100\ \text{ergs/gram}}$$

near the interface of the block and skin though beta dosage would taper off. The beginning of this tapering would be the average linear path of the beta or in the case of P 32 5-6 mm. The taper would continue to about 50% of the dosage at the interface. The spectrum of the beta at this interface would produce an $\bar{E}_{\beta}$ lower than if all P 32 atoms were at the surface because some of the betas would have lost most of their energy going throught the media. This reduced $\bar{E}_{\beta}$ might increase the dosage very near the interface because of the increased L.E.T., but again the total energy of the spectrum being reduced the dose mya be less than 50%.

1(a) Let me reming you that I did not ask for principles but but for a numerical dosage.

ANS: I could give you the approximate 50% dosage of the interior but no closer than that at this present time (THIS PROBABLY FINISHED ME OFF ! ! !)

2. I have here a depth dose chart 4 mm Cu. 100 cm^2, 100 FSD. If a tumor were at 10 cm. and you wished to treat this by rotational therapy how would you figure the T.A.R.?

ANS: T.A.R. includes no inverse square law, therefore one would multiply the 44 of the chart by $\frac{100^2}{110^2}$.

(This is compared to the surface dosage $\frac{100}{126}$ since 26% of that dose is scatter.)

Then since T.A.R. can be compared to a measurement in air at the greater F.S.D., the 100% maximum surface dose would be decreased by dividing by the scatter plus primary factor of this situartion shown as 126%, then this quotient would be reduced further by the inverse relationship of $\frac{100^2}{110^2}$

3. How would you determine the gamma factor of a given isotope?

ANS: Maynoerd produced the concept of photon flux. If a point source is producing gamma it will leave in a 4π geometry. The portion of this flux that passes through a window at 1 cm.^{2} would be $\frac{1\ \text{cm.}^2}{4\pi\ \text{cm.}^2}$ of the total flux.

knowing this density of flux one would multiply this by the factor found on a chart of Mev. vs photons/R at 1 cm.

4. What is the shape of that curve?

ANS:

5. How would you produce isodose curves if you only had depth dose (central beam) tables?

ANS: It would be tedious, by first drawing central beam line with 10% points on it the penumbra can be drawn in which would produce a 100 - 0% gradient due to primary beam. Then take numerous cross sections and by wedge shaped surfaces and scatter function table the scatter contribution of numerous points could be determined. If the field were large enough, inverse square law might be considered at the periphery.

6. Draw an isodose curve for 400 Kv.

ANS: 100% is near the surface (about 1 mm.) but can be considered surface. At 10 cm. the depth dose about 25-30%. The edges would be abrupt with about 20% just outside the collimated field.

Questions that were given but I have forgotten who gave them.

1. What isotopes do you use?

I-131
Tc-99
P-32
Cr-51
etc.

2. Pick out several and tell me how they are produced.

ANS: I-131 is a fission product earlier in the history of isotopes telurium was used as a target and I-131 was accelerater produced. P-32 is pile produced by a

reaction commonly called an NP reaction. Quite a few of the medical isotopes are pile produced where the target is increased to the isotope by increasing "A" with the simultaneous release of energy as a γ this is an n,γ reaction. I am familiar with $Ag^{109} \xrightarrow{N,\gamma} Ag^{112} + Q$ because I have done this reaction.

Schaffner

[redacted]

May 12, 1967

[redacted]

Dee [redacted]

Excuse me for bending your ear again so soon, but unfortunately there was a small error in my May 1st letter which I didn't catch in time. Also, I have recalled three or four more of my board exam questions which you might want to pass along to Dave.

The error I refer to was at the end of the second paragraph: "only 5% out of 1510 lost to follow up" should have been "only 5 out of 1510".

Some more of my 1965 board questions were:

1. Discuss setting up a program for incineration disposal of Carbon 14 and Calcium 45 wastes from a hospital. What sort of standards must the ashes meet?
2. Discuss the mechanisms of quenching agents in G.M. counters and liquid scintillation counters.
3. How can you calibrate the kilovoltage of a 250 KV constant potential unit, and a 2 Mev generator. (I might have mentioned that one before).
4. Discuss contrast and latitude in films.
5. Discuss the heat rating of X-ray tubes re MA-sec/exposure and exposures/min or hour.

Hope these may be of some help.

Yours sincerely,

Howie

(Mr.)
Physicist

EHC/rm

July 10, 1967

Memorandum to File

Subject: Board of Radiology Physics Examination

From:

The oral examination in Medical nuclear physics (only - taken by) given at Pittsburg, Pennsylvania, during the 1967 session was administered by Childs, Webster, Williams, and Krohmer. The categories of examination were fundamental physics, measurements and protection, radiation dosage, and clinical radiology (radiobiology). Specific examination questions were as follows:

1. What are the symptoms and signs of an overexposure to the hands?

2. What is considered to be the LD-50 for whole body exposure and what are its symptoms?

3. What is the effect on radiosensitivity by increased oxygen tension?

4. What are the various factors that effect the radiation sensitivity or biological effect of radiation exposure?

5. What are the expected changes in blood constitutents when an individual receives an acute whole body lethal radiation exposure?

6. Where should the Dosimetry film badge be worn on the body?

7. What phenomena of nuclear fission prevents a reactor from blowing up or exploding? (refers to delayed neutrons)

8. By knowing the atomic number, atomic mass, and the number of atomic mass units for Ni-65, Cu-65 and Zn-65, describe expected radioactivities.

9. What is the net counting rate and the limits of the standard deviation for the net count when a sample is counted and a count of 1200 counts are obtained in three minutes and the background count was 1600 counts in eight minutes?

10. The gamma spectrum of cesium-137 was shown and the participant was expected to point out the photoelectric peak, the compton edge, the backscatter peak and the fluorescence peak.

11. When observing the photoelectric peak with a sodium iodide scintillation system, what determines the resolution of the system?

12. Define the roentgen (the exact definition is expected).

13. If 100 millicuries of iodine 131 is given to a patient who dies five hours later, what instructions should be given to the Funeral Director or to the individuals performing an autopsy?

14. Discuss the linear energy transfer for alpha, beta, and gamma radiations.

15. Describe an extrapolation chamber and its usage.

16. The National Bureau of Standards Handbook #76 recommends that the radiation intensity outside of the collimator system should be less than 5% of the primary beam. These values are given in table 11 and do not necessarily agree with the number of half value layers as required according to Table 12 to accomplish the same 5% reduction. Why the difference?

17. Describe the design requirements for an ion chamber.

18. Can an ion chamber be used to determine the gamma output from gamma emitting radioactive materials?

19. Compare the radiation dosage rate at the surface of a sphere and at its center when it is loaded with an uniform distribution cobalt-60. The sphere is 10 centimeters diameter. Show calculations.

20. With the decay scheme of potassium-40 shown, compute the dosage to man per year from the normal distribution and concentration of potassium-40.

21. How many millicuries of phosphorous-32 is required on an infinite thick, 10 cm^2 source to give a contact dose of 10,000 rads in one day?

22. Why do we use infinite thick sources of beta emitters for contact therapy?

23. What is the formula for calculating the G value for a sphere? Compare this to the formula for calculating the G value at the center and at the edge.

24. Be able to compute the time necessary to create a gold-198 source at one curie per gram when the neutron flux, cross section, and decay constant are known.

AMERICAN BOARD OF RADIOLOGY
CERTIFICATION EXAMINATION
IN RADIOLOGICAL PHYSICS

Pittsburgh, Penna., June 3, 1967

Questions asked of (and recalled from memory by)
John W. Schaeflein

I. Fundamental Physics - Dr. Webster

1. I was handed a card whereon was something resembling the following:

			amu
28	Ni	58 (?)	xxxxxx
29	Cu	64 (?)	xxxx
30	Zn	66 (?)	xxxxxx

The mass nos. and atomic mass units for each isotope were specific nos., no longer remembered by me.

Discuss stability and probable transitions - in protracted and thorough detail.

2. With respect to protection problems, why do we use the currently recommended values for attenuation of scattered radiation?

He wanted a thorough explanation of why 500 KeV is used as the maximum energy of scattered radiation.

3. Given: sample plus background equals 300 cpm
background equals 25 cpm
sample plus background counted for 10 min.
background counted for 2 min.

What is the standard deviation?
How much error at 96% confidence limit?

4. A 30 KeV photon is completely absorbed in a scintillating material. How many blue light photons could be produced?

5. How much radium would be present in a given mass (?) volume (?) of "radium ore" (?) taken from the earth (?)?

The question is now fuzzy, but he wanted a thorough discussion of radioactive equilibrium both transient and secular.

6. How is fluorescent radiation absorbed in a given material (which is emitting it?)?

This is another dimly remembered question, but he wanted a discussion of absorbtion at the K edge - also use of various filter materials to absorb such radiation.

II. Measurements and Protection - Dr. Williams

1. Define the Roentgen.
discussed limitations and need for elect. equilibrium.

2. Asked me to explain an apparent discrepancy in Handbook 76, Table 11 and Table 12. Table 11, e.g., shows 0.15 mm Pb required to reduce 100 KVp beam to 5%; Table 12 shows HVL for 100 KVp beam is 0.24 mm Pb. How come?

3. How would you calculate the specific gamma ray constant for a given isotope?

4. Given: at some point in a beam you know that the exposure rate is 1.0 R/m. If you put in a chamber with a volume of 1 cc., will it measure 1 R/m?

   Discussed all of the corrections necessary for an accurate measurement of exposure rate.

5. Given: 100 mc I 131, patient dies 5 hours later. What do you do as RSO at autopsy?

6. Could you measure specific gamma ray constant with an ionization chamber?

III. Radiation Dosage - Dr. Krohmer

1. How much P32 needed in an infinitely thick applicator to deliver (to skin surface) 6000 rads in 24 hours?

2. How do you compute dose from an internal beta emitter?

3. How do you determine dose for moving field therapy?

4. Discuss relation of Roentgen to rep, rad, rem.

5. Define and discuss: RBE, LET, QF.

IV. Clinical Radiology - Dr. Childs

1. Do you wear a film badge? Where?
   Discussed exposure to hands compared with total body.

2. Discuss early and late symptoms of chronic irradiation of hands.

3. Discuss hyperbaric oxygen therapy.

4. List and discuss all the factors which influence the response of tissue to radiation.

I spent 50 to 60 minutes with each examiner; they were courteous, helpful, and thorough.

June 7, 1975

EXAM IN DIAGNOSTIC RADIATION PHYSICS

of

By David J. Klein, Ph.D.

Examiners: Dr. McConnel (M.D.), Dr. Charles A. Kelsey (Ph.D.), Dr. Edward W. Webster (Ph.D.) and John S. Laughlin (Ph.D.)

Dr. McConnel led off with a question on the gonadal dose in radiography and fluoroscopy wanting to know the dose in a barium enema procedure and what they could do about it to reduce the dose. My answer was that in males he can be protected by a gonadal shield, females cannot be so protected so they must take the radiation. They should only do this procedure in 10 to 14 days after menses. Males can be placed so that their gonads lie outside the main beam. I also did some mental calculations concerning the dose. Another question; female undergoes a barium enema and then is discovered to be pregnant. What would I suggest at a department meeting. My answer was a therapeutic abortion based on (1) the early first trimester exposure which is serious for the baby and the abortion would not be a serious operation, (2) probably it was an unwanted child anyway and (3) the ease of repeating pregnancy if the child is wanted.

Question; what is an IVP, a chest film, a pelvic examination, angiography or heart cath and myelography, compare the doses, and I just put them in order. The question; have I had patient contact, the answer was no. The question; do I want patient contact, the answer was yes. And the question; how? The answer was in angiography for instance. The conversation turned to whether I had any experience with angiographic procedures at all and I pointed out that I had witnessed the angiographic procedures and that I helped the nurses get the bubbles out of the injector and a few other things. The question; what do we mean by cancer? I answered

that I believe satisfactorily and, question; do I know the origin of the word tumor? and I said no. His answer; he says it simply means swelling. Dr. Kelsey, Dr. Webster and Dr. Laughlin had a number of questions, each one in his own field but the questions were mixed up in my mind and I cannot recall who asked which question. Among them they were; what is the critical area for getting rid of target heat? The answer that I gave was the focus, then the rotating anode. Question; what is meant by absorption coefficient? My answer was the linear absorption coefficient is the factor which when multiplied by a length expresses a pure number which is the exponent of e in the expression for attenuation coefficient. A mass absorption coefficient is the factor looked up in the tables. I like to call them μ equals a linear absorption, $\frac{\mu}{\rho}$ is the mass absorption coefficient. The question was asked as to the speed of screens par versus high speed, I answered a factor of two different, the high speed being a faster screen, from there it went to which one would have a better resolution and of course I answered that the MT and from there we went to MTF's, a short discussion. Back to screens, the question was the difference between rare earth types and calcium tungstate and I answered that. The reasons for improved efficiency and or improved resolution of screens; I answered that satisfactorily too but I did not know about the radical improvement of efficiency in rare earth screens. Question; why does a cine system that is used simultaneously require two lenses and the answer was it needs a virtual image for the eye and a real image for the camera. Dr. Laughlin had his questions on a card so that they are more easily remembered recalled first suppose you have a 20 cm thick patient and 100 cm target to film distance and a 60 cm target film distance,which gives higher

dose for acceptable radiograph? I answered that one on paper but a little bit haltingly. He asked the question on gonadal dose over again, but it was phrased differently. Then he asked why cannot electrons be accelerated in a cyclotron. He wanted to back away from the question since it was not a diagnostic question but I insisted that I could give an answer with coaxing from him. The electron orbits would be to small. I observed that the cyclotron effects had been observed in solids by Von Hipple, at NBS 25 years ago. The orbits were very small. He added in a question leading me toward relativity theory, the fact that at the accelerating voltage the electrons would be traveling at the speed of light or close to it.

My impression of the examination was that very little was asked that I had studied. There were no questions relating to the laws, to the law, the new law, there were no questions that simply wanted an answer. The examiners did not lead me on and allow me to follow one thought for a considerable length of time, did not encourage me to use pencil and paper. But on the whole, it was a fair exam and the fact that I failed it is only my own fault.

David J. Klein

David J. Klein, Ph.D.

June 21, 1976

EXAMINATION IN DIAGNOSTIC RADIOLOGICAL PHYSICS

DATED: MONDAY, JUNE 14, 1976

David J. Klein, Ph.D.

Examiners

Jack S. Kromer, Ph.D.,	Protection
James G. Kereiakes, Ph.D.,	Dosage
Marvin M.D., Williams, Ph.D.,	Equipment
Kenneth L. Krabbenhogt, M.D.,	Clinical Procedures
William R. Hendee, Ph.D.,	Fundamentals
Raymond L. Tanner, Ph.D.,	Measurements

The examination started promptly at 12:30 p.m. on the above date and was carried out in order of the above-listed examiners. Dr. Kromer was the first examiner. He did his best to put a person at ease and then we sat down and he explained that he was giving his questions out of the MD's examinations and he was expecting better answers or more detailed answers so he let me pick the cards. Their questions turned out to be nothing out of the ordinary for the subject of protection.

I then went on to Dr. Kereiakes. Dr. Kereiakes maintained a more formal attitude and did nothing to put a person at ease but there is nothing about his questioning that was out of the ordinary either. He also used cards to start one off on a subject of questioning but he did not offer as many cards. All of the examiners who used cards spread them out on the table face down, there would be about ten or so cards, and then let me pick them out.

The next examiner was Dr. Williams on equipment. He did not use cards as such. He simply asked questions as they came to his mind. The first question was on C.A.T. scanners. He simply wanted to know what the general purpose was. I answered it then we went on to linear vs. multidirectional tomography, (body section). His question was, what are the advantages of multi- and what are the advantages of linear-. I answered him but got into a friendly scrape with him over the disadvantages of linear tomography,

that being one of my pet peeves. He also asked one or two questions about fluorescent equipment, why there are so many lenses in the equipment and what the radiation doses would be in different sizes of film, 105 mm, 35, and 16. I was to compare them. Incidentally, the question of mammography dosage came up, first with Dr. Kromer, then with Dr. Kereiakes, and with Dr. Williams. I begged off with Dr. Kereiakes and with Dr. Williams. They assumed that since I had answered Dr. Kromer they could get more out of me by going to a different question. Dr. Krabbenhoft showed me a radiograph (turned out to be a cholangiogram) and asked me what it was. The right side of the lower pelvic region, it was the radiograph of an opacified gall bladder with a tube passed surgically into the patient, but I did not recognize the picture. I could have told him what the other parts showed on the picture such as the ribs, spine, heart the 12th rib and where we were in the body , but I did not have the presence of mind.

He asked whether a woman who was subsequently found to be pregnant had a lower GI. should she abort or not? He then asked the functions of erythrocytes, lymphocytes, and blood platelets. What other formed cells are in the blood? Dr. Hendee was the next examiner. His effort was to put me at ease first. After taking one of his cards I began to answer the questions on it which had to do with screens and films and he took over and presented a codicil to answer, in the form of a summing up. I don't know whether this is a good thing or not but I appreciated it. Then I got into another scrape with Dr. Hendee about a case where two screens are made of the same material but one is a par speed screen and the other is a fast screen. The question is, do they both exhibit the same amount of "mottle" and what two mechanisms are responsible? After a brief exchange on this subject, Dr. Hendee suggested that it would be a good subject to discuss over a cup of coffee, but he wouldn't waste time over it here. I did not resolve this question until the next day after thinking about it: If you assume that the densities of the films are the same, then you have the screen mottle to contend with, and having cut down the beam intensity to accomodate the faster screen, you have an increase in quantum mottle. My answer was couched in the assumption that the beam remained the same. Dr. Tanner was the last examiner. His examination was on measurements, and they were routine questions which I picked out of cards.

The results were that I passed all of the examination except that of Dr. Kereiakes on dosage, and that of Dr. Krabbenhoft in Clinical Radiology. I was conditioned in these two parts. It was different from the examination that was held last year and took me mildly by surprise. Last year my performance in the subject of dosage was considered passing.

D. J. Klein

D. J. Klein, Ph.D.

David Klein

Examination (cont.)

Clinical Portion (Dr. Christie, M.D.)

Q. A patient comes in complaining of abdominal pains. What would the M.D. do?

Ans. Ask for an upper and lower G.I.

Q. How are upper and lower G.I.'s carried out?

Ans. The upper by a barium sulfate swallow and is followed by fluoroscopy. It includes the esophagus, stomach, duodenum, cecum, a little of the small intestine.

The lower is by a $BaSO_4$ enema, the patient having been prepared. Includes the rectum, descending colon, transverse colon, ascending colon, ileum, jejunum, appendix.

Q. There followed a number of terms which I had to define or describe. Among them:

Cholangiography

Where the bile is formed

Blood - red and white cells, platelets

Ascites (I didn't know this one)

Dr. Christy then expressed hope that I would make it. He said that I had done all right by him.

Q. Do you have very many X-ray machines at your hospital?

Ans. Yes, about 200 tubes.

Q. Plop, 200?

Ans. Yes, 200.

David J. Klein

To Whom it May Concern:

Examination of David Klein, in Diagnostic Radiological Physics.

Make-up exam held in Atlanta, Ga., this date.

Dosage (Dr. Arnold Feldman, Peoria, Illinois)

Q. What factors does the skins dose at the table top depend on?

Ans. kVp mAs FOD, filtering.

Q. How much is a fluoroscope allowed in table top skin dosage.

Ans. 5R/min (new) 10R/min (old).

Q. How is the quality of the beam characterized?

Ans. HVL (Al) + kV

Q. A woman has a lower GI and then is discovered to be 3 mos. pregnant. What would you do?

Ans. Try to re-enact the dose with a phantom. If the midline exposure is 10R or more, fall back on Hammer-Jacobson and recommend a therapeutic abortion to the clinician. Depending on other factors he may pass this recommendation on to the pt.

Clinical Portion Dr. Christie, (M.D.)

Q. You are a radiological physicist. What can you do to help me as the Chief Radiologist?

Ans. I was slightly taken aback at this question, but I mentioned quality assurance, choice of equipment, patient and personnel dosage.

He asked about whether I would consider teaching and I told him definitely, but interrupted when I got to residents and radiologists. As he put it, I would like to teach technologists.

January 4, 1976

Greetings and happy new year to all! Just think, your stock of wines are all one year older now (assuming they made it past new year's eve).

Thought I'd take this time to fill you in on the ABR exam so you can keep your files current. As you can see from the enclosed memo, they now break the oral into a six part exam so you spend 1/2 hour with each of six examiners now and each covers one of the listed categories. Since the memo does not make this clear, I was not aware of it going in, but that is the way they are doing it.

I am happy to say that I passed five of the six sections, so I got a conditional and will have to repeat just the section on "equipment." My problem was I hadn't been around enough nuclear medicine and diagnostic equipment lately and I guess it showed when I tried to discuss some of the newer things such as CdZnS versus CsI phosphors and rare-earth screens, etc. You must pass at least four of the six to get a conditional, and if you're going for Radiological Physics as I was, you answer questions in each of the six categories in each of the three fields. So, it looks like I'll pay $150 to fly to Chicago in June, spend 1/2 hour with one examiner, and hopefully that will do it.

Now for the specifics which I can remember. Some of the examiners worked from cards and some did not. Most did. Here's the breakdown of the way the exam went and the order in which I took it:

12:30-1:00 Six of us sat around in a room waiting for the examiners to get it together and getting each other nervous.

1:00-1:30 Hendee - "Equipment"

That's right, I flunked old Bill. I've already burned his books. Really, though, I think it was because I haven't stayed up with nuclear medicine and diagnostic equipment and the fact of its being the first exam I didn't know what to expect.

Discuss and compare operational and beam characteristics of a betatron and a linear accelerator.

Discuss compensating filters, theory and mechanism of construction.

Discuss the construction and calibration of a dose calibrator.

Discuss physics of CsI versus CdZnS and rare earth screens.

(continued)

1:30-2:00 Had a 1/2 hour break. Each of us (except one) had this after we cycled past the 6th examiner, namely Hendee.

2:00-2:30 McConnell (M.D.) - "Clinical Radiology"

2 mCi I-131 to patient who 2 days later says she's pregnant. Do what?

List following scans in order you'd do them: lung, brain, bone, liver.

Explain MTF.

Discuss radiation sensitivity and factors which influence it.

Discuss cardio-pulmonary-resuscitation and typical values for BP, pulse, and respiration rates.

2:30-3:00 Krohmer - "Fundamental Physics"

He said he was testing out his questions for the physicians on us, but expected more complete answers from us. Lots of "RAPHEX" type questions. One I remember: Why use Iodine and Barium, and in what areas of the body are they used?

3:00-3:30 Tanner - "Measurements"

MTF of diagnostic tube, how measure and what is it? Variation of MTF along anode-cathode axis.

Measure surface dose of beta emitter.

Explain Bragg-G ray theory.

Explain ionization and thimble chamber to resident.

3:30-4:00 Kelsey - "Protection"

Safety procedures in nuclear medicine.

Estimate dose to fluoroscopist working from NCRP value for maximum allowable output.

Fetal dose standard.

Cleanup of a Tc^{99m} spill.

Dose rate near a tech.-99 generator.

(continued)

Co-60 head and source leakage.

Thickness of Pb in typical Co-60 head.

Radium needles, how checked and what to do if you find a leaker.

4:00-4:30 Webster - "Radiation Dosage"

Relative amounts of scatter components in 200 kVp and Co-60 beams at various depths.

Explain MIRD technique for internal dose calculation.

Define and give differences between energy fluence, rad, KERMA.

Well, that's about all I could remember after I got out. In fact I wrote these down in the cocktail lounge at Dallas International Airport, so they may be a little foggy. I feel like I've just been through the whole damn exam again! So long for now and may your wine glasses stay full all year.

WHITE MEMORIAL MEDICAL CENTER

720 BROOKLYN AVENUE • LOS ANGELES, CALIFORNIA-90033 • TELEPHONE: 269-9131 (Area 213)

DEPARTMENT OF RADIOLOGY

TO:

FROM: Donald D. Larson

DATE: 12/14/78

SUBJECT: ABR 1978 Oral Examinations on 12/11/78 - Notes and Observations

Following are the examiners:

1. Dr. Banerjee
2. Dr. McConnell
3. Dr. Kereiakes
4. Dr. Laughlin
5. Dr. Waggener
6. Mr. J. Morgan

The oral examination was for the ABR certification in Radiological Physics in Nuclear Medicine, Diagnostic and Therapeutic Radiology.

The following notes are not in the order of presentation or by examiner, but are given just as they were recalled.

1. Why use flattening filters on beams of photons from high energy linear accelerators or betatrons? Give details as to the construction of the flattening filter and the placement and results of the use of such filters. Should they be low or high atomic number materials? Why does lead have a beam softening effect on 25MV betatron photons? What causes the dip in attenuation coefficient for Pb at about 3MeV? What is the unfiltered spectrum of photons from a betatron? Why is Al better than Pb? Does Al have a dip in attenuation coefficient similar to Pb? Is betatron x-ray output continuous or pulsed? What is the pulse rate and the maximum dose rate per pulse? What engineering details of the construction of the betatron limit betatron dose rates? Dr. Banerjee discussed his point of view on this question. What determines the energy of the photon beam, and how would you obtain energies other than the maximum? What are contraction timing and intection timing, and how do they effect the output? Diagram the relationship of these two parameters on a typical cycle of the voltage to the magnet.

2. Does radiating a patient with high energy x-rays induce radioactivity in the body of the patient? What is the reaction, and what elements are activated? Which element is predominant? What is the threshold for such effects? What isotope or element has the lowest threshold for (ϑ,N) reactions? Is this a shielding problem with concrete walls for a therapy treatment room? What is a typical binding energy of a nucleon? Can an electron-neutron reaction occur similar to (ϑ,N) reactions?

3. If you were designing a diagnostic radiographic room that had a chest unit pointed toward a wall contiguous to a secretarial office and a fluoroscopic unit in the center of the room, which unit would dictate the shielding requirements for the chest unit primary barrier, the control room window, and all other walls? Where would you find this principle in NCRP publications? Where would you get typical weekly work loads for these units if you did not have any estimates from the department being designed? (NCRP #49, Table #2). What occupancy and use factors would be used for the floor, walls, and ceiling? What is the maximum weekly exposure to be permitted in a controlled and uncontrolled area, and define the restrictions on controlled areas vs uncontrolled areas? Are all walls primary shielding? Give the equation that is used to calculate the required barrier thickness. What values would be used to calculate shielding for scattered x-rays? (energy, angle, U, T, W, etc.). Explain what "B" is, and how a graph of "B" vs energy and shielding material thickness would be used. What is a dose rate at table top that might occur on a properly adjusted fluoroscope unit? What is the equation for integral dose, and how would you determine integral dose for a chest radiograph or fluoroscopic procedure given field size? How do you use inverse square calculations to determine dose rate at tabletop? What settings on a fluoroscope will determine the patient dose, and how should these settings be used properly? Where is 90^{o} scatter defined, and what is the convention in estimating scatter from primary beam exposure rate?

4. Image intensifier tubes. What must the exposure rate be at the input phosphor of an image intensifier tube in order to obtain properly exposed cine radiographs? What is the typical exposure rate at tabletop during a cine procedure? What does an image intensifier do? What sort of "gain" can you get from a typical image intensifier tube? What proportion of this gain comes from minification, and what proportion from conversion of a photon to a number of electrons that are accelerated across the tube? What is the voltage across the tube, and how are the electrons focused? How are x-rays converted in the input phosphor, and what is a typical input phosphor made from? What is the grain size of the input phosphor, and what sort of resolution exists on the input phosphor in line pairs per mm? What is the phosphor particle size on the output phosphor? How is light converted to electrons in the input end of the intensifier tube? What is the energy in eV of the light produced in the input phosphor, and how can this low energy light release electrons in the photocathode?

5. What is therapeutic ratio?

6. If there was an accidental P-32 spill on a given area of skin on the arm of a technician that was left in place for 12 hours, how would you estimate the dose delivered by the P-32?

7. Calculate the dose to a 20 gm. thyroid gland from a given accidental ingestion of some I-131. How is effective half life calculated? If the biological half life of I-131 in an organ is 8 days, what is the effective half life?

8. What, if any, is the difference in response to radiation of tumors and normal tissue? Which might be more radiation resistent, small colonies of distributed tumor or large massive contiguous tumor?

9. What is an ionization chamber? What is/are the limitations of ionization chambers under conditions of high dose rate? What can be done to minimize the high dose rate effects?

10. How would you attempt to measure exposure to skin on the beam entry side of a mammogram? How would this exposure compare to exposure to the mid-breast? What effect will varying the KV or HVL have on the ratio of mid-breast to skin exposure? What is a typical dose to breast midline from various types of breast examination techniques? (e.g. xero, mag, lodose). How can screens be used in mammography?

11. Discuss the pre-implant dose planning for the following types of implants: RA, I-125, CO-60, IR-192.

    A sample problem was given where an implant is to be made to a circular portion of the bladder wall with radon seeds. All constants were provided, but the treatment time and seed distribution (according to Patterson-Parker) was to be determined.

12. How would a person evaluate the distribution of P-32 colloid in the abdomen using diagnostic or Nuclear Medicine techniques?

13. A film was presented (IVP) and contrast media was pointed out to be identified. Some contrast in the large intestine was pointed out to be identified. Why use contrast material? Why is iodine a good contrast material? What type of contrast material is used to study the kidney? Where is the prostate, spleen, right kidney (anatomical variant with right kidney on the left below the left kidney), liver?

14. A therapy localization film (AP of lumbar vertical and lower thorax) was shown to be identified. What are opaque bars on upper and lower portions of the film? Is it a good localization film? What is that (a line drawn across the film mid abdomen)?

15. Given a 1Ci source of CO-60 enclosed in 10 cm. of tissue-like material, what will the dose rate be at 1 meter? (Use the formula 1 + UX to estimate the effect of build up).

16. If a diagnostic procedure is done to a patient, what dose level is considered to be the upper limit for a pregnant person before a therapeutic abortion is advisable? At what dose level do you advise a therapeutic abortion?

17. How do you determine dose to fetus or gonads from various x-ray diagnostic examinations?

18. How would you do a rotational hand plan to treat an esophagus with CO-60? Define TAR and discuss what factors do or do not influence its value.

19. How would you calculate or estimate the fetal dose from a "mantle" type therapy procedure? Is scatter more or less important than leakage through the head in terms of fetal dose? How would you propose to limit contributions to fetal dose from leakage?

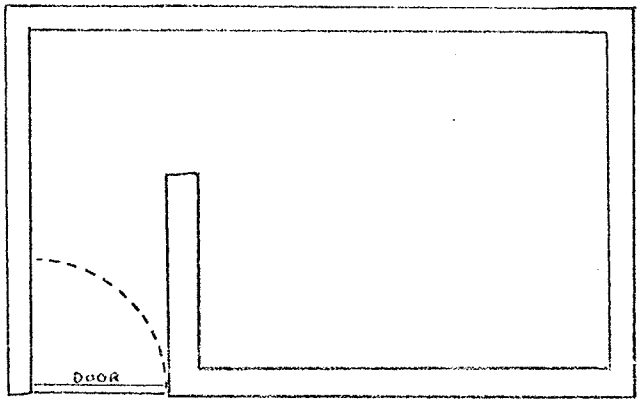
20. How do you recommend that dosimetry be done for I-125 implants? Should post-implant dosimetry be done routinely?

21. Compare typical whole body doses from diagnostic x-rays of the chest to a typical whole body dose from the administration of 20mCi of Tc-99m isotope.

22. Design a shielding container to reduce exposure from a specified quantity of I-131 at a specified distance to a level below the level permitted in a controlled area with 100% occupancy. Do electrons cause any problems in this case? How would you shield a source of electrons most effectively?

23. Should you use CO-60 or 4MV for irregular field "mantle" therapy on a pregnant woman who must be treated? Why? What percentage of the maximum useful beam dose rate should you use as the value of leakage from the head in the absence of any specific measurements?

24. Discuss the planning of a room for a 4MV electron accelerator in terms of protection at the door. How would the machine be positioned? Assume the room shape to be something like that shown below:



Describe how the projected dose rate at the door would be calculated and identify all sources of significant contribution to that dose rate. Suppose the accelerator was a 18MeV machine, what changes would be necessary? What is the quality factor for fast and thermal neutrons? How would you minimize the neutron problem in the room? How would you prevent an excessive dose rate at the door considering neutrons? What proportion of the emissions of the accelerator are neutrons? Why are they a problem?

25. What is an ultrasound transducer? How do you change a transducer's frequency? Does changing voltage applied to the transducer change its frequency? What is the frequency range of the clinically used transducers for diagnostic purposes? How would you specify resolution in ultrasound? What is acoustic impedance?

26. What tests would you do in the process of accepting a gamma camera installation? What routine quality assurance tests should be done? How often? What is a typical crystal thickness and how many PM tubes are currently being used? Who sells the camera with the most?

27. How are focal spot sizes determined? What are NEMA standards and what diameter should a pin hole be to image a given focal spot size? Using a line pair phantom, how do you determine the focal spot size?

BOARD EXAM QUESTIONS
(Medical Nuclear Physics and Diagnostic Radiological Physics)

1. Starting with the detector describe the components of a scintillation camera from the stand point of how they effect spatial resolution.

2. Describe the techniques for correcting field uniformity in a scintillation camera.

3. Discuss the role of the transducer as it determines spatial resolution in ultrasound.

4. Describe the types of displays that have been used for ultrasound (A mode, B mode, T-M, gray scale).

5. How does Autopeak work on Ohio-Nuclear Cameras? Do you use it in clinical imaging?

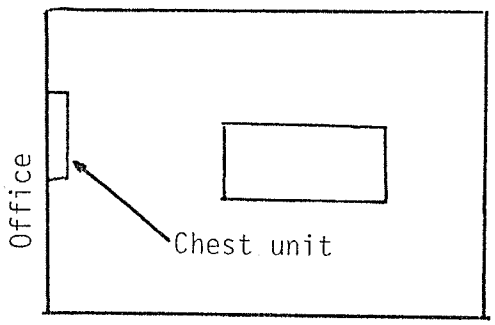
6. What do you see as the physicists' role in a clinical department of radiology or nuclear medicine?

7. A chest film was on the view box. Where is the mediastinum located?

8. Describe the flow of blood through the heart.
   a. What is the relative wall thickness of the ventricles and atria?
   b. Are there ever holes between the ventricular cavities?
   c. Which is most common: right-to-left or left-to-right?

9. What techniques are used for mammograms?
   a. What is the risk?

10. The dose rate from a generation (Mo-Tc) is 200 mR/hr.
    a. How much shielding is needed to reduce the exposure rate to an acceptable level in a manned telephone switchboard on the other side of the wall?

11. 

Combined radiographic/fluoro room

Describe how you would calculate the shielding needed to protect the occupant of the office (a radiologist). Distance is three meters.

12. Xe-133 is being exhausted through a hood with an opening of 1.3ft^2 and a flow rate of 233 linear feet. The MPC at the exhaust is 3×10^{-7} $\mu Ci/cm^3$. Calculate the amount of activity that can be released in one week.

13. How would you calculate the half-life of a very short-lived isotope, e.g. a few seconds?

14. How would you calculate the half-life of a very long-lived isotope, e.g. Ra-226?

15. How would you calibrate the output of a mammographic unit?

16. How would you determine the beam quality of a mammographic unit?
    a. Why is 50 cm used?

17. What is radionuclide purity and how is it measured? What is radiochemical purity and how is it measured?

18. What kinds of quality control measurements should be performed on radiographic or fluoro units to minimize patient exposure?

19. Describe the general characteristics of nuclides produced by reactors and cyclotrons.

20. What is the amount of scatter at 90°?
    a. How important is the correction for field size?

21. What is meant by "lateral decubitus?"
    a. Why is this position used?

22. How would you determine the absolute activity of a radioisotope?

23. 1μCi of I-131 is accidentally given to a patient. The average energy per disintegration is 0.19 and the gland is 20 gm. Calculate the beta dose only. Without doing a calculation, how would the gamma dose compare to this?

24. A 65 mg radium needle is located at a point. What is the exposure rate at a distance of 59 cm.

25. Where should a film badge be worn and what records should be kept? To whom, if anyone, should these numbers be reported? Describe a film badge and what doses are measured at various locations. Describe the film optical density as a function of energy for the open window and the shielded portion of the badge.

26. What is a Sievert?

27. How is focal spot size measured? (Three techniques)
    a. Draw a picture of a typical focal spot.
    b. Why is it double-banded?

28. A fluoro unit with automatic brightness control can be operated at ma values of ½, 1, 2 and 4. In which case would the absorbed dose to the patient be the smallest?

29. If the fluoro unit was changed from 9" to 6" what would happen to the patient dose?

30. Describe the absorbed dose to the thyroid from a scan.
    a. How would age effect the absorbed dose?
    b. What could you do to lower the absorbed dose?
    c. What is the reduction in dose for I-123?
    d. What are the problems with I-123?
    e. How else can the thyroid gland be imaged?
    f. In contaminated I-123 solutions, what happens to the patient dose if it is administered 24 hours late?
    g. How much lower is the absorbed dose for I-123, as compared to I-131.

31. One μCi of P-32 is accidentally dropped on the skin and dries. The area is 4 mm^2 and the activity remains on the skin for 12 hours. Calculate the absorbed dose.

32. Who introduced Tc-99m?

33. How does an image intensifier work and what are its benefits?
    a. How does the patient dose for a photo spot compare to a conventional spot film?

34. What factors determine CT resolution?
    a. What factors determine patient dose?
    b. Is scatter a major component?

35. How often should quality control measurements be made on a radiographic and fluoroscopic unit?

Examiner: Bannergee Question Set # 1 - Radiological Physics

1. Discuss beam flattening filters for photons and electron scattering filters.
   a. Shape, material, & WHY (attenuation)
   b. Betatron filters
   c. Compare outputs of accelerators (linear vs betatrons)

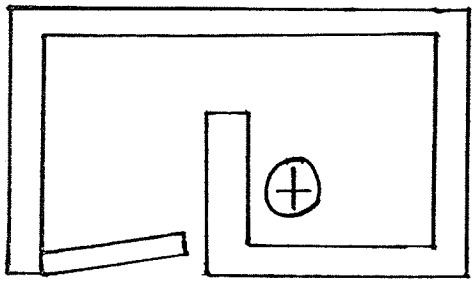
2. Why are there various size ultrasound transducers?

3. Discuss the parameters that influence exposure at the output phosphor of an image intensifier tube.
   a. Gain
   b. Resolution
   c. Bandwidth

4. What factors influence resolution in the construction of a head of an Anger Camera?
   a. All parameters and approximate limits of resolution
   b. Discuss various types of collimators and how they relate sensitivity and resolution.

Examiner: Jack Kromer

1.



4 MV Linear Accelerator
Stationary-pointed down

What factors are involved in calculating the dose rate at the door? (Interested in practical parameters.)
   a. Consider the two scattering geometries of straight down and patient at rear wall (know that stationary machines aren't stationary).
   b. Angles of scatter, which is worse, etc.
   c. Know $k = \frac{Pd^2}{WUT}$ in words only.

2. How would you design a hospital room (if you could have everything your way) to handle 30 patients per year, each with 100-150 mCi of I-131 for hyperthyroidism?
   a. Discuss location, bed placement, waste management, etc.
   b. Number of mCi to release a patient under all conditions- new & old?
   c. Where are these applicable tables, etc., located?

3. Cysto Lab: 30 exposures/week. Discuss shielding considerations.
   a. know formula for attenuation and all values & parameters.
   b. Both primary, secondary, & leakage (relative) values for each.
   c. Typical average workloads

3. Calculation techniques for implants.

Examiner: Waggener Question Set # 1- Radiological Physics

1. Estimate dose to thyroid from x mCi of I-131, given Biological Half-life= 8 days, weight of gland, and $\bar{E}_B$.

   Estimate the gamma dose to thyroid.

2. 1 Ci Co^{60} in a 10 cm diameter sphere of tissue. Rate of exposure is X R/mCi @ 1 cm. What is exposure at 50 cm from sphere?

3. Write expression for calculating attenuation by a primary barrier and explain the terms. (He meant completely, including typical values and units.)

4. When, or, are neutrons a problem in therapy shielding calculations? What are good scattering materials? What are typical neutron energies?
   a) Fast b) Slow c)Photoactivation d)Thermal

Examiner: Kereiakes

1. Discuss problems with placing an ion chamber in high exposure rate field and how to overcome them. (At least 4 methods)

2. Discuss pre & post operative calculations of implants at your center - including localization techniques.
   a) Planar vs volume
   b) When do you use volume and not planar calculations?
   c) Crossed vs uncrossed & corrections

3. How do you calibrate dose for mammography machines?
   a) Different machines
   b) Different techniques
   c) What are typical parameters (mAs, etc)

4. Discuss methods of acceptance testing for an Anger camera. Discuss quality control and how often.

Examiner: J. Morgan

1. X mCi of ^{32}P on a 4 x 4 mm^2 area of skin, $\bar{E}_B$ = 0.694 MeV. Calculate the dose in rads.
   a) tell how you would do the calculations.
   b) What procedures such as decontamination would be necessary?

2. How do you design a radon (gold) implant to deliver 5000 rads in _____ hrs, 1 cm from a circular implant of 25 cm^2?
   Given: X mCi/1000 rads. Inside Bladder implant.
   a) know Patterson-Parker rules
   b) total dose formula
   c) how did the physician implant it?
   d) gold instead of radon, how much?

Examiner: J. Morgan (continued) Question Set #1-Radiological Physics

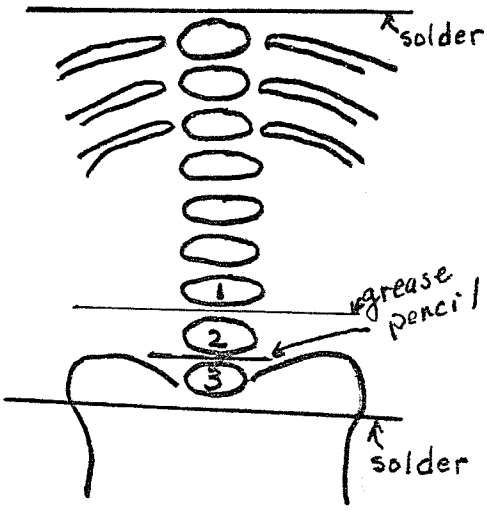
3. How do you calculate the dose for rotational Rx of esophagus? Discuss TAR's, etc., no computers.
   a) Corrections for Rx couch?
   b) Know how to get central axis and off axis points.

4. Estimate the whole body dose for an AP chest x-ray in a 70 kg human. How does that compare with the whole body dose for _____ mCi of tc-99m? Compare the kg-rad in both cases.

Examiner: McConnel, M.D. Clinical Questions

1. What is carcinoma? What is sarcoma?
   a) points of origin and cause
   b) drainage sites

2. X-ray shown of lower abdomen.
   a) locate spleen, left and right kidneys(superimposed), liver, and prostate
   b) What kind of film?
      1) IVP with barium in ascending colon
      2) What are the contrast agents?



3. X-ray shown on light-box.
   Q: What is it?
   A: Looks like upper abdomen
   Q: What are those?
   A: Cross-hairs-it's a localization film
   Q: What are the markers?
   A: Looks like upper and lower margins (Point to solder pieces)
   Q: I'm old fashioned; it's an orthovoltage film.
   A: "Gap?" --"Could be"
   "Exit Ports?"--"Could be"

4. Give method of localization of various radiopharmaceuticals. (Discuss about 5 different materials.)

5. You are called to the ER where victims of an airplane crash have been taken. The plane carried radioactive material. Estimate what's in the plane. What do you do?

6. Discuss mitosis with respect to radiation therapy. Subjective questions on benefits of fractionation, cell cycle, etc.

Examiner: Tanner Question Set # 2 - Radiological Physics

1. How do you determine the surface exposure rate of a mammography unit? How do you determine beam quality? How do you estimate mid-plane breast dose for a given surface exposure? How does the mid-plane dose vary with beam quality? Why don't you use 60 kVp for mammograms to cut down the dose to the breast? Draw depth dose spectra for high kV and low kV for a mammography unit.

2. What problems might you encounter using an ionization chamber to measure high dose rates? What have the commercial companies done to overcome this problem?

   As you vary the collection volume of an ion chamber, what adjustments do you make in collection voltage? Draw a graph of current vs voltage for a given exposure rate for an ion chamber.

3. How do you do implant dosimetry? Discuss localization techniques. How do Iodine and Iridium differ from radon?

4. Ultrasound: Does the transducer determine the frequency? What do you vary during examinations by using different transducers (frequency and pulse width)? What frequency do you use for abdominal exams, skull exams, cardiology, opthamology, etc?

   What are the characteristics of A-scan, B-scan, and real-time scanning ultrasound? When is each one used?

   What is the Doppler effect?

   What is the limiting factor (determining factor) of the frequency chosen for a particular scan? (Depth of tumor, etc.)

5. How do you measure focal spot size? Do you expect the star grid and pin-hole camera measurements to give you the same results? Draw sketches of how you set up these measurements. Draw what your images would look like on the film for both of these techniques. How do you calculate the focal spot size from these images?

Examiner: Callendine

1. What kind of quality control checks do you need to make on a linear accelerator and a cobalt unit? Why do you need to make each one of these checks and how often?

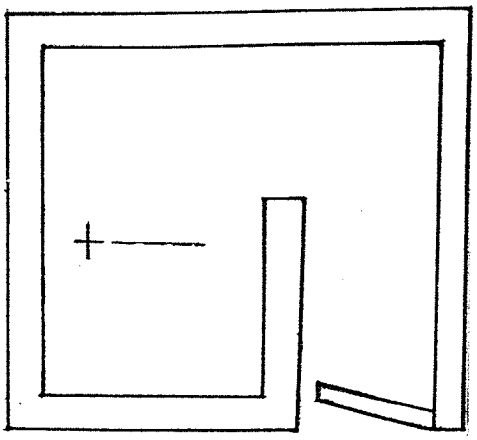
2. What quality checks do you do on the installation and acceptance of an Anger camera? What routine quality control checks do you perform on a camera? How do you do these checks and how often?

3. What effect do the number of photomultiplier tubes have on a camera? What about size of crystal? What types of maintenance problems do you have with cameras?

4. How would you design a flattening filter for a linac for: a) photons and b) electrons? Discuss shape and construction and materials used. What effect do different energies (4 vs 18 MeV) have on filter design and materials?

5. Image intensifiers: What are their properties? Why do you use them? Discuss advantages and disadvantages. What types are there? What are the crystals made of? What are the advantages of the rare earth image intensifiers?

Examiner: Hendee



1. 4 MV Linac design.

   How do you determine thickness of door required?
   How do you calculate the required thickness of shielding on any of the walls? Which angle of scatter is the worst?

   What is the permitted exposure rate outside the walls and door?

   What do you do differently to the door if the linac is an 18 MeV instead of a 4 MeV? What energy of neutrons are you shielding against at the door from an 18 MeV linac?

2. Assume you now have a 30^{o} beam stopper. How do you calculate the wall thickness beyond the maze? (Consider scatter, oblique incidence, etc.) What energy of beam are you looking at in this case? What are the factors used in the shielding calculations for one of the walls exposed to leakage and primary scatter?
   What are the occupancy and use factors for controlled and uncontrolled areas?

3. Nuclear Medicine Protection: You want to store 500 mCi of I-131 in a lead safe.

   Γ = 2.2 R/mCi-hr @ 1 cm

   HVL for I-131 = 0.3 cm of lead.

   You want a technician to be able to spend 10 hours per week at a distance of one meter from the safe. How much lead is required in the safe walls to permit this work situation?

4. Chest Unit in Diagnostic: What is the permissible exposure rate outside the wall behing the cassette holder? How large of an area do you need to shield? What are typical kVp and mAs factors for a "busy" chest unit? What are the Use and Occupancy factors for the wall behind the cassette holder assuming it is a public hallway? Using these WUT factors, calculate the amount of required shielding in the wall to reduce the exposure rate to a permissible level.

Examiner: Riemenschneider, M.D. Question Set #2-Radiological Physics

1. How do you view your roll as a physicist in each of the three departments: Nuclear Medicine, Radiation Therapy, and Diagnositic Radiology? How do you interact with doctors and what can you be expected to contribute and be responsible for?

2. Discuss fetal irradiation. When is it most important? When do you recommend an abortion(i.e., at what dose)? At various dose levels less than that necessary for an abortion, what type of abnormalities could occur?
How would you calculate (or estimate) the dose to a fetus for a given exam for a patient?
What is the acceptable dose limit for a pregnant occupational worker?

3. Discuss pituitary tumors. What does the pituitary normally do? What are some of the manifestations of pituitary tumors? What size are some pituitary tumors? Where is the pituitary gland located? Locate it on a diagnostic film on the light box. Locate the sella turcica.

4. You are the only radiation safety official in a small town. At the local airport on Sunday afternoon a plane carrying unknown types of radioactive materials crashes.
   1. What do you do?
   2. How do you estimate the doses received by personnel and passengers?
   3. What type of decontamination procedures do you institute?

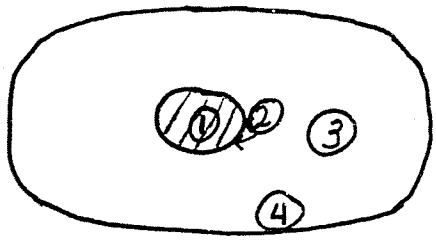
5. Discuss the anatomy of the heart: names of chambers, valves, veins and arteries leading to and away from the heart. Which chamber does the pumping? Discuss the pathway of the used blood once it enters the heart until it leaves in the oxygenated state.

Examiner: Webster

1. Radon seed implant of the bladder. Planar implant. How do you arrange the seeds for a 25 cm^2 area with a circular distribution? What is the ratio for distribution between the periphery and the center?
How do you determine the number of seeds?
How many mg-hrs to give 6500 rads?
How do you determine the strength of the seeds?
What is the mg-hrs equivalent for the total decay of 1 mg of radon?
What if you had to use ^{198}Au instead of radon? What is the exposure-rate constant for gold-198? What is the equivalency factor to convert from radon to gold?
How would the physician get the seeds in the bladder?
How would you take the localization films?
How would you make a final determination of the dose distribution of this implant?
Discuss in general the Patterson-Parker rules for implants in contrast with the Quimby system for implants.

Examiner: Webster (Cont.) Question Set #2 - Radiological Physics

2. 360^{o} Rotation for treatment of esophagus. 8 x 8 cm field. Assume you have no computer.



1. How do you calculate dose to point #1 (in center of tumor volume)? What factors do you use in your calculations and where do you get these factors? How do you set up the patient for treatment?
2. What is dose to point #2, located at 4 cm from center of tumor?
3. How would you calculate dose to points #3 & 4 (off axis)? Point # 3 is in the lung.

3. How does the integral dose compare for a chest x-ray and a 5 mCi dose of Tc-99m for a lung scan?

4. You are giving 100 mCi of ^{131}Iodine for thyroid therapy treatment. What is the contribution to the total dose from the beta emissions? Calculate the beta dose (not just the relative amount). Calculate the gamma dose. Use the old methods of average energies, etc., not MIRD methods. Explain all the factors in the equations.

Examiner: Lanzl

1. Neutrons. At what energy are they generated? Why are they important? Where do you check for them around a linac? How do you shield for them? Where do you put this extra shielding and what is it made of?
At what energy do they become thermal? What are the other energy levels of neutrons? What are the quality factors for dose calculations associated with each energy level?

2. You have one Curie of ^{60}Co in a tissue equivalent 10 cm diameter sphere. The Exposure rate for Cobalt-60 is 13.0 R/mCi-hr at 1 cm. The HVL is 1.2 cm lead. What is the exposure rate at one meter from the sphere? How much lead to you need to add to a wall two meters from the sphere to reduce the exposure rate below 10 mR/week?

3. You have a patient in a room with 65 mg of Radium in intracavitary sources in her. How long can a nurse attend to the patient at a distance of 50 cm? Assume the nurse is not an occupational worker.

4. What factors are included in the shielding calculations for primary barriers of radiation therapy departments? Explain how you obtain values for each of these factors?

5. When you are designing the shielding for an x-ray department, who all do you talk to and why?

Examiner: Webster Question Set # 3- Therapy Physics

1. Explain "rind-core" theory for a cylindrical Patterson-Parker volume implant, one end is uncrossed. Calculate how many mgs needed.

2. Calculate fetal dose from upper Hodgkin's mantle field.

3. What is beta and gamma dose from I-131 ablative thyroid therapy? (Old method, not MIRD).

Examiner: Tanner

1. Explain how to set up an implant and how to localize the implant after the procedure is done.

2. How do TLD's work? What does annealing do? Where are TLD's used in radiation therapy?

3. What type of physics training should be given to radiology residents in radiation therapy?

Examiner: Lanzl

1. Calculate shielding of x-ray film near a Ra-226 storage safe.

2. Describe the generation of neutrons from a 18 MV electron accelerator. Is there a threshold energy for neutron generation?

3. How does a film badge differentiate energy of x-rays?
If film in the badge was totally blackened, can it still be used as a monitor?
Describe how a double-emulsion film could be utilized in film badges.

Examiner: Callendine

1. Describe how a Linac works. (T-wave vs S-wave)
How do electrons get out of acceleration tube?

2. Describe how a Betatron works. How are electrons collected?

3. How is ultrasonography used in radiation therapy?

4. What are pitfalls of localization of therapy ports with CT scans?

Examiner: Hendee Question Set # 3 - Therapy Physics

1. Describe shielding necessary to protect x-ray film from Ra-226 (Cs-137) storage safe.

2. Describe scatter of leakage radiation from a 4 MV accelerator. What is different if it is 18 MV photons?

3. What is chemical makeup of polyethylene and why does it stop neutrons? What happens after the neutron is captured?

4. Explain scatter at a barrier from 30^{o} scattered radiation with beam stoppered linacs.

Examiner: Riemenschneider Clinical Questions

1. What is "epithesis"?

2. Give philosophy of "physicist - M.D." relationship in a radiation therapy dept.

3. What are the biological effects of 25R, 200R, 600R, 1200R total body irradiation?

4. Give a method of staging tumors, both pathological and histological. What are its effect on radiosensitivity and radiocurability?

5. How can effect of radiation to a tumor bed be enhanced? (π -mesons?)

6. How do tumors metastisize?

QUESTIONS FROM 1978 ABR PHYSICS CERTIFICATION EXAM

Question by Dr. Banerjee: Why is the flattening filter on a high energy Betatron made out of aluminum? It requires a weird shape; it's pointed; it's very difficult to adjust--why not lead?

Another question he asked: Describe an image intensifier--any one you want. I chose to describe an image orthocon tube. He wanted to know precisely how it worked, what the cathodes were made out of, and all that sort of thing; and exactly what the resolution limits were for every surface as the signal passed through.

I think it was a question from Lanzel: How does a Fricke dosimeter work? What are the chemical reactions, and what are the advantages and drawbacks?

Kromer: Decay scheme of Chromium-51, lines drawn backward.

There are electrons, x-rays and gamma rays that come out of this nuclide. Where do they all come from?

I think it was Lanzel: Why does C_E for an electron beam change with increasing depth? The answer he wanted was not that the average energy of the electron was changing--he wanted to know why (polarizing effect).

Banerjee: Gamma cameras - why are there such numbers of P-M tubes as 19 and 37? Also for cameras, approximately what is the resolution for extrinsic versus intrinsic?

Morgan (?): If a woman receives radiation therapy to a mantle field, and receives 4000 rads at midline, and discovers that she is pregnant, estimate the dose that the fetus will receive. Also, what percentage of it comes from scatter, what percentage comes from leakage radiation from the head.

Dr. Kromer asked a question about CT scanners. The question was, why is the density resolution very good while the spatial resolution is poor, as compared to conventional x-rays?

Dr. Laughlin wanted to know about ultrasound, typical frequencies, penetration depths, that sort of thing.

Mr. Morgan wanted me to go through the business of planning shielding without having a reference book in my hands. The figures were unimportant. He wanted all the units as we went along. He wanted to know what the titles of the columns in the book were and what they meant.

Perhaps Dr. Laughlin: I recall at various points having to compare resolution in terms of line pairs per mm of various kinds of imaging systems all the way from CT scanners to screen-film combinations, straight films, xerography, anger cameras, fluoro systems, TV's, etc.

Banerjee also at one point wanted to know about the material that phosphors were made out of on various kinds of orthocon and vidicon tubes, and what their resolving capacities were.

I think it was Laughlin who asked about materials used in various kinds of screens, slow speed screens, high speed screens, rare earth materials, etc.

DEPARTMENT OF RADIOLOGY
THE HOSPITAL OF THE GOOD SAMARITAN
616 SOUTH WITMER STREET
LOS ANGELES, CALIFORNIA 90017

Diagnostic Radiology
GERALD B. IBA, M.D.
ROBERT E. LEVIS, M.D.
GERALD M. MCDONNEL, M.D.
PHILLIP C. SHIU, M.D.
MAYNARD N. LEVENICK, M.D.
JOSEPH E. KENNEDY, M.D.
TELEPHONE 488-8251

Nuclear Medicine
LEONARD A. SWANSON, M.D.
TELEPHONE 488-8245

Radiation Therapy
R. WILBUR MELBYE, PH.D.,M.D.
PAUL R. HERSTEIN, M.D.
TELEPHONE 488-8983

Endocurietherapy
A.M. NISAR SYED, M.D.
AJMEL PUTHAWALA, M.D.
PETER A. FLEMING, M.D.
TELEPHONE 481-1500

Radiation Physicists
RICHARD M. GARVER, M.S.
MELISSA C. MARTIN, M.S.
TELEPHONE 488-8984

ABR ORAL EXAM - RADIOLOGICAL PHYSICS

JUNE 1979 - CHICAGO

Notes on the exam: Many of the questions were the same as given in December on the oral exam. The following are the ones that seemed to be different than the previous ones.

Radiographic Equipment (Ed Chaney)

1) For the following machines, using block diagrams, describe each component as to its function and the signals emanating from it. Then give a basic summary as to how it works as a total machine.
   a) Betatron
   b) Van De Graff generator
   c) Linear Accelerator

2) What are the components of an image intensifier tube for diagnostic radiology? What are typical voltages applied to these tubes and generated inside these tubes?

3) How do ionization chambers work? At what voltage do these chambers function properly and why do they not function properly at other voltages?

Radiation Safety (Robert Waggener)

1) Nuclear Medicine: What is the maximum permissable concentration of Xenon-133 in air for both occupational and non-occupational workers? Based on this figure, determine what (if any) further safety precautions must be initiated for the following situation:

   Workload: 20 patients/week for both lung and cerebral blood flow studies.

   Questions: What are the mCi amounts of Xn^{133} used in each of the two studies?

   What percentage of this amount of Xn^{133} can be expected to be ventilated by the patient to the room?

1) Continued.

Area of room: 11 x 13 x 9 ft^3.

Normal Airflow: 50 cu ft/minute

Based on these numbers, calculate the predicted maximum concentration of Xenon and how would you handle the problem?

2) If you have a sample of material that given you 100 counts/5 min and background is 10 counts/minute, how long must you count the sample to get a "significant" reading at the 5% confidence level?
   a) Explain what the phrase "statistically significant" means.
   b) Explain what "confidence levels" are.
   c) What is meant by standard deviation and variance? What percent of counts would be within 95% confidence limits in the above sample? What is the standard deviation of the sample? What percent of counts would be within $\pm$ one standard deviation?

Therapy Dosimetry (L. Lanzl)

1) How were the Patterson-Parker radium tables arrived at? Was it theoretical or measured data?

2) How does the Quimby system of implant dosimetry differ from Patterson-Parker system?

Radiation Shielding (James Kereiakes)

The shielding question was the same questions as asked by Dr. Hendee in December except that Dr. Kereiakes expected you to use the NCRP Reports to do the calculations.

Equipment and Quality Assurance (Dr. Banerjee)

First Question: What department do you spend the majority of your time working? Answer: Radiation Therapy.
Second Comment: Fine. All your questions will then be about Nuclear Medicine.

The questions were then the same basic questions asked in December on acceptance testing and quality assurance on cameras and rectilinear scanners.

JUNE 4, 1981

DEAR DENNIS:

I UNDERSTAND YOU ARE STILL COLLECTING PAST QUESTIONS ASKED ON THE ABR CERTIFICATION EXAM FOR THE BENIFIT OF FUTURE VICTIMS. THE FOLLOWING ARE SOME RECALLECTIONS JOTTED DOWN AS I WAITED FOR MY FLIGHT HOME FROM LOUISVILLE.

1. NAME SEVERAL NEUTRON SOURCES. WHAT REACTIONS ARE INVOLVED? WHAT IS THE APPROXIMATE ENERGY OF THE NEUTRONS PRODUCED? WHEN PRODUCING NEUTRONS BY BOMBARDING A BERYLLIUM TARGET, WHAT IS THE RELATIONSHIP BETWEEN THE ENERGY OF THE NEUTRONS PRODUCED AND THE INCIDENT DEUTERONS?

2. YOU ARE ASKED TO DO A RADIATION SAFETY SURVEY ON A CO-60 INSTALLATION. WHAT WOULD BE INCLUDED IN THE SURVEY? (WANTED A DETAILED DESCRIPTION OF HOW PRIMARY AND SECONDARY BARRIERS ARE CHECKED. WHAT TO LOOK FOR IN ANTICIPATING SHIELDING FLAWS AS WELL AS WHAT TO SUSPECT IF A BARRIER IS INADIQUATE. INCLUDE HEAD LEAKAGE CHECKS AND MACHINE INSPECTION.)

3. YOU ARE ASKED TO CALIBRATE AN 18 MEV ACCELLERATOR. WHAT FACTORS NEED TO BE CONSIDERED.

4. HOW IS THE ELECTRON ENERGY VARIED FOR THE VARIOUS ELECTRON ENERGIES AVAILABLE ON A MEDICAL LINAC?

5. DESCRIBE THE ADVANTAGES AND DISADVANTAGES FOR EACH OF THE FOLLOWING MEGAVOLTAGE MACHINES:
   A. CO-60 TELETHERAPY MACHINE
   B. LINEAR ACCELLERATOR
   C. BETATRON
WHAT IS THE ADVANTAGE OF MEGAVOLTAGE THERAPY? DESCRIBE THE PRINCIPLE OF OPERATION OF THE BETATRON.

6. YOU ARE ASKED TO TO DEPTH DOSE TABLES FOR PHOTON AND ELECTRON MODALITIES ON A 20 MEV LINEAR ACCELLERATOR. DESCRIBE HOW YOU WOULD PROCEED. WHAT FACTORS NEED TO BE INCLUDED.

7. GIVEN (DON'T REMEMBER THE VALUES) ION CHAMBER READING, TIME, TEMPERATURE, PRESSURE, CALIBRATION FACTOR (COUL/R). FIND THE DOSE RATE FOR THE ELECTRONS ASSOCIEATED WITH THESE READINGS. WHAT ELSE IS NEEDED? HOW WOULD YOU PROCEED IN DETERMINING THESE VALUES.

8. YOU RECIEVE A CALL FROM TE OPERATING ROOM. THE RADIATION ONCOLOGIST SUSPECTS HE HAS LOST AN IR-192 SEED. DESCRIBE IN DETAIL HOW YOU WOULD RESPOND TO THIS SITUATION.

9. DEFINE WORKLOAD, USE FACTOR, OCCUPANCY FACTOR. DESCRIBE THEIR USE. WHERE ARE THEY FOUND OR HOW ARE THEY DETERMINED.

10. HOW IS C(LAMBDA) DETERMINED?

11. HOW IS THE GAMMA FACTOR FOR A BRACHYTHERAPY SOURCE DETERMINED? CONVERT MILLICURIES TO MG. RA.EQ. FOR A BRACHYTHERAPY SOURCE. WHAT CHANGE IN DISTANCE WOULD REDUCE THE DOSE TO 80% OF THE DOSE AT 1 CM FROM A VERY SMALL SOURCE?

I HOPE THIS HELPS YOU TO CONTINUE THE GOOD WORK IN PROVIDING SOME HELP TO THOSE WHO WILL BE TAKING THE ABR CERTIFICATION EXAM IN THERAPEUTIC RADIOLOGICAL PHYSICS IN FUTURE YEARS.

REGARDS,

ARDEN E. DOCKTER

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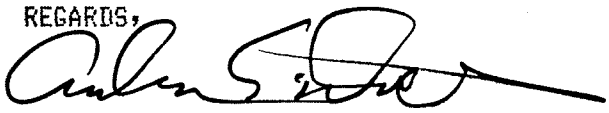


ARDEN E. DOCKTER

AMERICAN BOARD OF RADIOLOGY

THERAPY RADIATION PHYSICS

JUNE 1981

I had 5 examiners. I was excused from the clinical oral examination because I passed the clinical part on the written examination. Each examiner had 1/2 hour. Each examiner had 6 file cards on which questions on one topic were written. Each examiner then asked his own questions based on your answer to the file card.

A. Feldman - Clinical Therapy

1. Describe the isodose distribution of 2 right angle fields. What if wedges were used? What would you do about obliquity?
2. Describe beam treatment aids, backpointers, etc.
3. Describe variation of dose rate with distance from
   (a) point source
   (b) infinite line source - (1/r)
   (c) infinite plane source - (independent of distance)

B. Wilson - Equipment

1. Advantages, disadvantages
   (a) linear accelerator
   (b) Betatron
   (c) Cobalt-60

Describe in detail how the betatron works. How does the electron stay in an equilibrium orbit? If the magnetic field changes, how does the electron maintain its equilibrium orbit? At what point in the waveform do you pull off the electrons in order to vary the energy?

Describe how the standing wave linear accelerator works. Do you know why it was originally developed? (Power limitations at Los Alamos, N. M.) How do you vary the energy of the electrons in a standing wave linear accelerator? (Increase beam current?) What is the frequency of the betatron? How do they get this frequency? (Frequency tripler, motor generator).

2. How do you design a wedge filter? How would you use it in a clinical setting?
3. Describe advantes, disadvantages of cobalt, cesium, radium for brachytherapy sources

C. Hendee - Protection

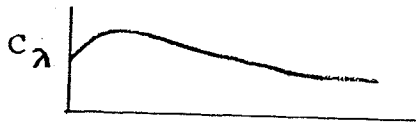
1. Formula for calculating protection. What is use factor, occupancy factor, workload, typical values. What is the use value for scattered, leakage radiation? Which is greater for a linear accelerator leakage or scatter? What is the formula for scatter radiation? What is the formula for leakage radiation?

2. What would you include in a protection report for 18MV installation? For 10 MV photons? For 18 MV photons? How would you protect for neutrons in 18 MV photons? Why does boreated polyethylene work? What happens to the alphas created?
3. What if the building were isolated and no one was on the roof, should you shield the roof? What is skyshine?
4. What would you include in a radiation protection survey?
5. How would you calculate the shielding in the floor below? What distance would you use? (Remember to convert to meters.)
6. Describe the scattering constant a. What distance is it correct for?
7. How would you shield nurses from a Cobalt-60 source? What is the dose rate in R/week? How is this dose rate determined? (5000 mrem divided by 50 weeks). What is the Γ factor for Cobalt-60? If you did not memorize it, how would you calculate the Γ factor?

D. Chaney - Radiation Dosimetry

1. Describe two ways to determine the energy of an electron beam. Describe a way that does not depend on range measurements (activation of foils from x-rays). What are you measuring, average energy, maximum energy, most probable energy for each of the methods above?

2. Describe why the curve below has this shape?



Energy

Describe the formula for C_λ

3. How do you measure dose with an ion chamber? Do you leave the equilibrium cap on or off? Would it matter much if you took it off?

4. Where are you measuring dose with a cylindrical ion chamber for photons? for electrons? Where do you measure dose with a pancake ionization chamber?

E. Callendine -

1. How do you determine dose for a point Cobalt-60 source inside a 10 cm radium sphere of tissue? (Use inverse square, 0 field size TAR's) What practical use is this problem? (Gyn brachytherapy sources inside a patient).

2. You are called to the operating room because an M.D. says he lost an iridium source. What do you do? What do you do first? (Check personnel and get them out.) If you suspect it still is in the room, would the patient with sources in him interfere? Describe the procedures to remove the patient. (Wrap him up in a sheet so that any loose sources do not fall out.) What would you do differently for Iodine ^{125}?
3. Describe a radiation protection survey in a therapy room. Do you measure leakage radiation? How?
4. How do you measure isodose curves?
5. How do you detect a leaking teletherapy Cobalt-60 source? What are the limits for detectable activity for teletherapy Cobalt-60 source? What do you do if the detectable activity is .1 mCi? (Notify the source manufacturer, hospital, shut the room down.)

QUESTIONS FROM 1985 ABR CERTIFICATION ORAL EXAMINATION IN DIAGNOSTIC RADIOLOGICAL PHYSICS AND MEDICAL NUCLEAR PHYSICS

1. Ed Channey (Nuclear Medicine)

   A. A woman was treated with 25 mCi of I-131 and released from the hospital. Estimate the dose to her husband. What advice would you give to the couple regarding radiation protection.

   B. Describe major components of a nuclear medicine computer.

   C. A department is limited to 65% of its patient load for Xe-133 exams due to restricted air flow. What can you do to increase the patient load. If Xe traps are used, what precautions should be made. What are the disadvantages of Xe trap.

   D. Describe the reciprocity theorem and its assumptions regarding calculation of radiation dose from internal sources. (How is the tables of MIRD report generated).

   E. How can you use xenon for blood flow studies.

2. Ray Tanner (Nuclear Medicine)

   A. You are designning a new department with four LFOV cameras and a computer. The hospital architect suggests two options: 1) put all cameras and computer in one big room, and 2) put each camera and the computer in individual rooms. What are the advantages and disadvantages of each design.

   B. What is a summation peak. Give a classical example (Co-60).

   C. A source is counted in a well counter, describe all the peaks and the reasons for them. Why is the photopeak broadened instead of a sharp line.

   D. Describe the difference between reactor produced radionuclides and cyclotron produced radionuclides. Name some of the sources commonly used in a nuclear department that are produced by these methods.

   E. A laboratory uses 2 uCi I-125 per test tube for a certain test. It is expected that the laboratory accumulate 200 test tubes per week. Is it possible to dispose the tube by incineration? (The maximum permissible concentration for I-125 in an unrestricted area is 8 x 10^-11 uCi/ml)

3. Arnold Feldman (Nuclear Medicine)

A. Describe the meanings of A, ^, and σ used in the formula for calculating dose using the MIRD report.

B. A department is storing 200 mCi of I-131. Assuming that the technologist spends 10 hr/week in the hot lab, what kind of shielding should you recommend so that the technologist is not over-exposed. Describe your assumptions.

C. What should you do when you decide to use a commercial waste disposal service. Under what circumstances can you dispose the sources yourself.

D. A worker is accidentally exposed to I-125. How do you estimate the dose to his/her thyroid.

4. Charles Wilson (Diagnositic)

A. Describe the difference between conventional fluoroscopy and image intensified fluoroscopy. Where are the quantum sinks in each case? Where is the quantum sink in radiography?

B. Film badge report of a technologist in the diagnostic radiology department shows that she had 3400 mRem in one month. As a RSO what would you do?

C. How do you check the shielding voids in a diagnostic radiology examination room? What thickness of lead is normally used for shielding of a diagnostic room?

D. What is a Hounsfield Unit. What is its significance?

E. Describe the advantages and disadvantages of carbon fiber. What can it be used for? How do you determine the attenuation in terms of equivalent aluminum thickness of a carbon fiber table top.

F. Describe the differences between a first and a third generation CT scanner.

G. How do you shield a mammographic room?

5. John Laughlin (Diagnostic)

A. A patient underwent 5 minutes of fluoroscopy and 8 shots of photospot film exposures for a lower GI examiniation. It was later learned that the patient was two month pregnant. Estimate the dose to the fetus. Are you going to recommend therapeutic abortion for this patient?

B. How do you estimate the exposure per frame in a cinefluorographic system? If you use an exposure meter, what kind of ion chamber should you use? Should you worry about collection efficiency? What factors affect the exposure per frame.

C. The following is a set of measurements made in an examination room.

Do you think it is normal or abnormal? Exposures were made at 90 kVp with an ion chamber on table top at 50 cm from source.

Focus to film plane distance : 100 cm
Field size at film plane : 35 cm
Exposure rate measured: 5 R/min
HVL : 2 mm Al

D. What should you do in an equipment performance survey?

6. Jack Krohmer(Diagnostic)

A. How do you determine the LSF and MTF of a screen film system.

B. What is the NCRP recommendation regarding therapeutic abortion?

C. A fourth generation CT scanner is place in a trailer. How do you do a shielding design?

D. Explain the following terms:
Pixel, voxel, slice thickness, back projection, reconstruction, and Hounsfield Unit.

E. Describe a general procedure to estimate dose for a diagnostic examination.

5 June, 1986

Dear Peter,

I've done my best to remember what transpired during an experience that, while not as bad as its reputation, I'd just as soon forget.

My six examiners were Drs Rothenberg, Wilson, Shearer, Tanner, Chaney, and Marsden. Of the six, I don't think any of them projected that brutal "I'm gonna stick it to this sucker" kind of attitude. Some were more helpful than others. Some were more ease putting than others. Some gave more hanging rope. Some stopped me before I could follow an incorrect premise or assumption into too deep waters. I was most uneasy during my session with Dr. Chaney.

Each examiner had 30 minutes to get the answers to 5 questions. If time ran out before getting to the last question, that was okay. Some people went 6 straight sessions. I had a break of 90 minutes between session 4 and session 5. There was no need to bring anything into the exam except the orange appointment slip that the board sent in the mail.

Perhaps the most helpful bit of advice I received was given immediately prior to commencing: think of the examiners as young residents -- and not very bright ones, at that.

Out of the 30 questions (less, actually -- I ran out of time a couple of times) I can remember about 18. This actually represents more, however, because many of the questions were very similar from one examiner to another.

1. Rough out the scatter calculations and barrier thickness calculations for Co-60 with and without beamstopper.

2. How would you calibrate for electrons?

3. How would you calibrate for photons?

4. How would you shield for 4 MV photons?

5. How would you shield for 10-18 MV photons?

   (4 & 5 particularly with respect to scatter and leakage)

6. What are the safety considerations for Brachytherapy?

7. What is the foetal dose to a Hodgkins patient?

8. Talk to me about rotational therapy of the upper esophagus (I considered this a trick question because

of the uncertainty of cord dose in this region. The examiner said, "Fine, but the doctor cannot be persuaded to change the prescription. Assume some sort of anterior rotation, and let's talk about rotational therapy.)

9. How do you set the timer for rotational skip therapy on a Co-60 unit? They gave two conditions of timer operation -- having to rezero and not having to rezero, I think.

10. Talk to me about the use of bolus.

11. Talk to me about the use of film dosimetry for electrons and photons.

12. What dosimetric considerations must you make when doing whole body photon irradiation?

13. What dosimetric considerations must you make when doing whole body electron irradiation?

14. How would you measure electron isodose curves?

15. How would you leak test your Co-60 unit? What would you do if you wiped your unit and got 0.1 uCi?

16. What safety equipment is required in a Co-60 room? (Don't forget the manual source moving rod. I think I did.)

17. What are the dosimetric considerations when treating tangential breast ports (how do you treat)?

18. What happens when you treat through lung?

All in all, I thought the questions were very reasonable. I also got the impression that although they would much prefer that you have equations and numbers at your fingertips, if you occasionally had to cite to some source, that was not too bad.

And with that, I hope to file the memory of this day back in the deep crevasses of my mind (along with other such memorable experiences like visits to the principle's office and wrecking my new sports car).

August 27, 1987

Dear Peter:

One of my more unpleasant ordeals has ended, but somehow I was able to pass the ABR exams. Having the observations which you disseminate from others who have partaken of the experience was definitely helpful in getting through. The following are my observations to contribute to your pool.

It was helpful for me to know the format of the orals. Each person is scheduled for thirty-minute sessions with each of six examiners. The sessions take place in the examiners' own hotel rooms. You are asked to sit at a small table facing the examiner with the door to your back. Six questions printed on index cards are handed to you one at a time. You are asked to read and answer them. Pencil and paper were available allowing you to draw pictures or rough out calculations for the examiner. However, at least one (Dr. Palliwall) was reluctant to allow semi-written answers. The questions, for the most part, were reasonable and straight forword. However, the examiners asked sub-questions based on your initial response. These could go in any direction, but generally toward weak spots. There was much difference in the attitude and approach of the individual examiners. I had been given some helpful personality clues which I will pass on with my own observations:

Colin Orton: Very encouraging; helped arrive at correct answer; a pleasure and honor to be with.

Doug Shearer: Much like Dr. Orton; ease-putting.

Faiz Khan: Straight forward and fair; business-like.

Phil Heinz: Somewhat intimidating; only moderately helpful in clarifying unclear questions.

B. Palliwall: Left me feeling uneasy about direction of my answers; had to ask him to repeat due to unclear speech.

Ed Chaney: Lived up to his reputation as most unpleasant to be with; found my weak spots and dug; intimidating when direction not going well; failed to clarify unclear questions.

The following are the questions I could remember. Some of the examiners did not get to all five questions.

1. What are polarity effects; most important beam and chamber.
2. How would you do a rotation plan of the esophagus w/o computer; given Co TMR's and isocentric isodose curves.
3. Describe staff precautions for brachy patients.
4. How would you determine neutron compliance for an accelerator room.
5. What are the problems associated with an intra-op suite.
6. How are dose rate (rep-rate or gun current) and energy (mag current and slits) varied on a linac.
7. How would you verify activity of a brachy source.
8. How would you correct for lung density; what about the therapist.
9. How would you calculate the fetal dose of a Hodgkins patient; what's the approximate dose from 4000r course; what about abortion.
10. Describe compensating filters; how to design & fabr.
11. Design a transport shield for 50mCi Ir with TI 10; given Gamma and HVL Pb.
12. Rotation plans have been suggested as a means for reduction of penumbra. Agree? Why?
13. How would you evaluate a computer before purchase.
14. Describe a safety program for a Cobalt room.
15. How would you measure head leakage for an orthoV unit. How would you calibrate the instrument.
16. What about n's from linacs. Source? Energy threshold? Mechanism? Measure?
17. How would you design shielding for a 12MV room.
18. How would you shield a Co room given WUT.
19. How would you measure electron isodoses.
20. How would you implement a computer plan without time, MU's, or normalization given.
21. At what depths do you calibrate photons and e's; why?
22. How would you calibrate a total-skin set up.
23. How would you shield a brachy store room given 500mCi and NucMed director's office adjacent; what about ALARA?

My main study references were Khan, '86 AAPM Summer School proceedings, and NCRP's 37, 38, 40, 49, and 51. Others were Saylor, Bentel, AAPM Mono. 5 & 9, Johns, and FDA 82-8181 (Linac Primer). The day before the orals, I spent several hours with a colleage answering questions verbally. Made a point to be well-rested and attempted to look good the morning of the exam. Most of all I prayed alot.

Best of luck to those contemplating this step. If I could do it, you can!

ABR Exam in Radiation Therapy and Diagnostic Radiology Physics 1987

The format for my exam was similar to that presented in past years. Three examiners covered Radiation Therapy Physics and three examiners covered Diagnostic Radiology Physics. Each examiner questioned me for 30 minutes using five or six questions typed on index cards. It seemed as though the questions were selected especially for me rather than taken at random from a pile of cards. These questions were usually the basis for discussion, as each examiner asked more questions based on my answers. Listed below are questions or topics (that I can recall) which either were presented on the index cards or verbally by the examiners.

1. Mycosis Fungoides total body electron treatments:
   - how do you calibrate the electron beam?
   - what areas on the body need shielding?
   - what areas are expected to be underdosed and how would you correct for this?
   - how would you assess the magnitude of under or over dosage?

2. What are some design characteristics that must be considered for planning an intra-operative radiation therapy suite?

3. How would you calculate the machine time setting for a 360^{o} isocentric arc treatment by hand?
   - how would you calculate off-axis points by hand?
   - how would you correct for transmission of x-rays through the metal rails of the table?

4. Basic high energy therapy room shielding.

5. How would you check the accuracy of film badges used for personnel dosimetry?

6. Draw the shape of a typical mantle field and explain what is treated.

7. If a patient was found to be pregnant and needed a mantle field treatment:
   - how would you calculate dose to the fetus?
   - would you use shielding?
   - how much dose to the fetus is expected from leakage radiation?
   - how would you calculate dose from scatter radiation?
   - if you had a choice of treatment units which would you recommend?
   - if the calculated dose to the fetus was 20 rad, what would be your recommendation as far as abortion?

8. What causes polarity effects in ion chambers?
   - how are these effects manifested?
   - how would you correct for the polarity effects?
   - what is the magnitude of the correction?

9. Describe the methods used to change the electron and photon energy of a dual energy accelerator.
 - describe the differences between a travelling wave and standing wave accelerator.

10. If a physician asked you to plan a prostate treatment what information would you need from him?

11. What is the leakage of neutrons from an accelerator treatment head?

12. What is the neutron energy spectrum from a high energy linear accelerator?

13. How are neutrons absorbed in matter?

14. How much shielding is necessary against neutron radiation in a linear accelerator installation and what material would you select?
 - how would you shield the door?

15. What is a thermal neutron?

16. How would you measure neutron doses inside and outside the treatment room?

17. What is a commercial rem meter?

18. What is an activation rem meter?

19. Discuss the flattening filter used in x-ray linacs and the x-ray target.

20. What would you choose as the ideal flattening filter material if there were no size restraints?

21. Describe the method of flattening electron beams.

22. How would you determine the electron energy in an electron beam?

23. At what depth would you take measurements for calibration of x-rays and electrons?

24. At what x-ray energy is neutron production a problem?

25. How is the klystron or magnetron energised?

26. Describe a cylindrical ion chamber and a parallel plate ion chamber with regards to its construction.

27. How do TLD's work?

28. How do ion chambers work?

29. How do you construct a tissue compensator and what is it used for?
 - What materials would you choose to construct it from?

30. Calculate the exposure from an iridium-192 source of (x) mCi at a certain distance.
 - what is the transport index?
 - design a shipping container to keep exposure at 1 meter at a certain level.
 - what is the HVL in lead and the exposure rate constant?

31. C.T. shielding problem.

32. Patient doses from various diagnostic exams.

33. Bucky factor.

34. How do you measure C.T. dose?

35. Acceptance testing specifications for an radiographic/flurooscopic x-ray unit.

36. Basic NMR questions.

37. What is the theory behind ALARA and should it be made manditory?

38. What is the maximum allowed leakage radiation from a diagnostic type x-ray tube housing?
 - low energy therapy x-ray tube housing?

39. What is a typical axial resolution figure for an ultrasound beam?

THERAPY

Equipment

1. The same ionization chamber may be used to calibrate a cobalt-60 teletherapy unit in terms of roentgens per minute in free air or rads per minute at some point in a water phantom. What conceptual differences exist in these two applications of the same instrument?

2. X-ray or electron dose distributions in a phantom are frequently produced by using radiographic film. What are the principles of this type of dosimetry and what are some of its "pitfalls"?

3. Answer the following questions regarding microwave linear electron accelerators:

    a. How is the dose rate varied?
    b. How is the beam energy defined?
    c. What is the "duty cycle" of the accelerator?
    d. What is the frequency and the source of the microwave power?

4. What are the considerations in the design of an ionization chamber for electron beam dose measurements?

5. How would you determine field flatness and beam symmetry for a high energy photon beam? How is it achieved?

6. Compare the properties and clinical applications of the various radionuclide sources used for brachytherapy.

7. Discuss the equipment necessary to provide electron beams for use in radiation therapy.

8. Why are electron beams used in radiation therapy? Discuss their advantages or disadvantages compared with photon beam therapy.

9. Describe at least two mechanisms of source exposure used with ^{60}Co units. How does the "source on" correction depend on the mechanism.

10. You are asked to set up a quality assurance program for a linear accelerator (therapy). How would you proceed?

11. Describe briefly a few sources of neutrons which may be useful for radiation therapy.

12. How is beam flattening achieved in linear accelerators? For photons? For electrons?

13. Discuss the use of wedge filters in radiation therapy. Indicate how you would design one to give a 45° slope.

14. Discuss the need for quality assurance checks due to equipment properties and characteristics.
    a. linear accelerators
    b. ^{60}Co teletherapy machines

15. Discuss the methods of high energy electron beam generation in linear accelerators.

THERAPY

Calibration of Radiation Equipment

1. In a Quality Assurance Program for radiation therapy equipment, what parameters should be measured and at approximately what frequency?

2. What are some special problems associated with the calibration of photon beams from 50 to 300 kVp?

3. Approximately what output in roentgens per minute would you expect from a 5000 curie Cobalt-60 source in a conventional teletherapy unit?

4. What correction factors are required in the calibration of an electron beam?

5. How would you determine the position of the "virtual source" for a photon beam when source position is not identified by the manufacturer?

6. What are the problems associated with measuring isodose distributions for electron beams?

7. How would you determine the most probable energy for an electron beam?

8. How would you verify the activity of brachytherapy sources?

9. Discuss the procedure and factors involved in the proper calibration of a supervoltage unit.

10. How would you measure exposures within a phantom? What measuring devices are available for these measurements?

11. Discuss procedure for proper calibration of a radiation survey meter.

12. Describe <u>two</u> methods of measurement of the spectral distribution of an x-ray beam.

13. Why are ionization chambers likely to be in error for the measurement of x-rays at high exposure rates? What can be done to overcome this error?

14. How do you measure dose distributions produced by x-ray or electron beams? What requirements do you have for ionization chambers used for this purpose? Where is the point of measurement for an ionization chamber. How does it depend on chamber geometry?

THERAPY

Radiation Hazard Control

1. What instrumentation and methodology would be employed in carrying out a radiation survey of an 18 MV Linear Accelerator installation?

2. Discuss neutron contamination in megavoltage electron accelerators.

3. What sort of Radiation Safety Program would you suggest for personnel caring for brachytherapy and radionuclide therapy patients.

4. What is the Maximum Permissible Dose for "Uncontrolled" areas around a radiation therapy installation and how can conformance with this MPD be evaluated?

5. What is the magnitude of the gonadal dose in a young woman treated for breast cancer by a typical treatment regime. What is likely to be the genetic consequences of this dose?

6. Discuss neutron contamination in megavoltage electron accelerators.

7. Describe a procedure for leak testing cobalt-60 teletherapy sources. What level of removable contamination is acceptable? What is to be done if your leak test indicates 0.1 μCi of removeable contamination is present?

8. You are asked to perform an appropriate radiation survey of a cobalt-60 teletherapy installation. How would you proceed?

9. You are asked to make a radiation safety inspection of an accelerator facility. Indicate the operational features of the accelerator which will have a bearing on the radiation detecting and measuring instruments you may use.

10. Discuss the advantages and disadvantages of Cobalt 60 and Cesium 137 as substitutes for radium sealed sources.

11. Discuss radiation safety aspects for personnel and patients associated with an intracavitary procedure.

THERAPY

Radiation Dosage

1. How do you go about correcting dose distributions for tissue inhomogeneities?

2. When a significant portion of a treatment field is blocked (e.g. a mantle field), what factors enter into the adjustment of the depth dose in the unblocked (open) regions?

3. How can you avoid overtreatment and undertreatment of small regions when two large radiation fields must be used to treat a very large volume?

4. What are the dosimetric considerations in total-skin electron therapy?

5. Discuss Iodine-125 dosimetry and treatment planning for implant therapy.

6. Compare the use of Phosphorus-32 and Gold-198 colloids for intracavitary therapy.

7. Discuss the dosimetry of parallel-opposed tangential photon therapy for the breast.

8. Discuss the use of radium-substitutes in brachytherapy.

9. How would you evaluate the accuracy of a computer treatment planning program?

10. Approximately what dose would be delivered to the spinal cord for an average sized patient receiving an AP mediastinal field treated to 1000 rads at a 3 cm depth using a Cobalt-60 unit?

11. How do you relate the result of a computer generated treatment plan to setting of time on a Cobalt-60 unit or monitor units on an accelerator?

12. How will you measure the build-up of dose at the surface of a phantom irradiated by high energy x-rays? What factors determine the <u>surface</u> dose rate compared with the maximum dose rate?

13. Discuss the depth in tissue and flatness specification desirable at that depth for high energy x-ray generators: a) why is it needed; b) where is it located; c) what tolerance in flatness over what area is needed; and d) sketch a flattened isodose chart for a 15 x 15 cm field for a 4 MV Linac.

14. What is a tissue compensating filter and when is it used? Describe how a tissue compensating filter may be constructed for a particular patient.

15. Two fields with a hinge angle of 90° converge upon a tumor, with the central axes intersecting at the tumor center. Sketch the resultant isodose distribution and comment upon its acceptability. Discuss procedures available for improving distribution (e.g., past pointing, using wedge filters, etc). If wedge filters are used, what wedge angle would you recommend and why?

16. A betatron operating at 20 MeV is to be calibrated for therapy. A Baldwin Farmer Dosemeter placed at a depth of 5 cm in a water phantom gives a reading $R^1 = 80$ in 1.20 minute. Temperature = 26° C; Pressure = 755 mm Hg. Calibration factor for cobalt 60 for chamber is 1.10; $C_\lambda = 0.90$. Determine dose rate in water.

THERAPY

Radiation Dosage

17. Sketch a mantle and an inverted Y field and describe how the treatment for these fields may be computed. What experimental technique may be employed to verify the dose per treatment delivered to different parts of the field.

18. Describe some devices used to improve the accuracy of beam alignment relative to a tumor within a patient. In what circumstances is their use particularly important?

19. A therapist is treating a mantle field for Hodgkins. The patient is 12 weeks pregnant. Decision is not to abort. Tumor dose 4000 rad midline to 20 cm patient, 60-Co unit, 80 cm SSD, 10 cm DD = 60%: a) could you calculate fetal dose?; b) what dose due to leakage (beam "on"); assume fetus at 100 cm; c) discuss any measurements you would make; d) discuss any shielding you want to design and e) would you recommend another unit 4 MV, 8 MV, 12 MV.

20. Discuss the effect of the presence of lung tissue when a lesion within the thorax is being treated. How can the effect be taken into account in the dose calculations?

21. How could you calculate a rotational isodose plan for a treatment of an esophagus (upper one-third)? You do not have a computer.

    a. discuss TAR
    b. discuss off-axis isodose points
    c. would you allow absorption of the couch? How would you do this?

22. You have depth dose data for a high-energy therapy machine for a source-skin distance of 100 cm, but in order to treat a larger field of 24 x 24 cm you wish to use an SSD of 120 cm. What factors would you employ to calculate depth doses at 120 cm SSD based on your 100 cm SSD data? Calculate new central axis depth dose for 10 cm depth.

THERAPY

Design of Installations

1. What is the ALARA concept and how does it enter practically into radiation therapy room design?

2. What enters into the determination of the shielding required in the door for a megavoltage therapy installation which uses a conventional maze?

3. What factors may be taken into account in planning barrier thickness to protect an uncontrolled area?

4. Discuss neutron problems associated with 18 to 25 MV photon beam installations.

5. What are the alternatives available to provide proper shielding outside of a megavoltage photon therapy installation when inadequate space is available for usual concrete barriers?

6. How would you go about providing neutron shielding for a high energy accelerator used for photon therapy?

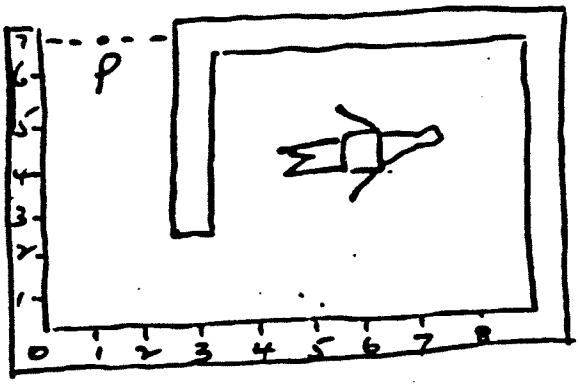
7. A 100 cm SAD rotational 4 MV linear accelerator is equipped with a 30° primary beam stopper. How would you estimate the wall thickness required to protect against scattered radiation for a wall parallel to the rotational axis of the unit?

8. A calculation of required protection for the useful photon beam of 6 MV linear accelerator indicates that 24 inches of concrete is required in a given wall. If the useful beam is always directed at 60° from normal to the wall, what actual thickness of concrete can be used in the wall?

9. Discuss the difference between "broad beam" and "narrow beam" absorption curves. Which should be used in radiation protection calculations? Why?

10. Cobalt-60 Workload 50000 R/wk at 80 cm. Maximum field size - 1200 cm^2 at 80 cm. Estimate scatter to door at point P

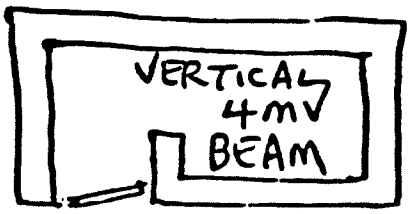
Room
3m
high



THERAPY

Design of Installations

11.



Describe the procedure for estimating the thickness of the door to the treatment facility. What differences would occur if this were on 18 MV photon beam unit?

12. Plan the thickness of concrete required for the wall of a room containing a Cobalt-60 irradiator (without beam stop).

Conditions

60,000 R/week at 1 meter
secretary's desk beyond wall, 14' from source
useful beam directed toward wall not more than 1/4 the time

How would you approach the calculation if the machine had a beam stop?

13. Describe the procedure for estimating the barrier thickness required to protect against leakage radiation from a 12 MV linear accelerator.

Oral Exam Questions 1987
C. Mesina

1. How does a linear accelerator work?
   Discuss main components of a linacc.

2. Discuss tangential fields for breast treatment.

3. Discuss 2 methods or mechanisms used in turning a cobalt source into "on" position. How do you correct for timer error?

4. Discuss methods for determining effective source distance of a photon beam.

5. Given a linear accelerator room layout, determine shielding necessary for a couple of barriers.

6. Discuss TG-21 method of determining doses for a photon beam and an electron beam. Also discuss different types of chambers used for calibrating either photon or electron beams.

7. How do you calibrate a linear accelerator?
   Discuss survey around a linacc installation.

8. Discuss ALARA. How do you apply ALARA in determining shielding for a door of a linear accelerator room?

9. What are some problems to consider in calibrating x-ray units in the 50-350 kVcp range?

10. Discuss I-125 dosimetry and treatment planning.

11. Differentiate between narrow and broad-beam attenuation measurements.

12. How do you do leak tests on a linear accelerator? On a cobalt unit?

13. Discuss protection procedures followed around brachytherapy patients.

14. Given an existing megavoltage therapy room, give ways to provide additional shielding.

15. What are methods to correct for heterogeneities in photon beam calculations?

16. Discuss methods to determine electron energy.

17. How would you calibrate an electron beam?
    Discuss field shaping of electron beams.

18. Discuss calculation of irregular fields.

19. Discuss treatment for mycosis fungoides. Discuss considerations for total body electron therapy, dosimetry, etc.

20. How do you correct for heterogeneities in electron beam mode.

Be prepared to answer spin-off questions, i.e. you will be led to further discussion of issues, topics, etc., relevant to the major question.

Written Exam Part II

1. Discuss methods for correcting for heterogeneities with photon beams. Figure provided showing position of heterogeneity in tissue. Calculate doses at different points indicated on diagram using one method.

2. Given drawings, compare % depth doses, TMRs, TARs, and TPRs. Give formulas to convert one from the other.

3. Discuss treatment for mycosis fungoides. Considerations for dosimetry and treatment planning.

4. Given linear accelerator (10 MV x-rays) room layout, determine shielding for all barriers.

Imaging Physics questions, 1988

1. Tanner, Ray
   a) measure HVL on fluoro C-arm with automatic exposure control which can't be disabled.
   b) How do you find mA when measuring leakage from an x-ray tube. 1) Fluoro 2). Radiographic. What are prescribed limits of ma variation.
   c) Upper GI done under the following conditions - are you happy with these parameters and if not, why not.
      1. 125 KVP, .5 mm Al filtration
      2. 25 mas, detail screen
      3. 76 in FFD, .3 mm focal spot
   d) 5 min fluoro exam of pregnant woman (5 weeks) and 8 spot films. Estimate dose and recommend whether or not she should have a theorapeutic abortion.
   e) Specify the purchase of a mammography unit for a practice without previous mammo.
2. Chaney, Ed.
   a) A nuclear accident has occurred and victims are coming into your hospital. How is your hospital equiped to treat them? How would you change this and what would you do? Further defined the accident as a nuclear power plant explosion
   b) Your neighbor asks you whether he should

have his house tested for Radon. You live in a Radon active area. What would you advise him and how should it be checked? We discussed the type of home most likely to be at risk.

c. Discuss sources of noise in a CT scan. How does slice thickness affect this. If the slice thickness is doubled what happens to the noise - be quantitative.

d. Wide angle dental images (these are like a tomogram, done through a slit). How would you measure dose? What if the chamber is not covered by the beam?

e. Calculate the II entrance exposure from a system used for DSA with a given SID and SOD and an anti scatter grid.

3. Bednarek, Daniel,

a) How do you measure mR/mAs, HVL, beam alignment, timing, and primary beam collimation. What are legal limits on these?

b) An orthopedic suite is being designed. The possible generators are 1) rectified single phase 2) 3 phase, 6 pulse, 3) hi frequency. all have the same power output. What considerations will help you make a choice?

4. Dixon, Robert

a) An x-ray exam of the head is done four ways. Estimate the dose for each method and give technique gradually used (KVP - mAs)

1. ~~CT~~
2. Tomography
3. Fluoro
4. Film

b) What's the difference between over and under table fluoroscopy - He had to lead me on where most of scatter emerged and magnification effects.

c) How does the Q of the transducer affect imaging

5. Rathenberg, Laurence

a) Discuss mammography units for 1. film/screen, 2. xerography. How do these doses affect the generation of excess cancers/10^6?

b) Define an AEC, describe how they are tested, and what are the limitations on them

c) How do you measure dose in a fluoro unit with an automatic brightness control?

6. Shearer, Douglas.

a) Discuss three generator types: 1) 3 phase, 6 pulse, 2) 3 phase, 12 pulse, 3) Hi frequency, and what questions about them do you need to ask their manufacturers?

b) What is the dose to the patient for cine operating at 30 frames/sec?

c) Shield a dedicated chest unit, 72" SID.

d) Mobile CT sheilding.

e) Where is the noise in a digital subtraction system? How do you test such a system?

additional questions - I can't remember who asked them.

1. What is TV interlacing? Is it always used? What else can you do? Why do you use it?
2. How do you sheild a mammography room?
3. Discuss ALARA. Should it be made mandatory?

General comments 3 weeks later: the questions seemed quite practical and could rarely be answered completely with "book learning" alone. Some experience was needed to answer most of the questions. There were no MRI or digital filtering, computer questions.

Sincerely

Carolyn Kimme-Smith

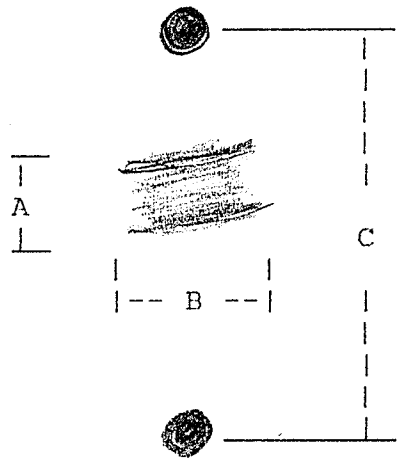
Diagnostic Physics Examination Part II
1988

(Choose three from the first four questions)

1. You are asked to provide performance specifications for a new film/screen mammography unit to be used for both magnification and screening:

A. State the performance specifications for the power rating of the generator, kV range and increment, tube current range, focal spot sizes, source to film distance, grid ratio, and film sizes.

B. A pinhole camera image for a 0.1 mm focal spot appears as shown below:



The image was obtained at the chest wall edge of the x-ray field from a pinhole camera with a 0.03 mm aperture. The real distance between the holes (measured in the object plane) is 1.25 cm. Which dimension (A or B) is parallel to the cathode-anode axis of the x-ray tube? Give a mathematical formula for calculating the true focal spot size in each dimension.

C. What three methods can be used for measurement of focal spots? Explain the advantages and disadvantages of each.

D. Is the focal spot size shown in part C above excessive? If so, what steps do you take to correct the problem?

Questions for ABR Oral Examination of June 5, 1989.

My examiners were Jack Krohmer, Gary Barnes, Thomas Payne, David Marsden, Philip Bourland and Rodney Wimmer. A former class-mate of mine had Colin Orton as one of the examiners, instead of Jack Krohmer.

Speaking for myself, everyone was okay except for Gary Barnes. (In the case of my class-mate, Rodney Wimmer gave him hell.) I tripped on one answer with Gary Barnes, and he was on top of me.

This was a question involving what kind of spectrum I would expect from wall scattering. This was a protection question, and was the fourth question of the six total. I answered Compton photon plus compton electrons. All hell broke loose after that. I was needled at to the very basics of photon interactions. It went on and on, seemingly without an end. Finally, the first bell sounded, and I was immediately excused.

He did not want to ask anymore questions, and he was only my third examiner. I knew I was dead. (In comparing notes with my class-mate later, he was a charm, and was even leading him on in a number of answers.) However, somehow, I must have convinced the others, because I passed.

The following are what my class-mate and I could think of immediately after this intellectual sadistic torture:

1.) 1 mg Radium-equivalent of ^{137}Cs in a pocket of a nurse.
Given: 0.5 cm from skin;
4 cm from marrow;
25 cm from ovaries;
Estimate the exposure to the nurse.

2.) How does X-ray scatter in the maze of the linac room?

3.) Why does an ion chamber require a bias voltage? What is the expected collection efficiency?

4.) What is a misadministration of a dose?

5.) A source is stuck in a ^{60}Co machine with a patient on the table. What are the emergency procedures?

6.) How do you design a 45^{0} wedge filter?

7.) How would you design an ion chamber?

8.) Describe how you perform dosimetry for a total body skin irradiation.

9.) A therapist wants a high dose rate remote after-loader put in an examination room. What are the factors you need to consider?

10.) Given 100 mg radium and 500 mCi ^{137}Cs to be placed in a cave next to an N.M. physician's office. What are the safety considerations?

11.) What does a mantle field and inverted "Y" field look like? What are the dosimetric considerations?

12.) How do you survey an 18 MV and 25 MV linac rooms?

13.) How do you determine virtual source distance? What field size would you use?

14.) How do you measure leakage from an orthovoltage machine?

15.) How do you determine SSD of a photon beam?

16.) How do you acceptance test mechanical specifications of a linac?

17.) How is ultrasound hyperthermia energy absorbed in fat, muscle and bone?

18.) What are the radiation safety features you look for in a 10 MV linac room?

19.) How do you measure neutrons in a maze, at the door, and in the room?

20.) What is the difference between "narrow beam" and "broad beam"? What are the consequences if the wrong graph is used.

21.) How are photon beams and electron beams flattened?

22.) How does a linear accelerator change energy?

23.) How does beam quality change across a field?

24.) What are the depths of calibrations and why (according to TG-21)?

25.) What is N^{gas}?

26.) How do you calculate a computer treatment plan for ^{60}Co or linac treatment?

27.) What are the primary barriers for ^{60}Co calculations?

28.) What are the shielding considerations for the door?

29.) How do you calculate dose to a lesion in a lung?

30.) Describe how you do inhomogeneity calculations.

31.) How does dmax for electrons change as the field size changes?

32.) How does a chamber in a field perturb an electron beam?

33.) How do you get N^{gas} from a parallel plate chamber?

34.) What instruments are necessary to measure an 18 MV linac?

35.) What are the kinds of TLD available? How does TLD work? What can you do to the reader to change the readings?

36.) What is the neutron spectrum in a linac room?

37.) What is the expected neutron leakage from a linac? Where do neutrons come from in a linac? What reactions cause neutrons?

38.) Does inverse square correction apply in total body skin irradiations?

39.) For a 6 MV linac room, what additional protection do you need in order to replace the machine with a higher energy machine?

Having gone through this examination process. I think this is an exercise in intellectual sadism by our peers rather than a test of our clinical knowledge in medical physics. (On my way out of the "torture chambers" to the airport, I was informed by some residents that apparently their peers subject them to the same kind of interrogation too!)

ORAL EXAM QUESTIONS - 1989 THERAPY

ELECTRONS

1. What are the pitfalls of current computer algorithms used for electron beam treatment planning?
2. How do measure electron pencil beam data?
3. Draw pencil beam isodoses.
4. How does field shaping effect electron output and PDD?
5. What is the difference between a traveling and standing wave linac?
6. What is the difference between scanning electrons or using a scattering foil?

BRACHY

1. Compare I125 to Au198 both from a clinical and protection standpoint.
2. How do you calibrate an I125 source? a Cs137 ? an Au198 ?
3. What are the advantages of Ir192 over Cs137 or Ra226?
4. Define Air KERMA Rate.
5. What is the current recommendation on brachytherapy source specification?
6. When would you release an I125 patient from the hospital?

PROTECTION

1. How would you calculate the shielding required at a door given a room layout of a Co60 unit?
2. What special considerations go into shielding calculations for linacs above 15MV?
3. How would you measure neutrons from a 25MV accelerator both in and outside the photon beam?
4. How do you calibrate a survey meter?
5. Draw current vs. voltage curve for an ionization chamber.
6. What areas of interest would be included ia an environmental protection survey of a radiotherapy facility?
7. What equipment is required for a radiation protection program?
8. How does the ALARA concept pertain to radiotherapy?
9. Calculate the shielding required to house 500 Ci Cs137 given the HVL of Pb.
10. What would be the approximate gonadal does from a typical breast treatment course?
11. What genetic effect could this have?

CALIBRATION

1. What would be involved in acceptance testing a linac? How and in what order would you perform these tests?
2. How do you calibrate a 50-300kVp X-ray unit?
3. What measurements must be performed before treating with a new orthovoltage unit?
4. How would you calibrate a 12MV linac?
5. What does the Energy Response Curve of a Farmer chamber look

like?

TREATMENT PLANNING AND DOSIMETRY

1. What acceptanc tests would you perform on a new treatment planning computer?
2. What are the problems with using film to measure isodose curves?
3. How would you calculate by hand the dose distribution for an esophagus rotational treatment?
4. Some sources say that using a rotational or arc treatment decreases the effect of penumbra in the field. Do you agree and why?
5. Draw TLD response vs Energy curve.

SELECTED ORAL EXAM QUESTIONS - COLIN ORTON - 1989 THERAPY

1. Briefly discuss what forms of dosimetry are available to the medical physicist.
2. How would you construct a compensating filter?
3. What instrumentation would you use to look for a lost I125 seed?
4. Your therapist is curious to know the surfac dose on the scar of a breast which is being treated with tangential cobalt fields. How would you measure the dose?
5. Describe the various aspects of a QA program for Radiotherapy.
6. Discuss the importance of head leakage from the standpoint of a patient.
7. Draw mantle and inverted Y fields. How is dose determined to various points of interest and what are these points of interest?
8. How would you verify the accuracy of a brachytherapy treatment plan?
9. What are the MPDs for various organs?
10. Your portal films are of poor quality. How would you investigate this and what might you try to improve the image quality?
11. What thickness of Pb is required to shield 300mg Ra at 30 ft. from film?
12. How would you measure dose in the buildup region?
13. How could you analyse the spectrum of an x-ray beam?
14. How does u/p change with energy for lead?
15. Why does C decrease with increasing energy?
16. How would you measure neutrons?
17. How would you go about designing a flattening filter for a linear accelerator?
18. Discuss the various uses of wedges.
19. Discuss CT applications in treatment planning.
20. Discuss risk/benefit in radiotherapy.
21. Discuss the effect of neutrons on patient dose with high energy photon beams and electron beams.
22. How does one assure accuracy in beam direction with respect to the tumor?
23. Why are the exposure rate constants different for Cs137 and Co60?
24. Discuss stopping power ratio. What is a restricted SPR?
25. Discuss the concept of integral dose in radiotherapy.
26. Discuss Direct and Indirect action of radiation.
27. What is collected in an ionization chamber?
28. How would you design an ionization chamber for electron beam calibration?
29. Discuss TG21.
30. How would you determine the appropriate settings to use on a TLD readout instrument?
31. How would you investigate the collection efficiency of your calibration system?
32. Discuss broad beam and narrow beam HVLs and whwn each is used.
33. Why don't electrons exhibit a bragg peak?
34. How does a linear accelerator work?
35. Discuss corrections for bone in electron beam treatment planning.

36. Describe the electrometer system you use for routine calibration of teletherapy equipment.
37. Discuss the Sievert integral.
38. How are TAR, TMR, %DD< and BSF related? Why is TAR not used at greater than 3 MV?

12/19/89

Peter Rosemark, Ph.D.
Cedars-Sinai Medical Center
Radiation Therapy Department
8700 Beverly Blvd.
Los Angeles, California 90048

Dear Dr. Rosemark:

I am enclosing $ 25.00, payable to the ~~Southwest~~ Southern California Chapter of the American Association of Physicists in Medicine for the American Board of Radiology Certification Study Guide for Radiological Physics. Below I am enclosing the notes of what I remember from the Diagnostic Radiological Physics and Medical Nuclear Physics Sections:

Diagnostic Radiological Physics:

1) Know BRH guidelines regarding amount of filtration required and dose allowances under the support plate for mammography.

2) Know the meaning of the Wiener Spectrum and how to interpret and use the spectrum.

3) Know how to use decision criteria curves to find false positive/true positive ratios.

4) Know how to calculate the focal length of a cine lens.

5) Know all framing modes and names.

6) Describe the difference between third and fourth generation CT Scanner Configurations.

7) Calculate a barrier problem using K_{ux}.

8) Calculate the penetration and reflection of a 5 MHz ultrasound beam in a kidney. Know penetration and reflection formulas.

9) Know Rose's signal/noise criterion for determining a structure.

10) Calculate number of light photons emitted from a 50 kvp X-ray. Information not given is the wavelength of light emitted from an ortho screen.

11) For the B scan ultrasound mode, what affects the aliasing of images.

12) Know the f-factor in bone, tissue and fat for 60-120 kev.

13) Calculate the bucky factor, grid factor and transmission factor and the relationship between them.

14) Know the wavelength of light for various intensifying screens.

15) Calculate the average gradient and gamma for a film-screen combination.

Medical Nuclear Physics:

1) Review Tracer Kinetic Modeling

2) Review RIA

3) Review Shilling test, and Cr-52 labeling.

4) Calculate gamma for a 150 kev photon, .33 emissions/dis.

5) Know regulations regarding % accuracy of dose calibrator, % Moly allowed in Tech, and % Al allowed in Tech.

6) Know the modes of isobaric transmutations.

7) Review and perform internal dose calcuations; review definitions, esp. absorbed dose fraction and specific absorbed dose fraction.

8) Know the features of a Cs-137 curve in a well counter.

9) Know the relationship between fwhm and an MTF curve.

10) What is the real part of 1,0,0,0 Fourier function.

11) What affects the noise found in SPECT.

12) What is the Kell Factor.

13) Know NRC regulations regarding quarterly rad safety meetings, dilutions for dose calibrator accuracy, daily wipe tests, etc.

14) Know about heart gating for SPECT.

15) Calculate blood flow using labeled red cells.

16) During end diastole, are the ventricles filled.

17) Review PET, know the sources of noise in PET and how to address them.

I realize these notes are somewhat haphazard. I remember only a few specific questions, so I hope these are of some help.

Sincerely yours,

Physics Section Topics. Thursday afternoon, 4 hours.

Maxwell's theory.
Transformers and their windings.
Nuclear Medicine Counting Statistics.
Binary, Octal and Hexadecimal notation (No conversions).
Lots of diagnostic radiology questions.
Free falling bodies: if a bullet is shot horizontally, how far does it go before it hits the ground.
Op Amp Circuitry: 1) identify the parts of the circuit
2) given R2 and R1, what is the gain
Optics, a lens question.
What type of laser is mounted on the CT Scanner?
From 5 answers given, pick outthree of the bones of the ear
Bones of the hand, arm, "shin"
Name the order in which the valves of the heart receive blood.
Identify which veins carry oxygenated blood.
Quantum mottle.
Grid ratios.
Is D0 equal to the slope of the survival curve?
Regions of the G-M tube curve.
Computer memory calculation.

Therapy Physics Section Topics. Friday morning, 3 hours.

Many, many shielding questions dealing with Tenth Value Layers and Half Value Layers!!!
Head leakage in CO-60 and in CS-137 therapy units.
Wipe testing of CS-137 needles and CO-60 gantry.
Detectors - which ones are used for which situations and for which sources?
Definition of a misadministration. (Given a situation, would it be considered a misadministration. For example, a patient has a prescription for CO-60 but is treated on a Linac. Is that a misadministration?
Cobalt-60 SSD calculations and TAR Calculations for doses.
Linac SSD calculations and TMR Calculations for doses.
Brachytherapy Safety. For example, given a patient with 80 mg Ra Eq, what values would you expect to detect in the patients room, in the hallway, in the adjacent patients' lounge. Are the values reasonable and acceptable?
Temperature and Pressure Correction factor calculation.
Given a 5% shadow block in the center of a 12 x 12 field, what will be the %DD at 7 cm depth on the Central Axis?
What is the microwave frequency of a Linac?
TG-21 Questions.
Do you need to wipe test the Uranium depleted collimators on a Cobalt-60 machine?

Given an AP and a Lateral view of two points, A and B, calculate the distance between them.

Barometer questions. If you are a traveling physicist and you go from region A to region B, should you recalibrate if your barometer goes around 1 full rotation while you are traveling? How do you compare barometric readings at two locations? Should you use another facility's reading of barometric pressure if there is a storm between your facility and theirs?

Convert temperature in degrees F to degrees K.

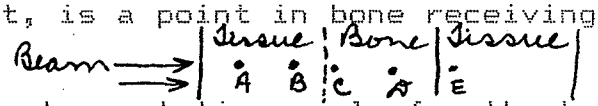
What is the ideal set-up for Total Body Irradiation? A moving source and a stationery patient? A stationery source and a moving patient? Multiple adjacent fields?

What SSDs should be used for the film and for the build-up material when checking light field and radiation field coincidence on a CO-60.

What is the largest source of error in a CO-60 calibration or calculation? Temp & pressure Correction? Monthly decay? etc.

When you rotate the gantry of a Linear Accelerator, what should be the radius of the sphere that contains the isocenter?

Given a picture of Points A, B, C, and D which lie along the path of a beam which encounters a tissue-bone-tissue interface, where is the dose highest, is a point in bone receiving more dose than a point in tissue?



Calculate the collimator rotation angle for the brain fields of a medulloblastoma patient given the spine field length & SSD.

Calculate the gap between two adjacent fields.

Calculate penumbra for a Cobalt machine.

ABR Oral Examination:
"Radiological Physics"
Radiotherapy Physics
1990, Louisville, KY

My examiners were all quite pleasant and the atmosphere was quite cordial and relaxed. They put effort into being non-intimidating. All in all, it was pleasant. My examiners were:

• Jack Krohmer, Ph.D.	avuncular, enigmatic, practical
• David Marsden, Ph.D.	businesslike, strait-forward
• Phil Heintz, Ph.D.	friendly but circumspect
• Gopala U.V. Rao, Sc.D.	very nice, theoretical
• Charles R. Wilson, Ph.D.	friendly, smart, and helpful
• R.L. Tanner, Ph.D.	friendly, businesslike, practical

In general, the questions were aimed at "hospital physics" emphasizing radiation protection, facilities design, regulatory responsibilities (including knowledge of NRC numerical limits), and medico-legal aspects of practicing consuiltative medical physics in radiotherapy.

There were six questions per examiner for a total of 36. The questions that I remember follow.

1) What are the design considerations for the installation of linacs:
   a) 4MV
   b) 25 MV (neutron production issues)

2) What are the legal aspects of linac "acceptance testing"? What constitutes "final acceptance"? What are the purchaser's rights and responsibilities? What are the physicist's rights and responsibilities? What are the vendor's rights and responsibilities?

3) Design a Cs-137 storage facility. Procedures. Will it hold radium?

4) Design a facility to handle radiation accident victims. Procedures?

5) Discuss two methods to calculate the dose at a point in tissue from an irregular field.

6) Discuss two methods to provide variable linac energy.

7) How do you determine the photon virtual source in a linac?
   How do you determine the electron virtual source in a linac?

8) Discuss the design, calibration, and use of High Dose Rate brachytherapy devices. Also, for which sites is HDR appropriate? What is the radiobiology of high dose rate irradiation?

9) Discuss the use of CT in radiotherapy port localisation. What are the problems and what are the benefits?

10) Design a 45-degree wedge.

11) How to's of HVL measurement: both good geometry and broad-beam.

12) Cobalt-60 unit radioactivity leakage: where? how to measure? and what the regulations?

13) Brachytherapy lab "hot room" management procedures.

14) Radiation protection procedures for a new radiotherapy department.

15) Quality assurance procedures for a new radiotherapy department.

16) Cone-down from a four-field box for prostate: What are the differences between a four-field box cone down and a pair of lateral arcs vis a vis dose to bladder and to rectum?

17) Secondary shielding calculations.

18) Calculate TVL from the HVL in an X-ray absorber.

19) Retrofit a 6MV linac room for an 18MV unit.

20) Design an electron extrapolation chamber for build-up measurements. What other devices would one use if an extrapolation chamber is not available?

21) How would one calibrate a fast neutron beam?

22) Calibrate a 1-3mmAL HVL contact therapy unit. How do you estimate the dose if a blocked field is smaller that the size of the smallest measured field and smaller than the size of your smallest chamber?

23) How does one calibrate a scanned electron beam? How does one measure flatness, symmetry?

24) Define KERMA. How is it different from LET?

25) How does one measure neutron "air kerma"?

26) Under what conditions is the kerma equal to absorbed dose? What determines the depth of maximum absorbed dose in a neutral particle beam?

27) Calculate the HVL of Pb from that of water.

28) How does one calculate the thorax dose through lung? What are the methods and considerations? Why do thoracic protocols (eg: for esophagus) not use heterogeneity corrected dose and dose distributions?

29) What data are necessary to use in a computer program for planning interstitial/intracavitary therapy for Ir-192? For I-125?

30) How does one calibrate for extended distance, low-energy electron total body irradiation? What are the clinical techniques? What are the motivations and trade-offs for such techniques?

31) What is the effect of a flattening filter on irregular beam calculations? What is the effect on OCR's? Hardening versus beam position?

32) Butterfly versus two-field lateral in the pelvis?

33) design and operation of Bonner sphere devices.

Peter,

The oral exam was a very interesting experience. This is not an impossible exam except in the participant's mind. I found the previous oral exam questions extremely helpful as a starting point for studying but you need to review not only the particular question but all of the aspects of whatever the question is covering. I tried to save some money by flying to Louisville on Saturday (my test date was Wednesday) and I found I learned more in those 4 days prior to the exam, than I had when trying to study at work or at home(too many interruptions).

The exam is structured as always. 6 examiners, 30 minutes each and 5 questions each. The questions are in 5 different catagories but I coundn't tell if a question had to do with shielding, calibrations or brachytherapy, in a couple of cases. They have you read the question off a 3x5 card. The question is usually a starting point and then they can go off at any tangent they want to test the depth of your knowledge in the field. The examiners liked equations because you could define variables and discuss what the equation was used for. If you knew the equation cold, great. If you could remember most of the equation but stumbled on a constant, they weren't upset.

Examiners were Dr's Barnes, Marsden, Syed, Rao, Wilson, and Sayeg.

Some of the questions I remember:

1. Dose from a Sr-90 applicator - calculate the dose to the eye and determine the treatment time.
2. Shielding design for a 250 kVp treatment room.
3. Neutrons - everything from origin, flux determination, energy of direct and scattered neutrons, shielding of room and door, detection methods, personnel monitoring, energy of neutrons, etc.
4. Use of linac for IORT using electrons only - shielding necessary? assume the unit is in the OR.
5. Health Physics concerns for a linear accelerator - shielding, safety devices in or outside the room, personnel monitoring, etc.
6. Calibration of Co-60 in air, dose to free space and dose to patient. The examiner talked about transient equilibrium of Co-60 and a B factor for dose to free space.
7. Relate %DD, TAR, TMR, and BSF.
8. Effect on %DD, output, and 2 other things when you block a 10x10cm electron cone down to 1 cm diameter.
9. Health Physics concerns for I-125 vs Au-198 implant.
10 QA program for Linac - what measured, how to measure, tolerances, frequency, etc.
11. QA program for high dose rate remote afterloading device.
12. Skyshine calculations for EM and Neutrons.
13. Converting Co-60 room into a room for a high energy linear accelerator - shielding concerns.
14. Difference in measuring electron flatness and symmetry at D-max vs 1/2 D-80.
15. Dose calculation to an irregular field and a field using asymmetric collimators.
16. What happens to electron beam if MW power to accelerator is increased.
17. GM paralysis around a linac - how coused, how evaluated, problems with Cutie Pie in same circumstances?
18. How is dose rate modified on a linac?
19. How do you determine the activity of a brachytherapy source?

They change their questions for every session (AM and PM each day). From the stack of questions I saw, they must use the same questions year after year. While the test is difficult, it is not impossible. If you study hard and do not get stressed out, you can pass. I won't know if I passed for another 2 weeks but if not, then I get to go to Kentucky next year.

Bruce

June 21, 1991

Peter Rosemark
Cedars-Sinai Medical Center
Department of Radiation Oncology
8700 Beverley Blvd.
Los Angeles, CA 90048

Dear Peter,

Now that the ordeal of the oral examination has passed on a positive note, I wanted to take a little time to pass on what I can recall from this year's exam in Radiological Physics.

The exam format was unchanged and I had six examiners with two each in Nuclear, Diagnostic and Therapeutic. The approach of the examiners varied with some simply listening to your answers and asking only for minor clarifications/details while others were able to develop an unending series of sub-questions for each answer given. My examiners were:

Sayeg (Therapy)
Barnes (Nuclear)
Marsden (Therapy)
Morin (Diagnostic)
Rao (Diagnostic)
Wilson (Nuclear)

Diagnostic:

1. What is the theory and purpose behind ALARA, and should it be legislated.

2. An orthopedic O.R. suite is being designed and you are asked as to your recommendations in regards to the choice of a generator; a) rectified single phase, b) 3 phase, 6 pulse, c) high frequency. Discuss the considerations and reasoning for your choice.

3. Discuss and compare the dose (both surface and glandular) for film screen and xero mamography. What is the expected increase in excess cancer deaths as a result of such a procedure (they were looking for a hard value, but in particular my examiner wanted to compare it with other general risk factors in life).

4. What is meant by Automatic Exposure Control (AEC) and describe how they work, how should they be tested, and what, if any, are their limitations.

5. How should one measure dose in a fluro unit equipped with ABC?

6. Discuss the needs and requirements for shielding a mobile CT scanner.

7. What is TV interlacing? Why do we use it? Do we have any alternatives? This question lead to rather intensive probe of noise, bandwidth, sampling rates, matrix sizes, etc.

8. Discuss the effects of KvP and filtration. What different materials are used as filters and why. This question led to a discussion of subtraction methods in DSA.

9. Discuss the methods for acceptance testing the following CT parameters: resolution, uniformity, linearity, dose/slice and contrast. The examiner wanted some hard and fast values for many of the parameters and details as to the test tools.

10. You are asked to perform a room shielding survey prior to the installation of the unit. What do you do. This question had many "what if's" as well as requiring the details and limitations of any and all equipment used

Nuclear:

1. Your facility is preparing ^{99m}Tc labeled RBC's as well as ^{111}In labeled leukocytes and platelets. Discuss the procedural aspects as they relate to the radiation exposure to the preparer and ulitmately the in-vivo dosimetry.

2. Discuss the generation, details, components etc. of a pulse produced in a NaI detector.

3. Contrast cyclotron and reactor produced radionuclides currently in use in Nuclear Medicine. Discuss production methods, costs, decay characteristics, specific activity, etc.

4. Compare and contrast two methods of determining the release criteria for a patient treated with ^{131}I.

5. Discuss how you would prepare bid specifications for a gamma camera for uniformity, linearity and sensitivity. Include the test methods and expected tolerance values.

6. Discuss from start to the finish the technical and computer aspects of a nuclear medicine gated cardiac scan for the determination of ejection fraction. Examiner wished details of how the study was acquired as well as the methods for analyzing the data.

7. Provide a functional description of the operation and purpose of a multichannel analyzer.

8. Discuss the calculations and considerations for using ^{133}Xe in a nuclear medicine department. This question branched in many directions including efficiencies of traps, sensitivity of detection devices, air flow, restrictions in the performance of portable studies etc.

9. A problem was presented which involved the administration of a a ^{99m}Tc "aggregated colloid" along the the biodistributional data. A thorough discussion of the dose to various organs as determined by MIRD was expected.

10. Discuss the criteria for determining a misadministration and the necessary reporting and time frames.

Therapy:

1. A shielding question as it applied to a high energy therapy room. This question was geared toward the values of occupancy and use factors for the control room area vs. a nearby broom closet. Shades of ALARA were clearly present.

2. Discuss the use of compensators vs. bolus in terms of use and design.

3. Discuss what is meant by timer error and end effect. How do you calculate for each and how correct for it in clinical use.

4. A muscle-bone-muscle interface was presented in the context of a ^{60}Co beam. Sketch out and explain the dose at the various interfaces. Does the appearance of a port film reflect these changes.

5. Discuss the considerations of performing an autopsy on an individual who had recently received a high dose permanent implant.

6. Discuss two available computer algorithms for electron dosimetry. Include details of their relative accuracy and limitations, if any.

7. You are called in to perform the radiation protection and safety survey for a new cobalt room. What do you need to do and what should you look for.

8. You are presented a brachy source storage room which contains 500mCi of ^{137}Cs, 500mCi of ^{125}I and occasionally up to 200mCi of ^{192}Ir. The room is adjacent to an office housing the head of Nuclear Medicine. How do you shield.

9. What is the range of 6 Mev electrons in tissue, bone and lung.

10. Discuss electron surface dose as a function of energy.

June 91

Oral Questions

Radiation Therapy

1) Design a C_S storage safe, and outline QC program for implant program.

2) Discuss sources, characteristics and methods of measuring neutrons both in and outside the accelerator room.

3) Tell how you would determine the effective energy of the photons leaking from the head of an accelerator.

4) Define Kerma. Under what conditions does it equal dose.

5) Design a 45° wedge.

6) What is the dose to the contralateral breast, and what do you do to reduce it?

7) Compare 4 field box vs. butterfly arc for treating prostate. What is bladder and rectum tolerance?

8) Give 2 methods you can use to change the energy of an accelerator.

9) Specify room design and procedures for handling a radiation accident patient. Assume patient contaminated.

10) How do you measure virtual source position for photons, and electrons, and how does it vary with energy and field size?

11) What is value of HVL for C_S and C_O for concrete and lead?

12) What activity is in a high dose rate afterloader? Give 2 isotopes that are used and pro's and con's of each.

13) What are the legal aspects of a consultant acceptance testing an accelerator? Suppose it does not meet specifications?

14) How would you calibrate for total body electrons?

15) Describe how you would correct for lung inhomegenities.

16) What perturbations does off axis blocking have on the effectiveness of flattening filters. (i.e., irregular fields)

Peter,

Some recollections of ABR ORAL EXAM, Therapy Physics, June 1991

Examiners:
Barnes
Marsden
Krohmer
Rao
Wilson
Sayeg

1. Describe the set up for narrow beam and broad beam attenuation.

2. Describe the QA program for a high dose rate remote afterloader.

3. Describe the field (isodoses) for two perpendicular beams. What effect would 45 degree wedges have on the distribution? Is this the best choice of wedges? What types of fields would you treat with this type of plan?

4. What is the hinge angle? What is the relationship between wedge angle and hinge angle? How is wedge angle defined?

5. Describe the relationship between DD, TAR, TMR, and BSF. How do you measure TMR?

6.

Date: May 15, 1992

Subject: ABMP Oral Board Exam

I took the ABMP Part III on Saturday, April 25th in Chicago. I was examined by Jim Purdy (Washington University), Chairman, Jimmy Fenn (Univ. of South Carolina), Jim Deye (Fairfax Hospital, VA), and Ned Sternick (Tufts-New England). N. Suntharalingam, Bhudatt Paliwal, Dave Goff and one other gentlemen were the examiners in the other room. The format was this: all four examiners were seated at a table opposite me (much like the court-martial scene in "The Caine Mutiny"). I was seated at a table facing the board or standing at a grease-board behind the table. They asked questions on 8 previously announced general topic areas, roughly 15 minutes each (Photon Clinical Planning, Electron Clinical Planning, Radiation Measurements and Detectors, Brachytherapy, Shielding and Regulations, Linac Acceptance Testing and QC, Computer Calculations, Special Techniques (IORT, Stereotactic, TBI, TSET)). They initially asked me to briefly describe my background and experience. I noticed that they almost completely avoided asking any questions in areas I stated that I had worked in. They only asked me about areas in which I did not acknowledge particular expertise. The printed description mailed to me months ago stated that they would ask me questions "designed to test the limits of my knowledge". Dr. Purdy stressed that they would fire questions at me rapidly, interrupt me in mid-sentence and try to test my ability to think on my feet. None of them helped me along if I got into difficulty or assisted me in working my way thru something. This was more of an adversarial proceeding.

The first hour seemed to go well. They would often ask me to draw on my own experience for examples. I felt that my worst problem was not to have personally experienced all aspects of acceptance testing and calibration of a linear accelerator, and the subsequent loading of beam data into the Theraplan computer. I described my experience painstakingly measuring

buildup curves with an extrapolation chamber for all three of our new Philips accelerators at two photon energies (which was my primary task) and they were not very interested. One examiner asked, "Yeah, but what are you going to do when you are acceptance testing a linac somewhere in Iowa?" I had no answer for that. Questions were in great detail and there were quite a few that I could not answer. My worst problems were in electron beam dosimetry. After a good initial exposition of depth dose profiles, corrections for polarity, ion recombination, etc. they began to ask about the effect of field size on depth dose. I knew that large field sizes shift Dmax toward the surface, but got in trouble when I began to draw the depth dose curves (for one energy but different field sizes). I showed different depths at the deep end and they immediately asked me "You mean the energy changes??" I knew the familiar range-energy relationship but was not certain of the exact measurement conditons under which it was derived. I was unable to puzzle out the exact nature of the requested curve before time ran out on that section. The next problem area was brachytherapy. I thought I was doing pretty well with a Fletcher-Suit cervical procedure, when they noticed that I had a sphere instead of a cylinder for the ovoids. Next they wanted to know about the shielding in the ovoids- what was it, how oriented, how do you know if it's correct. Jimmy Fenn asked me to elaborate on acceptance testing of a new Fletcher-Suit applicator. I had no idea such a thing would be asked and improvised as best I could. They asked me to identify the exact location and shape of the shielding and how I could prove that it was oriented correctly.

I studied thoroughly all major textbooks and every NCRP and ICRU report ever suggested in the two previous exams. I had 50 pages of notes from all sources which I distilled from these references and attempted to memorize. It still wasn't enough. No equations, constants or other pertinent information was given. All of it had to be from my own memory. They asked for details on the California State radiation regulations and an illustrated analysis of the shielding of one of our linac rooms. Nothing was asked on Total Body Irradiation, Total Skin Electron Treatment, Hyperthermia, radiation surgery or intraoperative radiation therapy, even though all these were on the study list.

I learned afterward that it is possible to "conditionally pass" all but some one or more parts of the exam. Results will not be available for 6 weeks.

1992 ABR Oral Exam - Diagnostic Radiology and Nuclear Medicine

I had six examiners, all of whom were courteous and attempted to put me at ease. However, I was somewhat intimidated by one examiner who consistently took the answers I gave and repeated them them back to me in the form of questions.

The following are some of the questions I remember:

Diagnostic Radiology

Describe how to determine the plate glass thickness necessary to shield the control room of a CT unit.

How do you shield a mammographic x-ray room?

Why do patients in cardiac cath labs receive high exposures? How might you reduce patient exposure?

What are typical mammographic skin exposure and mean glandular dose values? How do you determine mammo mean glandular dose? What is the composition of an ideal breast?

List factors that determine the mR/mAs output of a diagnostic tube. How do you measure mR/mAs and HVL?

An 18 year old woman has a BE exam and some radiographic films to determine the source of an abdominal pain. She is 3 weeks pregnant. Estimate the dose to the fetus.

What is the Bucky factor?

What is a gray scale?

Describe the sensitivity to kVp of rare earth and calcium tungstate screens.

Discuss differences between rare earth and calcium tungstate screens.

A technologists film badge report shows an exposure of 3400 mRem. As Radiation Safety Officer, what do you do?

What is a typical HVL for a diagnostic x-ray machine, for a film-screen mammo unit, for a Xerox mammo unit?

Nuclear Medicine

Discuss methods of attenuation correction used in SPECT and PET.

Why are In-111 leukocytes difficult to label? Describe the labelling procedure.

Given a patient treated with 25 mCi I-131 and released, estimate the exposure rate and total dose to her husband and give safety recommendations.

A 5 year old child is accidentally given 50 mCi I-131 instead of 50 uCi I-131. What actions do you take? What harmful effects may occur?

Describe reconstruction methods for PET and SPECT.

Xe-133 problem. Determine activity that may be released per week given the stack air flow rate and area of top of stack.

What improvements have been made in gamma cameras in the last 30 years?

How often should air flow tests be done in a Xe-133 exam room?

What are limits for Xe-133 in controlled and uncontolled areas?

What is background radiation and where does it come from? What is the average dose per year in the U.S.?

List factors that affect spatial resolution in a gamma camera.

What is Lugol's solution and when and why is it used?

Calculate the dose to the thyroid from 110 mCi I-131 (no other information given).

Why are BEIR V risk estimates different from those given in BEIR III?

ABR Oral Examination - 1992

Diagnostic Radiological
and
Medical Nuclear Physics

The examination format was unchanged. Normally one would have six examiners only. I have seven examiners because I fail to pass the clinical portion of the written examination part I. All my examiners were quite pleasant and they all tried to put me at ease. I took advantage of the reduced air fare by flying to Louisville on Saturday and my examination date was on the following Tuesday. I covered more materials in those two days in Louisville than previous two weeks at home. I spent the last two days studying the past oral examinations questions which I found **extremely** helpful for the last minute preparation. Looking back, I think all the questions are quite reasonable and my biggest problem is anxiety. My examiners were:

Laughlin, Ph.D.	(Nuclear)
Chaney, Ph.D.	(Nuclear)
Marsden, Ph.D.	(Nuclear)
Wilson, Ph.D.	(Diagnostic)
Barnes, Ph.D.	(Diagnostic)
Ritenour, Ph.D.	(Diagnostic)
Wiot, M.D.	(Clinical)

Nuclear Medicine:

- Discuss and compare: I-131 and I-123.
- Discuss the characteristics of the pinhole collimator for Anger camera.
- How would you estimate the absolute activity per voxel for SPECT study?
- Discuss daily survey in the Nuclear Medicine Department. What instrument would you use and what would you do if contamination is detected?
- What is the meaning of "peaking" for scintillation camera? Discuss the spectrum obtained from a NaI(Tl) detector. Discuss the causes of broadening of photopeak.
- A patient received an administration of 100 mCi of Au-198 into the peritoneal cavity. The patient die two day later and autopsy is requested. What recommendations would you give to the pathologist?
- In most patient care areas in hospital, the air pressure is positive. The air pressure in the Nuclear Medicine Department is usually negative. Why? How to determine the air pressure is negative?
- Discuss the ventilation requirements for Xe-133 gas. Given the opening of the fume hood, 30" x 48 " and air velocity of 100 linear ft per minutes. How much Xe-133 can be released?
- Discuss disposal of I-123 by incineration.
- Discuss the concept of MIRD absorbed dose estimation. What if the bio-clearance is non-exponential?
- Discuss the count rate performance of scintillation camera. Why image contrast decreases as the count rate increases?
- Discuss and compare dose: a normal patient and a patient with liver decease undergoing liver scan using Tc-99m sulfur colloid. *(I don't recall the exact liver decease that was stated in the question.)*
- If you are moving into an area which was previously occupied by the Nuclear Medicine Department . What would you do? What if contamination is discovered on a spot?

Diagnostic:

- Discuss shielding designs, using plate glass for operator viewing window in a CT installation. *(We discussed the method of using the K_{ux} table for concrete, with a density correction to determine the required thickness for plate glass, and He also asked if the attenuation factor for the window have to equal to the attenuation factor for the barrier where the window was located.)*
- Discuss the advantages and disadvantages of 3-Phase and High Frequency X-ray generators.
- Discuss patient dose for the following examinations: chest, skull, CT, angiography of extracranial carotid artery, and angioplasty.
- Discuss parameters of x-ray film processor that will affect image quality.
- How to measure patient dose from 8 CT slices? *(We discussed TLD dose profiles for surface and central axis, and pencil chamber to measure MSAD.)*
- How to measure HVL on a capacitor discharge unit? *(We discussed the kVp and mA waveforms.)*
- A nuclear accident has occurred and victims are coming into your hospital. How is your hospital equipped to treat them? What would you do?
- Film badge report indicates over exposure from high-energy beta source for a x-ray technologist working in cath laboratory. How would you investigate this incident?
- Discuss the techniques for film/screen and Xero mammographies (screening). Compare the dose for the two techniques. What is the expected increase in excess cancer deaths as a results of such a procedure? *(He was looking for a hard number.)*
- Discuss the considerations and specifications that you will make in purchasing a R/F x-ray room for your hospital.
- Discuss and compare: undertable and overtable R/F configurations.
- If you measured 10 mR /1000 mAs at the location (uncontrolled area) behind a vertical chest bucky and the workload of the medical office is 50 patients per day. What is your recommendations? *(We discussed using the HVL Table from NCRP No. 49 to estimate the amount of lead needed to reduce the exposure to 10 mR/week)*
- A x-ray technologist in the cath laboratory informed you that she is pregnant. How would you handle it?
- How does the Q-factor of the transducer affect images?

Clinical: *(No film or image was shown)*

- Discuss the anatomy and physiology of the heart.
- Discuss the anatomy and physiology of the lung.
- Discuss and compare: perfusion and ventilation lung scans
- Discuss the anatomy and physiology of the liver, kidney, spleen and pancreas.
- Which parts of the body or which organs are most sensitive to radiation?

ABR Radiotherapy Physics, June 1993

1. Relationships of %DD, TAR, BSF, TMR?

2. How to shield a 250 KVp machine?

3. A Cs needle was found in a nurse pocket, calculate the exposure to skin and ovary. If pregnant, what is your recommendation for abortion?

4. How to change dose rate from a linac?

5. Describe the production of neutron. How to detect neutron and why.

6. What is the difference between Ngas and Nx?

7. How to retrofit a Co room with a high energy linac?

8. How to calculate CAX dose for blocked field for
a. regular jaw;
b. asymmetric jaw?

9. Discuss wedge design of individual wedge, universal wedge and dynamic wedge.

10. What are the wedge factors for 15, 30, 45, 60 degree wedges?

11. What are the field size factors for 5x5, 10x10, 20x20 fields?

12. What is the wall thickness of your linac room? and door?

13. What are the survey readings of you linac room?

14. What are the popular definitions for flatness? Symmetry? Why do we want a flat beam?

15. If a few I125 seeds dropped into a toilet, what will you do? Will you allow a plumber to take it apart? If seed are flushed, what will you do?

16. How do you do QA for simulator?

17. How do you do QA for linac?, what are the frequencies?

18. What will you do for intraop in linac room? in OR room?

19. How do you do a acceptance test?

20. Describe the effects of a 1 cm diameter cut-out on electron
a. %DD
b. Output;
c. What would you tell physician?

21. How do you shield a room on ground floor? What is skyshine?

22. What are the advantages and disadvantages of I and Au for permanent implant? When can you release patient? What would you advice the family?

23. A Ir implanted patient needs CT, what would you do for transport the patient?

24. What data are needed for RTP computer?

25. How do you measure e depth dose, profile? what are the equipments? any corrections, why?

26. How do you calibrate brachy sources?

27. How do you calculate meter set?

28. What is the bias voltage for your ion chamber? what is it for?

29. What collecting efficient is required for ion chamber? What is yours?

30. How would you do acceptance test for RTP computer?

31. How would you do QA for HDR?

32. Describe two radiosurgery system and their prescribed dose?

33. How would you do QA for HDR unit?

34. What are the considerations for TBI?

Here are some questions from last oral ABR '93 exam for
Nuclear Medicine Physics. (sorry for misspelling and check answers).

1) Which regulations applys to radiation protection matters ?

A: NRC Title 10 CFR20 and CFR35

2) Which assumption is used in reciprocity theorem, using S factoirs and in absorbed dose calculations.

A: Densities of source and target organs are the same or very simillar. S-factor is average MIRD value

3) 300 mCi I-131 therapy problem. What precautions one has to take for personel, room, discharching the patient ?

4) Uptake probe(or other device) used for I-131 and I-125. What should be changed and taken differently? Does uptake probe has collimator ?

A: I-1312 is high energy emitter (360 KeV ?) and I-125 low-energy (30 KeV X-ray emission ?). Change of collimator and energy window.

5) Thyroid studies of pregnant woman. What are concerns about dose to fetus ?

A: Fetus thyroide developes in ?? months of pregnancy and is main source of cumulated activity.

6) Cause of distortion of pinhole collimator. How septum looks like ?

7) Paralyzable system (gamma camera). What causes it ? Role of crystal in it. How to measure dead time constant ?

8) Nuclear medicine computer. Scheme .

9) I-131 in therapy. How to determinate dose in room, what to do with personel, patient and residual activity in room ? What precautions have to be taken (blue pads for urine and vomity collection etc)?

10) Formatter tests and calibrations.

11) Callibration of GM , Cutie Pie, and other detectors.

12) How to monitor radiation in Nuclear Medicine department ?

13) Role of radiation protection officer ? (spillings, badges, etc.)

14) 300mCi of Au-198 in patient who died two days ago. Obduction consideration. Dosage to physitians, storage and collecting of residual activity .

15) Survey meters

ABMP March 1993 Part III

Praveen Dalmia

There were three groups of four examiners each for Radiation Therapy and one group of four for Diagnostic. My examiners for the two hour session were Drs. Ann Wright (Brachytherapy, Radiation Measurements/Detectors) [1], Jim Purdy (Radiation Safety/Shielding, Treatment Machines/ Simulators), Ed Sternick (Clinical Electron Beam Therapy) and Randy Ten Haken (Special Procedures, Treatment Planning Computers). Some of the examiners in the other rooms were Drs. Khan, Sunthralingam, Williamson (very extensive Brachytherapy), Chu, Horton and Paliwal.

The examiners were seated around a long conference table, two on each side of me. I was asked to sit at the head of the table. There was a writing board behind me. The examiners introduced themselves and asked me to give my background, including all education, starting from undergraduate program, where I had trained, and professional experience (with dates). They then asked about the equipment (with make and model of each item) I had worked with: Treatment units (including beam energies), dosimetry equipment (water phantom, Farmer chambers, parallel plate chambers, solid state phantom, film scanner, TLD system, diode system, etc.), superficial unit, simulator, treatment planning system, etc. They asked about the number of physicists in department, number of dosimetrists and physicians, my responsibilities, if I did nuclear/diagnostic too, if I was also the RSO, daily patient load in the department, etc.

The entire process was like a discussion and an inquisition at the same time. They went through the list of topics (see attachment), spending approximately 15 minutes on each of the 8 topics. The emphasis was on my past experience. They did not dwell on equipment I had never come across. The philosophy seemed to be to question what I knew and not what I did not know. The questions were related to what one does (or should be doing) on a regular basis or situations that one might face on the job. If I did not have experience with a certain piece of equipment, they questioned me on its acceptance testing, what I needed to do before putting it to clinical use were I to acquire it, protocols I would follow, quality assurance, etc. For example, since we do not do stereotactic radiosurgery at my hospital, I was asked what I will tell the physicians and the management if they wished to start using the present linac for the procedure. These questions obviously have no "book" answers. The examiners also questioned the theoretical basis of my clinical observations/practices. In a sense, I was made to defend everything I do on a regular basis.

The examiners were very pleasant and tried to put me at ease. If I had difficulty answering something, they tried to direct me toward the right path. They tried to throw hints (which I often foolishly ignored). The moment they realized that I knew the answer, they switched

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[1]These are the main topics each of them questioned me on. The way it worked was, one person started the discussion and the others either joined in or asked their questions after the main person dealing with the topic was done questioning.

to another topic. They did not dwell on a topic unless I was giving a wrong or an unsatisfactory answer. Usually the examiner started the discussion on a topic with a question. The questions that followed were off-shoots of my answers, i.e. one answer led to another question.

HINT: Whenever I say that I was questioned "extensively" on a certain topic, I really mean that I "screwed up" that answer. For had my answer been precise and accurate, the examiners would have proceeded to another question. They persisted on a question/topic only if I could not answer it -- in a sense they tried to point me in the right direction by either throwing hints or asking related questions.

Below I have tried to portray what really transpired in the 1 hour 25 minute session. (They let me go 35 minutes early!!). The phrases in parenthesis are the answers I gave -- they may or may not (eek!!) be correct. Wherever I could remember, I have tried to give names of the examiners who asked the question(s). I was first questioned on Brachytherapy and Radiation Measurements/Detectors by Ann after which she left.

Treatment Machines/Simulators

Jim: What kind of a Quality Assurance program do you have for your linear accelerator? I asked if he wanted to know about the daily, monthly or annual QA program. He wanted all of it. I talked about the daily, monthly and annual QA protocols I've established, along with the acceptable tolerance levels, phantoms and tools used, who does it, etc.

Jim: What depth do you calibrate the (6 and 18 MV) beams at? I calibrate both at 10 cm depth and Jim wanted to know why.

Jim: What do you use to calibrate the electrons with? How do you calibrate your p-p chamber? What do you use for electrons less than 10 MeV? Why can't you use a Farmer chamber? At what depth do you calibrate the electrons? Why?

Randy: You're calibrating a scanning beam. Which chamber will you use? What do you think will happen if you use a small volume chamber?

Jim: How do you calibrate your 2.0 cm cone on the superficial unit?

Jim: Write down the formula for dose to water according to TG-21. What is N_{gas}? Write down the formula. Describe each term in the dose equation. What is P_{ion}? How do you measure it? (I drew the graph from TG-21). Which curve will you use (for Clinac-2100C)? What does P_{wall} mean? Write the formula. What is P_{repl}?

Jim: You scan an electron beam with a chamber. How do you convert the ionization to dose?
Randy: Which energy do you use to come up with the restricted stopping power? How do you calculate E_z?

Jim: What QA program do you have for your simulator? How do you check the low resolution?

Radiation Measurements/Detectors

Ann: Describe the construction of a Farmer chamber.

Ann: What do you have with your RFA-3 water phantom? (Diodes) Do you need to do anything with those diodes before you use them? How do you check for energy dependence?

Ann: Do you have a diode system for patient dose measurements? Were you the one who accepted the unit? Do you know if the previous physicist make any measurements before using them clinically? What do you need to test? What kind of angular dependence do you expect? How do you use the system? So the readings you get after placing the diodes on the patient are dose readings? There is one conversion factor for all the beams? What kind of tolerances do you allow for your in-vivo measurements?

Ann: I know you do not have a TLD system but, were you to acquire one, what will you do before putting it to clinical use? How will you calibrate it? Do you need to graph anything? Once this is done for one beam, can it be used for all beams?

Clinical Treatment Planning - Photon Beam Therapy

Ed: Draw a Hodgkin's field. What are the points of interest? How do you calculate the dose?

Jim: Show a breast treatment. How much lung do you need to include? Where are the medial and lateral edges? How do you match the lower border of the fields (beam divergence)? How do you match the superclav field with the breast fields?

Ed: How do you match field for AP/PA treatments? Show the fields and calculations. How will you match a PA spinal field with lateral head fields like for medulloblastoma? Show with diagrams. (I was questioned "extensively" on this. They tried to throw hints -- like Randy asking why I had my head tilted -- but I was too thick skulled to take the hints. Actually, I had my diagrams wrong. Anyhow, after some time they gave up and decided to move onto another topic.)

Clinical Electron Beam Therapy

Ed: Your physician wishes to treat a 1.5 cm thick lesion on the lower lip with a 2.0 cm cutout with electrons. What do you do? (I started by saying that there were two problems: output/d_{max} and shielding for areas underneath.) why will the output change? Why and how will the d_{max} change? How will you measure it? What depth will you place the films at? What do you need to convert the film reading to dose? What energy will you use? What is the d_{80} for 6 MeV? What is the skin dose fore 6 MeV? So what will you do? (Use bolus) How thick? (Approximately 0.5 cm, depending on the depth dose curve to bring the surface dose on the skin to 80% or greater. Of course, the effective depth of treatment will increase to 1.5 cm + thickness of bolus).

Ed: What else do you need to address? How will you shield the underlying areas? What thickness of lead will you use? Why should you cover it with wax? Which side of the lead will you place the wax on? Why? How much backscatter do you expect?

Brachytherapy

(Ann) What procedures do you perform in your clinic? Draw a typical loading for a Fletcher-Suit applicator using the Patterson -Parker system. Show the isodose lines. What are points A and B? What about a deviated uterus? What do they represent? Where is the pelvic wall on your diagram?

(Ann) If a large source is placed in the ovoids, what should be done to the ovoids? (One had to be careful with her for she would make remarks in passing that may or may not be true. They did not have the tone of a question, but were questions all the same. If one just nodded his head, he effectively agreed to a wrong statement!!).

(Ann) What is the dose to the bladder and rectum? What is the limiting dose in this application? How is the dose prescribed? What if the physician picks the 42 cGy/hr line? Show this isodose line and calculate the dose to point A for this isodose line on your diagram. Also show a typical isodose line for this loading through point A for this loading.

(Ann) Did you use an HDR unit while you were at Wayne State? (A few questions on HDR followed)

Radiation Safety/Hazards

(Jim) Draw a linac room layout. What is the typical shielding for the primary and the secondary? What energy do you consider for the scatter? Why? Is the scatter all the shield for in the secondary barrier? What is the energy you consider for the leakage? Which requires more shielding - scatter or leakage? What do you shield for in the door? (Randy) Where are the fast neutrons? (Jim) Why do you need lead in the door? What is the energy of the gamma ray given off in the (n, γ) reaction?

(Jim) Tell me about the radiation safety aspects of brachytherapy. (I asked if he wanted me to talk about the patient safety, source receipt/shipment, or source leak test, etc., aspects.) Tell me about the clinical aspects. Name one instance when the patient needn't be surveyed. (When after some thought I told him I couldn't think of one, he said that there isn't any!!).

(Jim) Have you heard of the Quality Management program? What is the definition of a misadministration in Teletherapy? Is there another classification other than a misadministration? What events fall under recordable events? What are you supposed to do with them? (Randy) Did you do an annual review of the program? What did the review include?

(Ed) This maybe outside of the questioning, but I was just interested. Who do you report to? (Management and NRC) So you don't report to the physician at all? If you were to report to the physician, what is the possible conflict of interest?

Special Techniques

(Randy) We know that you do not perform any special procedures, but we have to ask you some questions anyhow. Say your physician and the management wish to start a whole body photon irradiation program. What will you do? What if you are using a linac, do you still need to flatten the beam? Is there something already in the linac (for the purpose)? What chamber will you use to calibrate it with?

(Jim) Will you treat AP/PA or R/L lateral? Why? Which will give you a better dose distribution? Why do people treat with lateral fields ? Which energy will you use? Why do people use 6 MV instead of 18 MV when 18 MV will give you fewer hot spots? (Randy) What is the purpose of this treatment?

(Randy) What will you do if you had to start a whole body electron treatment program? (You will have to decide on the technique you're going to use for the treatments, i.e. 4 field, 6 field, etc., and would have to reduce the bremmstrahlung contamination which will otherwise add to the dose at depth). How will you reduce it? How much photon contamination do you expect? (I was questioned "extensively" on this. I stated that the photon contamination from a single 6 MeV beam is 0.2-0.4% of the maximum dose, and thus the contribution from six fields would result in a 1-3% dose to the center). (Randy) Show me on the board what you expect to see. (He questioned me further on this). (Jim) What is the photon contamination for a 20 MeV beam? (Usually 4%. The manufacturer's usual limit is 5%. I realized my mistake and told them that I had been thinking of 1 cm on the depth dose curve as 1% when it is actually 10%. Thus all the figures I had given them needed to be multiplied by 10. They moved onto the next topic.)

(Randy) Your institution wishes to start a stereotactic radiosurgery program on the machine that you already have. The special equipment required (head ring, base frame, etc.) is already present. What do you do? (Measure gantry isocentricity to see if it is within $\pm$ 0.5 mm.) (What is the AAPM guideline for gantry isocentricity? Radius or diameter? (Ed) What about older machines? What do you do if you find the gantry isocenter is more like

2 mm? What do you tell the physician and the management?

(Randy) How is the procedure performed? But the gantry only moves in one plane. How do you accomplish arcs in the other planes? What is the tolerance for the table rotation? What if yours is 2 mm? What do you tell the management? (Get a new table or a new machine. You can't use this one if the tolerances are exceeded).

(Randy) How will you calibrate the unit? What field size are we talking about? Why do we need a long cone? What chamber do you need? (I talked about people using P-P chambers, small volume chambers standing on end and measuring effective point of measurement of the chamber, using films and cross calibrating with a larger field, etc.)

(Jim) Have you heard of a small volume Farmer chamber? (I hadn't. I asked if he meant a small volume chamber like a 0.1 cc or a 0.06 cc chamber). No, it is a 0.6 cc chamber with a shorter length(!!). (As far as I understand, A Farmer chamber is one made by Farmer, using the same dimensions and materials. The PTW 0.6 cc chamber, for example, is a "Farmer type" chamber because the materials are different although the design is the same. So how can a chamber be called a Farmer chamber if it's length is different from the one originally designed by Farmer -- unless, of course, Farmer had designed another one). (I still don't get this one.)

Treatment Planning Computer Systems

(Randy) Which Treatment Planning system do you have? Tell me about the algorithm it uses for photon beams. How does it account for wedges? Blocks? Scatter? Sloping surfaces? Does it do irregular beams and how? How do you correct for inhomogeneities. (Jim) Electron algorithm?

(Ed) You had said that you were going to be soon acquiring a new computer system. What are you looking for in this system? How will you test the system when you get it? Besides algorithm testing, what else will you test? (CT image transfer accuracy, CT number to electron density conversion accuracy). What else? (Plotter accuracy). What else? (I should have stated digitizer, viewing console. Is there anything else??)

Frustrated as hell, they gave up on me.

ORALS – ABR 1993 Therapy Physics

1. Port in wall near control area for beam calibration cables. Shielding issues.
2. Design sealed source safe, issues involved. What sources might be present in it.
3. Radiation safety aspects of design of Cs storage area. Record keeping requirements.
4. Design of Radiation Safety plan for a radiotherapy department.
5. Plan for handling radiation accident victims.
6. Shielding design issues for a linac >10MV.
7. Design secondary shielding for a 6MV linac.
8. QA program for HDR.
9. Calibrate an e^- beam per TG-21.
10. Calibrate and measure symmetry, flatness, profiles of a scanned beam.
11. What are pitfalls of using a CT for port localization.
12. What would depth of symmetry and flatness be defined at 100 or 1/2 of 80. What does TG-25 suggest? Why?
13. Bilateral arc va 2 lateral ports for tx.
14. What energies would you suggest for a purchase of a new dual energy linac? Why? Benefits and bad effects of each?
15. What would you do if you were consulting and calibrating a linac and found it to be off?
16. Design a 45° wedge. What depth is defined at? Why? What are wedges used for?
17. Flattening filter and effect on irregular beam calc.
18. How will you measure effective energy of leakage radiation from a linac.
19. Two methods of changing e^- of a linac.
20. Dose to radiation therapy patient from scatter and leakage during tx.
21. MPDs for occupational and non-occupational people. All limits. Where are the rules found for radiological MPDs? etc.

22. Calibration of a survey instrument.

23. Convert 6 MV linac shielded room to an 18 MV room and neutron problems associated with it.

24. Tx a thorax through lung. How will isodoses change? Inhomogeneity correction methods; pitfalls, etc.

25. Neutron shielding for an 18--25 MV linac.

26. At what E doses neutron production become a problem in a linac?

27. Leak testing of a ^{60}Co teletherapy source. Procedure; limits. (Any other substance that may interfere? Levels for depleted uranium)

28. How would you specify activity for a brachy source in a treatment planning computer.

29. Butterfly arc vs 4 field box technique to boost a prostate. Dose to bladder and rectum.

30. How will you calibrate beam to tx whole body skin with e^-s.

31. Depth dose measurement with extrapolation chamber in buildup region. How will you do it without an extrapolation chamber.

32. Problems with field matching of e^- fields?

Some questions that came up

1. Shielding requirement for a ^{90}Sr eye applicator.

2. How you measure neutrons outside a linac room. Inside the room, gold foil detectors, detectors which produce bubbles when irradiated, amount of neutron leakage, the energy of neutrons, shielding for neutrons in linac room door, (n,γ) reaction, Bf_3, how it works, room air activation; generation of toxic gases.

3. Ducts leaving from linac room.

4. MPD for different areas; for uncontrolled vs controlled; if the corridor outside a brachy patient's room is controlled/uncontrolled, why?

5. GM counter r/s Cutie Pie for linac shielding testing.

6. Neutron energy and flux near head, in room, outside the room.

Selvaraj Nagappan - ABR ORAL EXAM - Therapeutic Radiological Physics
Archana Somnay June 10, 1993
Louisville, KY

1. How do you do the shielding calculation for control console area of two high energy Linac sharing same control area.
2. Describe the QA for high intensity remote afterloader.
3. Total body photon irradiation.
4. Describe the QA for Linear Accelerator.
5. How do you apply temp^{e} Pressure correction when you calculate dose from chamber reading? If its is a haricane weather, what will be the chamber reading (High press - more reading)? If you are living in colorado (mountain region) what will be the effect on the chamber reading (low pressure - less reading - due to less mass (PV) in the chamber). If you don't have the barometer, how do you get it?
6. what is stem effect? How do you measure it? what type of chambers does have the maximum stem effect?
7. How would you measure the virtual source position for e^- beam?
8. How would you check the accuracy of the dose monitoring services. eg). film badge, TLD services etc.
9. How would you treat Aretio Venous Malformation (AVM)? What kind of dosimetry measurements would you need to do before that?
10. what is the difference between the two field bi lateral arc Vs two lateral fields? (what therapy equipment do you have in your dept., & how do you treat for eg.) prostate?
11. what is the effect of build up in the dose measurements?
12. For high energy Linac, What is the length of the maze and how it should be & and different aspects you consider for designing maze for neutrons, dose at door, door materials etc.

13. Converting 6MV Linac room to 18 MV Linac room, what are the factors need to be considered?

14. How would you do the asSymmetric Jaw dosimetry for photons?

15. What is the use factor, occupancy factor, work load? what are the typical values for megavoltage beam facility?

16. As per TG-21 what bias voltage needed to apply for your ion chamber? How would you measure Aion & Pion?

17. What is the beam uniformity, Symmetry & flatness for photon and electron beams and how is it measured?

18. What QA would you do for your high intensity (dose rate) remote after loading machine?

19. (or) what are the different isotopes used in brachytherapy? what are the issues involved in the high dose rate remote afterloader?

19. For 18 MV Linac how would you shield for neutrons? what effect of Maze does have it on dose to door?

20. What are the exposure limits on the patients in a room next to the brachytherapy patient room? (Ans: For a Hospital visit: max. of 100 mRem

21. In a newly installed Linear Accelerator, what safety checks would you do?

22. If Ngas is given for a chamber, from that how would you calculate Dose to medium or Dose to water?

23. How would you check the accuracy of treatment plan using film? what kind of dosimeter the film is? whether it is absolute or relative? what are the pitfalls of film dosimeter used as a absolute dosimeter?

24. what are the pitfalls of using diagnostic CT information for treatment planning with high energies?

25. what QA needed for the dose planning computers?

26. How would you calibrate small electron fields?

27. In the operating room, How would you survey for lost Df I-125 seed and what instrument would you use for the survey?

1994 Diagnostics Board

I took the ABR for Diagnostics physics on Monday, June 6. It was very nice to get it over on Monday. I studied old oral questions from this handbook which I found EXTREMELY useful! I was examined by Drs. Wu, Tanner, Gooden, Banerjee, Marsden, and Brateman. Following is a list of questions.

There is an accident at a nearby nuclear power plant. Your hospital gets a patient with a radioactive material involved. How does your hospital handle it? This led to what kind of accident might have occurred and what isotopes could be involved from a power plant.

You are replacing a regular angio fluoroscopy unit with a DSA unit. Your walls are shielded with 1/16 Pb. How do you determine if this is enough?

How to measure dose from 8 CT slices.

Explain B-mode, and Doppler.

What is the theory behind ALARA, and should it be legislated?

If you measure 10mR/1000 mAs at the location (uncontrolled area) behind a vertical chest Bucky and the workload of the medical office is 60 patients per day. What is your recommendation? (I actually calculated this, using the amount of mAs used for each PA and lat chest exam and determining the the rate per week.)

How do you measure LSF, and how is it related to MTF?

You are replacing a single phase unit with high frequency generator. How do you adjust the technique to maintain the contrast and quality of the images? (Need to know that intensity is proportional to kVp squared.)

What do you take into consideration when designing an MR unit? (This led to RF dose limits, SAR. Would the SAR be higher with echo planar or spin echo imaging? Pacemakers used: Why not, what happens to them?)

How do you determine axial and lateral resolution for ultrasound? (This led to US phantoms. What do they look like?)

The frame rate for a cine cardiac cath unit is 30 frames/sec. What is the dose? Do you need any more info? (This led to American Heart Association recommendation of cine dose limits- high level dose rate 20 mR/min- has it been passed by the FDA.)

How do you measure dose rate on a fluoro unit?

What are typical resolutions of ultrasound, nuclear medicine, CT and general radiography? (lp/mm)

Given these parameters for an upper GI study, are you happy with these and if not, why? 1) 125 kVp 2) 0.5 mm AL filtration 3) 25 mAs detail screen 4) 76 FFD 5) 0.3 mm focal spot

What is the best way to describe cancer risk to breast tissue, skin dose, tissue dose, or glandular dose and why do think that? (This led to mammo typical doses, ESE's and MGD'S)

How long do you have to clear the x-ray room after an exposure is taken? (This question was asked because this is a typical question that patients may ask you and how would you go about answering this question.)

Measure a dose on the office wall opposite a chest room. What do you take into consideration concerning determination of shielding?

You've measured pinhole focal spots for 3 different units, You get a uniform distribution, Gaussian distribution, and edge band distribution. How would you rank the sizes of thes focal spots and why? (Blooming was brought into this discussion.)

Describe how one ABC system works on a fluoro system. (I then had to describe how minification gain and brightness gain are related and describe how an II worked.)

There was a question about Grids and Bucky factor (I can't remember it.)

Describe the difference between quadratic, linear and linear quadratic for risk levels. (This led to a discussion on how they get

this data. Risk levels for mammograms and cancer from diagnostic doses.)

How does you badge program work and why do you badge some people and not others.

Describe how the acquisition of US images is done.

What different type of filters are used in radiology and how does this affect kVp and the images.

How do you measure dental panoramic unit? What doses would you expect from one or from a bite wing?

QUESTIONS FROM THE ORAL EXAM IN RADIOLOGICAL PHYSICS IN JUNE 1994

EXAMINERS: BERG, BARRISH, DIXON, HENDERSON, EDWARDS, MCGINLEY

1. Discuss room design for both 4 MV and 25 MV machines. What differences are there?
2. How would you calibrate a superficial X-ray machine that is used with qualities between 1-3 mm HVT?
3. What special signs, if any , would you expect to see on the entrance door to a linear accelerator room? On the door of a Co-60 irradiator room?
4. Discuss how you might use CT scans to help calculate the dose planned to a tumor located behind lung tissue
5. You are required to safely store an inventory of Cs-137 sources. Describe how you would do this.
6. Describe the key features you would include in a quality assurance plan for a therapy accelerator.
7. You are designing a room for a Co-60 irradiator with a backstop. How do you determine the wall thickness requirements?
8. You are called as a consultant to check the output of a therapy linear accelerator while the regular physicist is on vacation. You discover that your measured output is different from that being used. Describe what you would do. What criteria would dictate which decisions?
9. At what depths in phantom do you calibrate the beams from a linear accelerator? Whe do you calibrate at these depths?
10. A patient presents for radiation therapy with an implanted cardiac pacemaker. What are your recommendations if the pacemaker is inside the treatment field? If the pacemaker is outside the treatment field?
11. Discuss two ways to estimate the dose to a point in an irregularly blocked field
12. What is the allowable leakage radiation from the head of a linear accelerator? How do you verify this?
13. You are considering the purchase of a 20 Mev linear accelerator with both photon and electron capability. What fundamental design features would you want to see in the head structure?
14. What type of sources would you expect to find in a high dose-rate remote afterloader?
15. In the new formalism, how are brachytherapy sources specified? What prompted the new formalism?
16. How would you estimate the dose to a critical structure(e.g. ovary, eye, pacemaker) away from treatment fields? When would you recommend external shielding if any?
17. You have been asked to recommend a single energy machine for a new facility. Only one machine can be purchased. What would you recommend? If they could afford a dual-energy, which energies would you recommend and why?
18. How would you verify brachytherapy dose calculations on a new treatment planning computer?
19. How would you verify heterogeneity corrected doses made by a new treatment planning computer that uses CT input?
20. Discuss various ways to obtain necessary anatomical data on a patient to allow calculating isodose distributions

ABR ORAL ... 1994

Wayne State University
DMC Harper Hospital
Gershenson Radiation Oncology Center

QUESTIONS FOR ORAL ABR

- DISCUSS DYNAMIC WEDGING
- IF A PATIENT HAVE A PERMANET IMPLANT (WITH A SEALED SOURCE AND WITH AN OPEN SOURCE) AND DIE, ADVICE METHODS OF PROTECTION FOR THE PERSONNEL MAKING THE AUTOPSY AND THE PERSON IN CHARGE OF EMBALMING
- DISCUSS TG-21 AND EXPLAIN ITS LIMITATIONS AND PROBLEMS THAT YOU HAVE ENCOUNTERED
- PROBLEM WITH ROTATIONAL THERAPY
- DISCUSS THE DIFFERENCES BETWEEN KLYSTRON AND MAGNETRON

DISCUSS THE DIFFERENCES BETWEEN A TRAVELING WAVE AND A STANDING WAVE

DISCUSS THE DIFFERENCES BETWEEN SCATTERING FOILS AND SCANNED PRODUCED ELECTRONS

- PROBLEM WITH A TRANSMISSION CORD BLOCK AND CALCULATION OF DOSE BEHIND THE BLOCK AND CHANGES DEPENDING ON THE WIDTH OF CORD BLOCK,WHICH FACTOR CHANGES IN THE MU CALCULATION
- IF WE NEED TO CHANGE A CO-60 UNIT FOR A LINAC 15MV AND WE HAVE IN THE CEILING RESTRICTION IN WEIGTH FOR THE SHIELDING, WHAT YOU WILL DO
- DESIGN A DOOR FOR A LINAC MORE THAN 10MV
- PROBLEMS OF SHIELDING ASSOCIATED WITH A LINAC OF ENERGY GREATER THAN 10 MEV
- METHODS OF MEASURING NEUTRONS INSIDE, OUTSIDE THE ROOM , IN THE BEAM, HOW WOULD YOU MEASURE THE ENERGY OF THE NEUTRONS, FIGURES FOR LEVELS OF RADIATION FOR X-RAYS, N, CAPTURE GAMMAS.
- CALIBRATION OF HDR
- HOW YOU WOULD TREAT A PATIENT WITH STEREOTACTIC RADIOSURGERY
- RESTRICTED STOPPING POWER, 10 KEV, WHAT IT MEANS

BENDING MAGNET CURRENT , FORMULA DEPENDING OF RADIUS

- FROM WHICH POINT OF THE MACHINE YOU MEASURE LEAKAGE RADIATION
- OCCUPANCY FACTORS
- DOSES TO THE FETUS IF A CS SOURCE OF 1 MG RA EQ IS PICK UP BY A NURSE AND PLACED AS A PIN IN THE COAT. OVARIES 25 CM FROM THIS PLACE
- FLATNESS AND SYMMETRY FOR ELECTRONS, DRAW AND EXPLAIN BEAM HARDENING
- IF A I-125 SOURCE IS DROP INT HE TOILET AND IF IS SENT THROUG THE SEWAGE
- WHY WHEN MEASURING ELEXCTRONS THE CYLINDRICAL CHAMBER IS SHIFTED
- HOW DO YOU CHECK THE MONITOR CHAMBER, LINEARITY, HOW YOU KNOW THAT YOUR SYSTEM IS WORKING WRIGTH, HOW YOU CHECK YOUR SECONDARY MONITOR CHAMBER, INTERLOCKS.

Harper Hospital
3990 John R Detroit, Michigan 48201 313.745.8040

Wayne State University

DMC Harper Hospital

-DOSIMETRY FOR ASSYMETRIC JAWS AND DIFFERENCES BETWEEN ASYMMETRIC JAWS AND BLOCKS(JAWS ARE UP AND PASS MONITOR CHAMBERS,ETC, BLOCKS ARE AT 15 CM FROM PATIENT. COMPUTER SOFTWARES
-TWO METHODS FOR CALCULATING PDD FOR EXTENDED SSD

June 9th 94
Louisville, Kentucky.

Dixon

1. Discuss the QA program for a radiotherapy department

2. What are the shielding considerations for designing a 6MV & a 15MV therapy room

3. Define air Kerma. What is its significance.

4. How do you calculate dose to the rectum & bladder for Gyn brachy implant? What are the tolerances for these organs? How can you reduce the dose to them?

5. A patient is being treated on a linear accelerator. You discover that he/she received a dose 14% higher than prescribed. What will you do?

Coffey

6 Define flatness, symmetry and uniformity for a photon & e^- beam.

7. Why does the surface dose for electrons increase with increasing energy?

8. Given the hinge angle how would you calculate the wedge angle. What are the diff-

ereat sites . . . and techniques utilizing wedges? Draw isocose distribution for an orthogonal wedge pair

9. Outline the radiation safety considerations for Ir-192 patients.

10. How can you check beam alignment with respect to patient?

Borrae

11. How can you calculate the dose to a point beyond the lung?

12. What kind of input data is required for a treatment planning computer?

13. What are the safety considerations for sealed sources and radiopharmaceuticals?

14. How will you calibrate a linac beam for stereotactic radiosurgery per TG21?

Banerjee

15. Draw an inverted Y and a mantle field How will you calculate dose to a point?

16. Design a fluoroscopic X ray unit room.

17. What are the restrictions and recommendations for patients with permanent implants

18. What is the difference between Krypton & Magnetron

Marsden

19. What are the HVLs in Pb & concrete for Co-60 & Cs-137? Why?

20. What is narrow beam attenuation & broad beam attenuation? How do you measure HVL?

21. Polarity: why? How do you correct for it? Where do you see it the most?

22. What is misadministration & recordable event?

23. How do you treat a breast & a Supraclavicular field?

Chaney

24 What are the tests to v the isocenter of a therapy machine

25. What is bolus? where and why do you use it for e^- & X-rays.

26. How would you calibrate a Co-60 unit per TG21

27. What are the advantages & disadvantages of a beam stopper

28. What are the QA procedures to be done on a high intensity HDR?

ABR ORAL EXAMS 1994

RADIOTHERAPY EXAMS
JUNE 8, 1994
LOUISVILLE, KY
Q.K. NCUBE

All my examiners BUT ONE were quite friendly and pleasant. They created a very cordial and warm atmosphere. When I stumbled and perhaps seemed to grope in darkness they would put an effort to guide me toward the expected answers as much as possible. Whereever I knew the answer right away they would waste no time and would quickly move on to the next question or card. Of all the six examiners, Dr. Dickson was I mean, a nightmare; intimidating, not helpful not friendly, businesslike etc. He was mostly interested in what I didn't know and I think he did a good job on that.

My Examiners were: Dr. Chaney..... 1:00 pm
Dr. Shearer..... 1:30 pm
Dr. DICKSON..... 2:00pm
Dr. Borras.....2:30pm
Dr. Marsden.....3:00pm
Dr. Wilson.....4:00pm

The questions were very similar to the previous years and stressed heavily on Radiation Hazards and Control, and Regulatory responsibilities and NRC numerical values. There were a total of 30 questions; five from each of the examiners covering all five categories as stipulated in the pink ABR Information Booklet.

1. Calculate Dose to the cord under a mediastinal block. given the field shape and blocked area. **Dr. Dickson.**

2 Shielding calculation of 250KVp Orthovoltage unit, leakage and secondary barrier **Dr. Dickson**

3. An autopsy is to be performed on a patient who died after receiving an I-125 permanent inplant. What should a physicist do ?

4. How do you change the energy on a dual X-Ray energy Linac ?
Dr. Wilson

5. Monitor Chamber of a linear accelerator: how would you check the normal functioning of the monitor chambers ? (he was looking for monitor linearity QC).....**Dr Shearer**

6. How do you measure the average energy at surface of an electron beam? How do you get Rp? How do you convert /correct ionization curve to depth dose curve? What if any are the correction factors? **Dr. Chaney**

7. Draw the isodose distribution for bilateral arcs of the esophagus tumor boost. What does the distribution look like? **Dr. Chaney**

8. Rotation Therapy: How would you treat esophagus boost fields with rotation therapy? (Explain the reasons for your field arrangement.) Is this the best way to treat esophagus boost? (I also mentioned the three field technique-with 120 degree hinge angles). How do you account for the effect of table during rotation therapy? **Dr. Borras**

9. Draw the isodose lines on a rotation therapy. (by hand) Any Corrections? How do you do MU hand calculations for rotation therapy? Dr. Borras

10. How do you calibrate a HDR afterloader ? **Dr. Borras**
She was extremely impressed when I quoted S.J. Goetsch/Attix paper on Re-entrant Well Chamber with Ir-192 10Ci, 10-8 ampere etc .

11. A physicist requests pressure reading from an airport which is 4000ft above sea level. The airport pressure is reported as 30.12 inches mercury. The physicist's facility is at 6000ft above sea level. What corrections if any do you need to know? **Dr. Shearer** For a moment I had no clue what corrections to make- I knew it wasn't TPC. Since I can relate to pressure in SI units better than inches, I converted this to mmHg=765.05. I also used the R.O.T equation of Pressure = $760x \exp(-3.5x10^{-5} x\ h)$ where h is height in ft. With this calculation my pressure was 660.7mmHg. instead of 765.05 as reported. Although I had dug my own grave here, he knew I knew the solution because I had given him every relevant info about the question but the answer he had in mind, so he quickly guided me with a clue and then we moved on.

12. Retrofitting a Co-60 room in a free standing facility with a linac room. We want to limit the ceiling shielding to a minimum. Discuss two alternatives to achieve this.
(I briefly discussed skyshine calculations/problems in passing).
Dr. Wilson

13. Discuss TG-21 (yes that's it) Seems like a very open question . I started by stating the reasons for switching from the previous protocols e.g. SCRAD, HPA etc, then the differences between the old and TG-21. Finally the advantages/disadvantages or its pitfalls. This was my kind of question. **Dr. Shearer.**

14. Want to treat at 120cm SSD, using SSD technique. Given: Field size= 20x20, depth of prescription =10cm. What do you do? (I Knew this was a Maynord Factor %DD correction so I wasted no time.) **Dr. Wilson**

15. Neutron Shielding calculations for a high energy linac. Discuss neutron spectrum at maze, door, in and outside treatment room. Discuss what instruments (detectors) to use inside room, at maze and outside room. (With my Nuclear Engineering background I discussed in detail what instruments to use and where- Activation foils=In-115,Au-197, P-31; Rem Meter i.e. Erbelin Rascal; Bonner balls or Bonner Spheres- She didn't seem to know a lot about Li I(Eu) scintillator in Bonner Balls so I may have scored high on this **Dr. Borras**

16. How do you detect leakage radiation?
How do you quantitate energy of leakage radiation ? **Dr. Marsden**

17. A nurse (out of ignorence I presume) placed a 1mg Ra eq Cs-137 source in her pocket. Calculate dose to skin at 0.5cm, at 4cm depth. If you found out that the nurse was pregnant, would you recommend abortion? **Dr. Dickson** was so demanding on this question. For instance, he wanted to know what 1mg Ra eq means, wanted me to calculate and give numerical dose value both at 0.5cm and 4cm depths. When I told him that I was only a physicist therefore it wasn't for me to recommend abortion but could only give calculated dose values to physician, I quickly realized he had a problem. He was about to ruin my entire afternoon, afterall, this was his first question and for the next 30min. I would be subjected to a torture chamber. This is the kind of examiner he was to me, unfriendly and certainly not very helpful, so I reported him to Dr. Kromer.

18. Neutron Shielding calculations for a 10MV linac. **Dr. Marsden**

19. Shielding calculations on high energy linac. Broom closet near a control console.

a) What occupancy factor would you use for the broom closet ? What's your rationale? I got myself in trouble when said I'd use T=1/4, he then asked What if the administrater (due to space limitation) decides to convert this broom closet into a physician's office, now what occupancy factor would you use. I could sense right away he was trying to guide me so I told him I I'd T=1 this time and he asked me why I changed my mind. When answering the question I didn't keep in mind the closet was near the treatment room, hence I used T=1/4. **Dr. Chaney**

20. How do you measure the profiles and how do you do QC for Dynamic Wedge?

After giving a quick description what dynamic wedge is, how it is created, its clinical uses and also quoting several papers by Dennis Leavitt of Salt Lake City, he was convinced I knew what Iwas talking about. Film dosimetry was my 1st choice then array of detectors or TLDs across the field. **Dr. Wilson**

21. How would you modify a standard linear accelerator for Sterotactic Radiosurgery unit? What modifications would you make on the following and why?

a) on the collimation system?

b) on the PSA (patient support system)? **Dr. Borras**

22. Question on eyeglass shape of parallel opposed beams.

a) How does it vary with energy and depth or patient separation?

b) Suppose you were to treat mediastinum, larynx or pelvis, what energy would you use?

When I drew the depth dose profiles as illustrated in Khan's 2nd ed. pages 240 and 241 I realized I had just hit a gold mine. **Dr. Shearer**

23. How do you check dose uniformity on your linear accelerator? I told him we have an automatic PTW Freiberg Water Phantom scanner which gives you everything you need within seconds. He then went on to ask what if you don't have an automatic scanner, how do you check for dose uniformity. I told him we have a Tracker System which has five parallel plate chambers, one on each of the four quadrants of the field and one on the central ray. He asked me if I liked this system. I said no and told him of its pitfalls. When I thought I had given him all he wanted or at least satisfied him, he went on to say: What if you were a physicist in a remote area say in a 3rd World country (he was kind of jocular about this). I also jokingly told him I didn't like the term 3rd World and reminded him there are far more remote areas here at home so I told him if I was a physicist in N. Darkota or Iowa I'd use the only chamber I have by taking readings at selected points across a large field. This is the old fashioned way. It turned out he was pretty happy 'cause this is all he wanted **Dr. Shearer**

24. I-125 mistakenly flashed in a toilet. What do you do?
What if it was lost in a pile of trash, then what do you do? After pondering with these two question for some time I realized this was **Dr. Dickson** and he certainly wasn't about to give me a good time. Although during my discussion I mentioned at least three times that I-125 is not a reactor-produced radionuclide and therefore was not NRC controlled, that didn't seem to appease him that well. I can't quite recall all the details he asked but suffice to say every time he asked a question it was like jumping from purgatory to hell- 30 minutes with him was the longest yardage of my life.

✓25. What do you use to calibrate high and low electron beams? I told him 10 MeV and lower is low energies and I'd use plane parallel plate chambers and 10 MeV and above I'd use cylindrical chambers. Discussed perturbation problems and chamber gradient correction and the like. He went on to ask if I'd use a parallel plate chamber to calibrate an 18MeV beam. I said yes I would. **Dr. Wilson** (he is such a nice man)

26. Discuss dose calculation for:
a) asymmetric fields
b) blocked fields (photons)

Reference to my paper presented at the 1992 AAPM meeting in Calgary on Dosimetry of Asymmetric Fields was sufficient to get the job done here.
Dr Marsden

27. How do you shield for common wall adjacent linac rooms ? I assumed the worst case for, say two 25MV beams both facing the common wall at the same time and calculated barrier transmission. **Dr. Marsden**

28. An I-125 permanent implant patient's wife is pregnant. How do you advise the patient ?

✓29. State major reasons for switching form old calibration protocols to TG-21

30. How do you measure leakage radiation on orthovoltage? What is the allowable limit?

.....

GRADING SYSTEM: There are only five possible scores for each category;
68, 69, 70, 71, 72
A pass is 70 or better. If you get one 69 they may choose to waive it, otherwise anything less is either a conditional pass or fail. That means you can only condition if you failed one category.

.....

On a scale of 1 to10 .(ten being the highest) I would give the following points to each examiner taking my biased overall impression of being a good fellow physicist examining his colleagues.

Examiner	**Score**	
Dr. Wilson	10	
Dr. Marsden	9.5	
Dr. Borras	9.2	
Dr. Shearer	8.5	
Dr. Chaney	7	
Dr. Dickson	2	(he deserves it)

.....END.....

1995 ABMP Oral Questions for Diagnostic Imaging Physics

The following questions are those that I can still remember from the ABMP Oral Examination.

* Film gamma of mammography films as compared to conventional films.
* Which is the best target/filter combination in mammography? Mo/Mo, Mo/Rh, Rh/Mo, or Rh/Rh. Why?
* CT number definition, CT numbers of gray matter and white matter, would a physician be able to distinguish the gray matters from the white matters?
* What is the CT dose to the eye lens in a typical head scan? If the lens received 35 rads what would you suggest?
* What will happen if a dose of 10 Rads or higher (15 rads) is delivered to the embryo during fluoroscopic examination in the 7th day from conception? What will you suggest to the physician if he/she ask for radiation assessment?
* Patient dose calculation from imaging geometry and from handbook.
* High dose exposure encountered during fluoroscopic procedures. What will cause the high dose exposure? How high will the dose cause skin erythema? Is this a stochastic effect or non-stochastic (deterministic) effect?
* How to set up the ALARA dose level? What is the most effective and economic way to monitor the area of interest regarding radiation safety?
* How to monitor the radiation dose for pregnant personnel?
* If a physician worn two film badges; one outside the lead apron which received 1000 rems and the other inside the lead apron which received 0.1 rem. How do you justify the radiation dose to the physician ?
* Shielding design by NCRP approach or other approaches. What radiation sources need to be concerned?
* IIIER, image resolution, and patient dose of different imaging apparatuses, e.g., cine camera, 100 mm camera, photospot, DSA, digital cine DSA, digital fluoroscopy, fluoroscopy.
* Where is the "noise" sound coming from during MR scanning? Why different types of coils are used for different examinations?
* What does the MR artifact look like if aliasing occurs?
* How to reduce the scan time in MR imaging?
* What is the relationship between the transducer's frequency and spatial resolutions in ultrasound?

ABR ORALS - RADIATION ONC. PHYSICS

JUNE 1995

I had the following examiners;

Bill Hendee
Doug Shearer
Arnold Feldman
I. Syed
P. Rao
Van de Riet

Bill Hendee asked me why I had decided to take the Boards after all these years, and then we chit chatted a bit. He also stated that they had been making a concerted effort to be more practical with the orals (to make up for the written I'm sure!).

There were numerous questions having to do with the following specifics;

Treatment planning systems, acceptance and quality assurance (I think I had four examiners ask me this)

Shielding, especially for high energy machines -neutrons. What equipment used for measuring neutrons inside and outside the vault. What is the energy of the neutrons produced, with which reactions, what photon is produced, etc.

Lots of brachy. Shielding, exposure limits, dosimetry. Doses to nursing staff, safety issues.

Rad. Safety. How does California regulate and how does it compare to the NRC. Current Part 20 and 35, what does that mean to the RSO and the physicist.

Design of a wedge. What material, how to do it, wedge angle, hinge angle. What does the wedge do to the beam itself and how so at what depths (percent depth dose change, isodose changes)

Current Task Group 25 and 40 recommendations.

Electron beam blocking.

Basic accelerator acceptance testing, with specifications.

Photon beam compensators, materials used, how made, where positioned.

Accelerator power requirements. I was asked this by a few examiners in a variety of different ways.

Stereotactic, a bit about set up and equipment, beam considerations.

Intra op, same as for stereotactic.

All in all, not a bad experience. All of these gentlemen were extremely cordial, and tried their best to help you out if you got stuck. If your clinical background is pretty good it shouldn't be a problem.

The results were sent out within three days.

My special suggestion (with thanks to Nancy McCreary) is to not stay at the Executive West. Stay in town. I stayed at the Seelbach Hotel, they provided free shuttle to airport and to the Executive West. It's much quieter. I went in two days ahead of time, I think it helped alot.

1995 ABR Therapeutic Radiological Physics Oral Exam

Exa

Examiners: Dr. Van de Reit
Dr. Syed
Dr. Feldman
Dr. Payne
Dr. Hubbard
Dr. Wimmer

I believe all the examiners were clinical (as opposed to academic), and most were consultants. All were pleasant and helpful, Dr. Payne being the most so and Dr. Wimmer the least; no one was the least bit confrontational. The format was identical to that of the recent past: 5 questions to be answered in 30 minutes per examiner. Due to the number of students being examined, I unfortunately had an hour-and-a-half break between examiners two and three.

The exam stressed shielding measurements and calculations, radiation protection, brachytherapy, data acquisition, treatment planning computers, and quality assurance. Results were tabulated immediately upon finishing with each examiner. My exam was Wed. June 7 and I received written notification by regular mail on Sat. June 10.

Questions which I was asked (* these questions seem similar/identical to QKNs 1994 exam):

Discuss desirable characteristics of a linear accelerator to be purchased primarily for stereotactic radiosurgery.

Discuss quality assurance of a treatment planning system.

How would you verify the data in your treatment planning computer.

How do you design a compensator?

What are field flatness and symmetry, how do you measure them, and what are allowable tolerance for each (and give references)?

*A single story facility is replacing a Co-60 unit with a 10 MV linear accelerator. The present structure does not support additional weight on the roof. Discuss options for shielding/protection with regard to the ceiling.

Describe characteristics of a hospital room for implant patients. Describe surveys you would perform.

Discuss what you would do for an implant patient who requires a CT scan.

Discuss measurements necessary to obtain therapeutic beam parameters. What corrections are necessary to convert ionization to dose (both photons and electrons)?

How would you verify output calculations for electron cutouts?

Discuss issues of maze design for a high energy (25 MV) room.

Calculate the isodose distributions for oblique incidence (i.e. contour corrections).

What is N_{gas} and how is it determined?

Discuss shielding of an orthovoltage unit: primary, scatter, leakage, occupancy and use factors. Give limits. If a room is shielded with 2 HVLs for scatter and 4 HVLs for leakage, how much additional shielding, if any, is required (rule of thumb from NCRP #49)?

What different settings do you need on an electrometer?

Pressure vs. elevation question. Also, what are typical pressure ranges for your particular area of the country?

What does the NRC regulate? What document(s) cover regulation of x- and gamma- radiation in your state?

How is leakage measured around a high energy linac? What are the leakage limits? If a unit has one small area of high leakage, can it still be acceptable?

*How do you calibrate electron beams?

Neutron — NCRP - 79

Questions for ABR Oral in 1995 at Louisville, Kentucky.

1. QA program for a linac. TG 40 42
2. Shielding for a console area from a multi treatment room. NCRP #49, 51
3. The use of radiographic film for radiation measurement. — H&D
4. How many methods you can use to get anatomical information for your treatment planning system. CT SIM SIMET C.T. MRI. PET
5. Scanned electron/pulsed electron advantage/disadvantage. SCATTER FOIL
6. What data you put in your treatment planning system for brachytherapy sources. (new unit?)
7. What procedure and instruction you will give to for an implant patient move from his room to a CT room.
8. Co-60 room emergency procedure. (plus other safety procedure)
9. What is the optimum treatment machine. PROTONS ISO
10. Cardiac pacemaker in high dose radiation. CMOS EM RADIATION
11. Co-60 with beam stopper function, transmission, etc.
12. Low electron energy eyelid treatment. KEEP of ENERGY LOW USUALLY 6
13. Total body photon irradiation dosimetry. BACKSCATTER TLD, DIODE DISTANCE LUNG BLOCKS —
14. Problem without ceiling. SHIELDING ROOF (SKY SHINE)
15. What depth you choose in your calibration. 10cm VS DMAX
16. Calibrate a superficial unit. — HVL VS VS TSO ~~20~~ EXPOSURE (R)
17. At which point to calculate the thickness of shielding.
18. Shielding between 4 MV and 25 MV. —
19. Neutron spectrum from high energy photon. 100eV
20. Scanning electron beam dosimetry. — PENCIL BEAM ? 15meV
21. ~~Change foil for each electron energy.~~
22. Two methods of calculating irregular field. — CLARKSON
24. Gap calculation. GEOMETRY
25. Interfacing problem (muscle, bone, muscle).

BONE Hi Z — MORE PE

26. How to decide wedge angle and where to use.

27. electron cutout problem when changing from 10x10 to 1x1 cm.

28. Compensator design.

29. What factors contribute to open field in block.

30. Measurement of surface dose.

31. Mantle field.

32. Dose underneath cord block.

33. Electron beam algorithm.

Dr. Horton (very formal)

(1) What is the purpose of a compensator? In what way does it differ from using a bolus? How do you design a compensator?
(2) What are the difficulties and shortcoming of the TG-21 calibration protocol?
(3) Draw the isodose lines for a 6 MeV electron beam used to treat a small lesion on the eyelid, using a 1 cm diameter circular cut-out. If a 2 mm lead shield is placed behind the eyelid, explain how it will influence the isodose lines down and upstream?
(4) What is meant by skyshine, when is it important and how would you estimate its magnitude?
(5) How would you set up a linac QA program? Which tests would you perform and how frequently would you perform each test?

Dr. Das (very helpful when you got stuck)

(1) In a tandem and ovoid treatment why do we not treat with just the tandem alone? What is the dose contribution to point A from the ovoids? What is the ovoid contribution to the bladder and rectum?
(2) You are in a reactor and are give two detectors contained within polyethylene spheres of 10 cm diameter. One is coated with 1 mm of cadmium. Describe the neutron response of the two detectors?
(3) You have a safe containing iridium sources, and one of the radiation oncologist wishes to add a few radium sources? Would you allow him to do this or would you buy a new safe? Discuss your recommendations.
(4) In an intra-operative brachy procedure, you are called upon to act as radiation safety officer. What equipment would you bring, and what measurements would you perform?
(5) How would you calibrate a brachytherapy source?

Dr. Niroomand-Rad (formal but relatively friendly)

(1) Describe the function of a flattening filter and scattering foils. What are the typical FWHM of photon and electron beams without these devices?
(2) How would you calibrate a stereotactic radiosurgery beam. What detector would you use? How would you obtain the TMR's for a 1 cm field?
(3) Describe the shielding requirements for a 250 kVp orthovoltage unit?
(4) If a brachytherapy patient is required to undergo a CT, how would you transport him and what equipment would you take with you? What would you do to ensure the integrity of the source positions after transportation?
(5) You are asked to set up a total skin irradiation procedure using a 3 MeV electron beam. What radiation geometry would you use, how many fields and how would you verify the dosimetry?

ABR Exams (June 96)

Dr. Windham (very friendly - made me feel relaxed)

(1) When is the concept of radiation dose equivalent important in shielding calculations of a 25MV linear accelerator?
(2) What kind of safe would you use to store brachytherapy sources? What signs would you need to post and where? How frequently do you need to fill out an inventory of brachytherapy sources?
(3) How is a CT scan useful in radiation treatment planning of a lung tumor.
(4) The source becomes stuck in the ON position on a Co-60 machine. What would you do?
(5) What are the roles of the different energy photon beams in a linear accelerator?

Dr. Hubbard (very aggressive - made me feel insecure)

(1) A nurse leaves a 1 mCi Ra-226 equivalent brachy source pinned to her top pocket for 8 hr. What would be the dose to her skin (0.5 cm distance), bone marrow (the sternum is 4 cm away), and to her ovaries (20 cm away)? What is her whole body dose? Would you need to report this incident to the NRC? If she were pregnant would an abortion be recommended?
(2) A 4 MV 80 SSD linac is to be replaced by a 15 MV 100 SSD machine. What recommendations would you make to the chief radiation oncologist? Does the different SSD have any consequences?
(3) Describe how you would estimate the dose to an arbitrary point in a Hodgkins mantle field. How would you calculate the dose under the block?
(4) When commissioning a linac, what measurements would you perform and in which sequence?
(5) What sources are used in brachytherapy. What are the physical differences between the isotopes and what is the clinical significance? What sources are used in a HDR remote afterloader, and what is the reason for that choice?

Dr. Urie (very helpful when you got stuck)

(1) How would you calibrate a neutron beam? What is the principle source of neutrons in a high energy linear accelerator, and draw the energy spectrum?
(2) Estimate the neutron dose at the door of a linac facility. How would you shield the door for neutrons?
(3) Which are the measurements, made during linac commissioning, which are incorporated into the treatment planning system. How would you test that the data entry was correct? What accuracy of agreement is required between the treatment plan and directly measured data?
(4) How would you match photon beams? Draw the appearance of the isodose lines near to the match line.
(5) Can't remember

A.B.R. Notes
11 June 1996

Follow-up to oral examination taken at Louisville, KY

The Executive West Hotel is two minutes from the airport using the courtesy shuttle. That part could not be easier.

The standard of dress was a coat and tie. Examiners have removed their jackets, but most examinees did not.

A half hour was allotted for each examiner. The oral examination was 25 minutes in each period. Generally the full period was used. However, the examiner could stop before the time was completed. Each examiner had five cards with questions on each one. We read the question outloud and then gave our answer. While answering the questions the examiner would ask additional questions. My impression was that often the additional questions were to help us to cover key points that was important to the answer as if they needed to hear key words. Other times I felt that I was making some mistakes and the questions were to help me see problems with my answer.

I was taking the exam for therapy physics. I had six examiners and each examiner had five questions. Some questions were similar to those asked by other examiners. There was a half hour of orientation in which we signed in and the procedure was explained to us. We were given a printed schedule of rooms, times and examiners. My schedule worked out to have an hour and a half before three examiners, then I had an hour and a half of open time and finally another hour and a half with three more examiners. I heard others talk of having a similar break but with only one interview left. During the break I was free to go where I wanted such as back to my room. Results can be expected in two weeks.

The following are things that I remember from the exam.

What is a MISADMINISTRATION for radiation therapy?
- Teletherapy?
- Brachytherapy?
- What are state requirements?

Helpful to know the ionization vs bias voltage curve naming the different regions. This came up in a question of the bias potential of the monitor chamber on a linear accelerator. This came up when I gave a number that was way to high. The original question was dealing with ion recombination and how to reduce it in the monitor chamber. Since it deals with relative values reducing recombination may not be that important.

Energy of ^{192}Ir? What is the half-life? What is typical activity of H.D.R source? The original question may have been to name typical nuclides used in H.D.R. sources. What is the

size of the source. What are the medical purposes for using H.D.R? Does H.D.R. have a superior out come? What are the advantages of H.D.R.?

What are two types of electron accelerators?

Questions which help to define occupancy factors, workloads, and use factors for radiaiton safety. What exposure level would be allowed on the lawn outside of an accelerator? What would an instrument read if left there for an extended period of time, e.g. a week?

What are advantages and disadvantages of
- Standing and Traveling waveguides?
- Klystron and Magnetron accelerators?
- Scattered and Scanned electrons?

What are the needed changes, if any, for a room door when changing from ^{60}Co to a 20 MV machine?
- Draw the absorption curve for lead.
- What does B - polyeythlene do? At what neutron energies is it effective? What is the cross section of boron in barns?

What are the HVLs of ^{60}Co and ^{137}Cs in lead and in concrete?

How can you measure the air-kerma of radionuclides?
- Can you get an ^{192}Ir calibration factor from an ADCL?
- Can you measure air-kerma directly with a well ionization chamber?

How do you set up a linear accelerator for stereotactic radiosurgery?
- How many beams do you need to use?
- What energy is best?
- What medical conditions is it used for?
- What relative dose can you get outside of the target?
- What was the original stereotactic unit and how many beams did it use?

What are the various points in GYN intercavitary brachytherapy and what do they correspond to? How do you image the rectal wall? What dose relative to Point A do you expect (or try to get) to the rectal wall?

How does an adequate bias potential change with dose rate? How do you determine if you have adequate bias potential? Have you changed the dose rate and measured the recombination rate? What kind of change did you observe? How important is it?

What are the advantages of conformal therapy? What recent changes in machine design have made conformal therapy possible? What considerations has conformal therapy made necessary? Have the clinical results been improved?

How do you recognize a standing waveguide? A travelling waveguide? What makes a standing waveguide work? Draw the inside of a standing waveguide. Diagram the electric field. How are the electrons accelerated? What are the components of a linear accelerator.

What are the factors used in converting electron depth ionization to depth dose?

What factors are involved in setting up Mantle and Inverted-Y fields?

Draw typical fields.
Does matching the fields require a gap?
Are there multiple computer dosimetry points?
What concern do you have for the gonads? How can you protect the gonads? What can be done to protect the gonads of a young female? (Move them surgically)

What factors are to be considered in the setup of a tangential breast treatment?

Do you do it SSD or SAD? Which do you think is better? Which would be easier for the therapists?
How do you match to a SC field?
Why use wedges? Diagram their placement.

Compare and contrast tissue compensators and bolus?

What materials would be suitable for tissue compensators?
How is a tissue compensator designed?

What effect does accounting for tissue attenuation and radiation scatter make in brachtherapy?

How important is it?

What would be included in a complete safety survey of a new ^{60}Co teletherapy unit?

Is a wipe test done with the source on?
How would you count the wipe test?
What conditions would you use with a primary beam survey?
A secondary barrier survey setup?
What instruments would you use?
What is the size of the meter?
How do you find voids in the walls?
Do you scan the entire wall?

Oral Exams for Therapeutic Radiological Physics
June 10, 1996
Louisville, Kentucky

Format: The exam consisted of 6 examiners. Each had 5 questions written on file cards. Note that the question on the card was only a starting point for the discussion. Each examiner asked many more than five questions and sometimes probed very deeply into one or more of each subject. Each examiner had one question from each of five areas, Shielding, Brachy, Machine design etc. The grade on the oral consisted of an average of your scores from each area for the five examiners. Therefore, if one examiner hammers you in one area, you may be able to make this area up with another examiner. The duration of each exam was 30 minutes for a total of 3 hours.

1) Your department chairmen wants to replace a 4 MV machine with a 6/15 MV machine:

- What would you use to add shielding if not enough space was available for concrete ?
- What other concerns would you have
- Have regulations changed since the 4 MV machine was installed? What concerns or problems might this cause.

2) How would you design a facility for 250 kVp ortho unit.

- which walls would be primary barriers ?
- how do you measure beam quality ?
- would you put the console inside or outside the room?

3) How would you design a safe for Cs-137 ?

4) Your department chairman wants to start I125 and Au198 therapy program.

- What concerns would you have for OR staff ??
- You take over sources from another **old** hospital. What sources would you expect to get? (looking for radium)

- Could you put radium sources in existing Cs-137 safe? why or why not

5) You have 2 neutron detectors. One w/ 10" poly sphere and one with 6" with a cadmium shell. What would you be able to measure with these two detectors?

6) Describe TG-21.

- Write the equation for dose to a medium from dose to a gas and explain the parameters.

- What problems have you sun into with some of the parameters.

7) What types of neutron detectors are available?

- are they sensitive to spectra?

- what is the energy of neutrons generated in a linear accelerator

8) You are asked to move a brachy therapy patient with sources to CT. What is your response.

- if the sources cannot be removed, what precautions are necessary

- who would move the patient

- what happens if the sources become dislodged? (are there any regulatory concerns?

9) What is skyshine?

- how do you incorporate this into shielding calculations?

- when would you be worried about it?

10) How have the exposure regulations changed in the past few years.

- Is there a maximum recommended lifetime exposure limit? what is the source of this limit?

11) Draw the head of a therapy accelerator and describe how neutrons are generated.

- what reactions are responsible for the neutron production
- what dose is given to the patient from the neutrons in the beam
- what is the dose to other parts of the patient from neutrons

12) Draw the flattening filters for a dual energy accelerator.

- how are the flattening filters different for the 6x vs the 18x
- what are the scattering foils made of ?
- how do they change with energy
- what happens to the photons produced in the scattering foils

13) What happens to the PDD curve for a 1 cm field as compared to a 15 x 15 field.

- you want to treat a 1 cm field on an eye lid, what kind of field shaping do you use and where do you place it??
- you want to place a lead shield in the patients eye, what does this do to the dose to the eye lid? how much?

14) Describe a quality assurance program for a brachy therapy program.

15) Describe the acceptance tests you would perform on a new accelerator.

16) What is the difference between compensating filters and bolus

17) How do you measure compensation

18) Are the PDD's for wedged fields different from those for an open field at the central axis, apart from the obvious wedge factor. Why?

- Does your treatment planning system utilize different PDD for wedges?

General Format
ABR Oral Exams in Medical Nuclear Physics
June 9, 1997

In case you didn't know already, the oral exam consists only of specialty Physics (Diagnostic, Nuclear, and/or Therapy). So you can now forget the definition of a Fourier series and the solutions to the Schroedinger wave equation. The questions fall into one of 5 categories, as described in the ABR booklet: (1) Installations and Shielding, (2) Equipment Calibration, (3) Radiation Hazard Control, (4) Radiation Dosage, and (5) Equipment. It seems to me these categories are somewhat arbitrary, and intended more for the Board's benefit than yours. Some of the tried and true questions are hard to fit into any one of these categories, but they're still used over and over.

That's an important point to remember in preparing for the orals, one that was less true for the written exam. When the Board finds a question it likes, they use it over and over. A good fraction of my questions were as old as the hills, and that can make life much easier. If you do nothing else, make sure you work through an answer for any of the questions you find repeated in this notebook. A question that's already been repeated is one the Board likes, as is likely to use it again.

Standard format, 6 examiners, 5 questions each, 5 minutes for each question, and a 5 minute contingency period for running over time and changing rooms. You'll be seated at a card table in a hotel room with a stack of cards (face down) in front of you. You'll turn over one question at a time, read it aloud, a start answering. There's scratch paper, but you're not likely to need it, unless the examiner explicitly wants to see you set up a calculation. Highly unlikely that you'll be asked to work through to a numerical answer. There just isn't time, and the format is discussion, so perhaps back-of-the-envelope calculations might be needed. Better if you can do it in your head. Oral format enables examiners to cover much more ground than in typical written exams, and they can usually tell after only just a few words, if you know what you're talking about. There isn't time to resolve paradoxes in your answer, so you better make sure you've thought through them carefully, even rehearsed them out loud. My examiners were:

Hubbard - Casual and friendly. Helps you work through a problem.

Gooden - Very knowledgeable (by reputation), slightly formal. Friendly, but businesslike. Potentially intimidating if you don't know your stuff.

Simmons - Old school, informal, not particularly detail oriented. Helpful.

Wimmer - Virtually silent. Listens intently and gives few clues. Seems to enjoy pursuing avenues that you open up by your own discussion - cat and mouse approach. e.g If your discussion mentions MPC's, he'll interrupt you: "What are those ? Where would you find them ?"

Banerjee - Animated. Asks unusual, sometimes confusing questions. Can be helpful if you're forthright. Known to be vocal and intimidating. "Are you sure you work in a Nuclear Medicine department ?"

Williams - Soft spoken. Takes the "play dumb" approach, so as to avoid giving you clues about the correctness of your train of discussion. Never sure if you're hanging yourself or right on target.

I think I was fortunate to get mostly helpful examiners. The way you interact with them can make all the difference, in my opinion. My strategy was not to try not to be intimidated. If you don't know the answer, then say that, but in an intelligent way. "Well, I don't know what a tritium energy spectrum would look like, but let me see if I can construct it. I know it's exclusively low-energy beta so... " Don't guess unless you're explicitly asked for an answer. Better to avoid answering directly by spouting related information that you do know. Verbalize your train of thought and the examiner will see your difficulties, and may help you out.

Questions I can remember:

1. Xe-133 and Tc-99m are used for lung ventilation studies. Discuss the pros and cons of each, typical doses, views, logistical considerations for combination with Tc-99m perfusion studies. If the patient was pregnant, would you modify the typical protocol ?

2. Compare and contrast two agents used for measuring ERPF and GFR with Tc-99m. What are the typical doses used, and what are the technical issues with performing each measurement ? If the patient is pregnant, how would you estimate dose to the fetus ? Could either imaging protocol be modified accommodate such a patient ?

3. Common nuclides encountered in research applications using radionuclides are C-14 and H-3. Describe and sketch the energy spectra produced by these nuclides with liquid scintillation counting system. Examiner: What are the components used in a liquid scintillation counting system ? System configuration, shielding, electronics ?

4. Describe a comprehensive quality assurance program for SPECT. (Discussion followed with many little question about details).

5. You are asked to arrange two SPECT/WB scintillation cameras in a 20 ft x 20 ft room. Discuss all factors involved in arranging the cameras and other equipment the way you did.

6. Design a Nuclear Medicine radiopharmacy so as to maximize efficiency, while providing necessary protection for several radiopharmacists working in the room 8 hrs/day. Include facilities necessary for all types of Nuclear Medicine procedures.

7. A facility using 100 mCi of Xe-133 per week wishes to know if it can vent this amount of activity directly into a nearby fume hood with a linear flow of 50 ft/min over a 24 hour period. The hood opening is 1 ft x 3 ft. What are the options available to this facility if this activity turns out to be too much ?

8. A bioassay of a radiation worker measures 3 μCi of I-131 in his thyroid. Is this an alarming amount ? What sort of threshold would you use in intervening and preventing this worker from continuing in his job ?

   (Upon attempting to work out beta dose to a 20 g thyroid from 3 μCi of I-131, examiner became frustrated and pointed out that a I-131 delivers 1.3 rads for each μCi in the thyroid. I didn't argue, but it turns out this is the dose for each μCi *injected,* assuming 25% thyroid uptake. The number is more like 5 rads for each μCi *in the thyroid.* Used the examiners' suggestion. Yearly limit to individual organs is 50 rem, according to 10 CFR 20).

9. Describe the components of a nuclear medicine computer.

   (This question is wide open, and in my case, quickly shifted to the subtopic of the examiner's choosing. Begin with the position and energy signals (analog) produced by the camera. Follow through to the creation of a digital image. If I want a 256 image, how many bits in the ADC ?)

10. A research lab comes to you asking if it's okay to dispose of 200 vials containing trace amounts of I-125 by incineration. The vials read 10,000 cpm and incinerator has an air flow rate of 250 cfm.

11. A Nuclear Medicine facility wishes to amend its license to include Xe-133. What questions would you ask and what calculations would you perform ?

12. Describe in detail the measurements of differential and absolute spatial linearity. Is this done intrinsically or extrinsically ? When and why would such a measurement be performed ?

13. A woman is given 10 mCi of I-131 for ablation of her thyroid. Estimate the dose to her husband. What advice would you give the couple for the period of time following her administration ?

    (This led to an involved discussion of the recent modification to the NRC release rule, part 35.75 of 10 CFR. The new rule went into effect only days before the exam (5/29/97), and so made for great exam fodder).

14. What are MPC's ? Where would you find them ? What is MPC for Xe-133 in a scanning room ? At the top of the stack where the Xe-133 is exhausted ?

15. Describe two ways to produce a Mo-99/Tc-99m generator. Is one method better than the other and why ? (I butchered this one. Fission of U-235 with chemical separation, or direct neutron bombardment of Mo-98 (low specific activity). Latter requires more eluent and more alumina).

16. Discuss considerations of designing shielding for storage of P-32, Sr-89, and I-131. You must protect a worker spending 10 hours per week at a distance of 1 m.

17. A Tc-99m generator is found to measure 20 mR/hr at 50 cm. What sort of shielding would be necessary to protect a secretary seated behind a wall 10 cm from the generator ? Is this exposure rate reasonable for such a generator ? (I decided to put shielding at the generator). Why did you decide to put shielding at the generator ? What's the other option, and why didn't you choose it ? (Shielding in the wall - more area to cover, doesn't protect workers in the hot lab).

18. What are I-125 and I-131 used for ? How much of each is likely to be used ? Which gives a higher dose ? (Got confused here - I-131 gives higher thyroid dose, per mCi injected, but I-125 produces more biological effect, for a given thyroid dose. Has to do with distribution of iodine in the thyroid follicles).

19. You must perform two measurements on a patient involving I-125 for plasma volume and Cr-51 for red cell mass. Which should be given first and why ?

20. What is the uniform isotropic model ? Define the reciprocity theorem with regard to this model. Give a hypothetical example.

21. A patient is to be given a diagnostic dose of a radiolabeled MAb, prior to ablation of a tumor with the same compound. How would you estimate the dose to the tumor ?

22. With regard to internal dosimetry, what is an S-factor ? What are its units ? How is it used ?

23. Describe two methods of measuring the number of μCi taken up by a patient's thyroid gland following ingestion of an iodinated radiopharmaceutical.

24. Discuss the issues surrounding quantitative measurements with PET and SPECT. Describe absolute and semi-quantitative parameters that are typically measured. Discuss why the measurement in one modality might be better than in the other modality ?

25. What is the philosophical basis for ALARA ? (Discussion of linear, no-threshold model for radiation protection). Where do occupational and general public dose limits come from ? Where do you come down on the issue of radiation hormesis ? (Mentioned stochastic process.) What is meant by stochastic ? Is there a scientific basis to support one side or other of the hormesis debate.

26. Two identical SPECT systems with identical sets of collimators. One collimator is damaged. Would it be acceptable to use collimators from camera A on camera B, or vice versa ? Are there any precautions or additional measures you might want to perform. (Collimator specific floods, and maybe COR corrections (less critical)).

1997 ABR Radiation Oncology Physics

My examiners are:

Dr. Heintz

Dr. Bourland

Dr. Burras

Dr. Coffey

Dr. Henderson

Dr. Berg

The followings are some of the questions I recall:

1. ALARA principle and application
2. Co-60 survey. How to do, instrument, procedure, how often.
3. Orthovoltage survey, instrument.
4. MU calculation formula for SSD, SAD
5. RTP system: inhomogeneity, what are the methods, how accurate can they be, where do they fail
6. Wedge: principle, design, application
7. Electron: total skin
8. Electron: cutoff output factor
9. Electron: p-p chamber features
10. Shielding: many questions, x-ray and neutrons (for high energy linac), 1 mR/hr vs 1mR in one hr
11. Brachytherapy: room shielding, upgrade from normal room
12. Linac principle: how energy changed, filter material, for both high and low energies

Make sure that you communicate well with your examiners. Good luck.

June 12, 1997

Peter Rosemark, Ph.D.
Cedars-Sinai Medical Center
Radiation Oncology Department
8700 Beverly Blvd.
Los Angeles, CA 90048

Dear Dr. Rosemark,

I found that reviewing from past oral exams to be extremely useful in my preparation. I hope that these questions will be of help to those taking future exams

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Oral ABR questions - Therapeutic Radiological Physics June 11, 1997

- define KERMA, What is the relationship between KERMA and absorbed dose?
- What is the "virtual source"? How do you measure it? What are typical findings?
- Shielding design for a 4 MV to a 10 MV vault, space is limited...
- You have 2 neutron detectors. One with a 10" poly sphere and the other with a 6" poly sphere surrounded by Cadmium. What would you be able to measure with these two detectors?
- Discuss shielding considerations for a ceiling (skyshine).
- How do you estimate neutron dose rates at the door?
- Describe how neutrons are produced, what are the reactions responsible, in what quantity, how would you measure them, what dose is given to the patient (in beam, out of beam), ... on and on and on...
- How do you do acceptance tests on a new treatment planning computer?
- Describe some of the mechanical acceptance tests performed on a LINAC.
- What is the QA for a HDR afterloader? What are the common sources? How do you verify their activities?
- Design a storage facility for Brachytherapy sources. What are the allowable levels to the public, and controlled areas? How would you provide additional sheilding for a Physicians office sharing a common wall with this area?
- Wedges... when/what are they used for, what does a 90 degree wedged pair isodose curve look like? How would you define a wedge angle? At what depth?

- How do you calibrate a Co60 unit per TG21? What is unique about this..?
- How do you calibrate a Superficial unit?
- How would you treat an AVM? How do you calibrate? With what type of instrumentation?
- What is a waveguide? (This lead to multiple questions about accelerator design).
- Your service engineer wants to turn the current on the magnetron down from 108 to 100 amps, What concerns would you have? What checks would you do? Describe a magnetron, how does it work?
- Describe methods used to change energy on a dual energy LINAC.
- Dose to various parts of persons anatomy if a Cs137 source was pinned to their uniform.
- A patient has recieved 6000 cGy to the breast utilizing tangential ports. Estimate the dose to the uterus. If this patient is pregnant, would you recommend a therapeutic abortion (2months pregnant).
- Considerations if a 10 mCi I-125 source is dropped in the toilet. What if is flushed. What if this same source is thrown in the garbage and is heading for the landfill? How would you find it, and what would you use.
- Define flatness, at what depth is it measured?
- How do you determine the effective leakage energy of a LINAC? Scatter calculations, Leakage calculations for walls. What are some common use factors? How thick are your primary and secondary barriers? What is the energy of scattered radiation?

1997 Therapy Physics Oral Exam Questions

1. What are the differences, advantages, disadvantages, etc. between
   a) Standing / Traveling Wave Guides
   b) Magnetron + Klystron
   c) Scanning + Scattering Foil e^- beams
2. An autopsy is about to be done on a person who recently had a high dose rate permanent implant. What are the radiation safety considerations?
3. How would you design shielding for a common control area when a 2nd treatment room is to be added right next to the first?
4. How would you design an electron detector? - include material properties, electronics, etc.
5. What is the significance of pt. A? pt B? Typical dose to rectum?
6. What are shielding + protection concerns for a room next to a brachytherapy patient?
7. What are the HVL and TVL for Cs-137 and Co-60 in lead + concrete: How are they measured? How could you get one value from the other?
8. For a $10 \times 10\ cm^2$ low energy e^- field blocked down to 1cm, how are the following affected?: Todd, output factor, flatness
9. The AAPM recommends certain depths for calibrating e^- and photon beams. What are they, and why?
10. How would you do the acceptance testing and calibration of a new 18MV machine before its initial use?
11. What would you survey for a Co-60 machine? Frequency? (radiation safety)
12. How would you calibrate a ~~brachy~~ brachytherapy source (check its strength)? What is the recommended way to specify source strength?
13. A room with a 10mV accelerator is going to be replaced by one with 18 or 20mV. What would you do with the shielding on the door?

(14) What are the dosimetric considerations of a tangential breast treatment? one where a SCV field is also being treated?

(15) How would you do a protection survey for an 18MV accelerator?

(16) What detector problems would you encounter with a high dose rate beam? How could you correct for the problems? If the dose rate is changed, what error would you expect in the measurements?

(17) How would you test the brachytherapy algorithm on your treatment planning computer? How does it account for tissue attenuation?

(18) Choose a mantle or inverted Y field and describe the dosimetric info necessary for MU calculations to on + off-axis points.

(19) Describe Radiation Safety + qa for a HDR unit

(20) How would you do a radiation protection survey for an 18/20 MV room? (neutron measurements)

(21) How would you check the calibration of the monitors in the accelerator collimator head? How would you know they are working properly? (asked about linearity)

(22) What happens to absorbed dose in front of and behind bone? Does the appearance of bone on a port film contradict this?

(23) What is the occupancy factor for a broom closet off of a controlled area?

(24) Describe 2 types of modern accelerators that produce electron beams.

(25) How would you adapt a linear accelerator to do stereotactic radiosurgery?

(26) Discuss bolus vs. tissue compensators.

1998 Therapy Physics Oral Exam Questions

1. Explain the differences between a Klystron & Magnetron. How do they work?
2. Name 2 methods for producing 2-levels of energy from an accelerator.
3. Explain what a bending magnet does. Is it better to have a 90° or 270° bend?
4. What is the biggest error you would find in an ionization chamber exposed to a pulsed beam? continuous beam? How do you correct for it?
5. Discuss the shielding necessary in a primary barrier if the machine has a 30° beam stopper.
6. How do you measure head leakage?
7. What qa checks do you do on a stereotactic linear accelerator?
8. What are the recommended calibration depths for photons & e^-? Why?
9. What kinds of warning signs go on the door to an accelerator room? brachytheraphy HDR room? storage room?
10. What are the differences in distributions when using a 1/2 beam block versus asymmetric jaws? Is one preferred? Why?
11. How would you determine the effective point source and how is it used?
12. Explain the recombination effect, bias voltage. What is a typical value for bias voltage?
13. Showed film of LDR implant - tandem & ovoids. Asked to identify points, anatomy, etc.
14. I-125 vs Pd-103 for prostate implants. Describe their use.
15. Explain the hour-glass shape of the dose distribution for opposed beams in a 25cm thick patient. What energy would you use to treat?
16. Discuss matching fields for photon & electron treatments. What are the problems, techniques?
17. What kind of chamber would you take to the OR for an implant with loose I-125 seeds vs. Ir-192 strands? Why? What other precautions would you take?

(18) How would you construct a safe to store 500mCi of Cs-137? What dose restrictions would you use? Materials?

(19) Define kerma. What are the differences between kerma & absorbed dose in muscle? When is one higher, lower, the same?

(20) Define the use factor. What are typical values? Why? Is it okay to have the total greater than 1? Why? How is it used?

(21) Define occupancy factor. What are typical values, where are they used, and why?

(22) A. one story roof needs additional shielding for a new machine, but can't support it. What would you use and why? Discussed photons & neutrons, sky shine, shielding materials, boron reactions.

(23) Name 3 things that affect surface dose, and how they affect it. (electron fields) How would you reduce surface dose when using a blocked field? (discussed tray to patient distances, immobilization devices)

(24) What would you include in an annual calibration? Discuss differences between acceptance testing and commissioning.

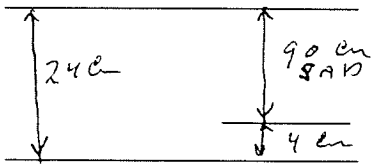
(25) Define a misadministration. Who is it reported to?

(26) How would you do a calibration for a high dose rate source? What are typical source strengths? Why not higher? What isotope is used?

(27) Name or draw 2 models for radiation damage vs. dose. Explain them. Which one does NIST use for protection standards?

1. Several questions concerning the NRC regulations. (see below)
2. Calc. dose to cord

Given



3. Many questions in TG 41.
4. Some TG 30 questions.
5. also TG?? On electrons.
6. Dose to patient on Linac x3} Needed to interpret charts, Inv sq.
7. Dose to patient on Co. } Eq. Sq. Calc. etc.
8. All data was given when isotopes were involved i.e. T1/2, HVL, Γ factor etc.
9. TMR calculations
10. Given dose to an isodose line i.e. 200 cGy to the 105 % isodose line what is given dose for 100% to field #1.
11. Follow up to above lat field had a wedge and asked to calc given attenuation of wedge and asked to calc given dose use data from above.
12. F factor calc. given μ/ρ H2O and muscle etc.
13. Thickness of A1 needed to compensate for missing tissue. Factors given.
14. Sc and Sp calc. given TMR. Collimator open 40x40 blocked to 8x8. Calc. Mu for midline dose.
15. Neutron questions width of maze effect on scatter energy at end if maze. T-F A wider maze will give less scatter at the door than a thinner maze.
16. Given a 20 MeV neutrons and the door mounted backwards i.e. Borated polly on outside, what is the energy of the gamma coming off polly? Given choice of answers 10 KeV neutrons, 10 KeV photons, .5 MeV photons, 100 KeV photons and 10 Mev photons.
17. questions on acceptance checks for wedge factor. See below
18. In commissioning a new linac with 6 and 18 photons and electron up to 20 MeV you should determine neutron dose from which selection of beams.
    a. Both 6 and 18 photon
    b. 18 photon and all electrons
    c. 18 photon and 20 electrons
    d. 18 photon only
19. Gap calc.
20. Manard's f calculations.
21. Many brachy question all factors given Γ and T1/2 etc.
22. Calc dose from Ir after 45 days. Given Do= 8cGy hr T1/2 must convert days to hours etc.
23. Could not remember any HDR or stereo questions.
24. Many WF questions. Ie wedges from fields 90° and 220° and 180° apart, in plane cross plane diff FS, depth doses, dynamic wedge.

25. Dose outside of Rm need for additional shielding or if it meets NCRP standards. T1/4, U1/4, and W, given instantaneous dose rate. Reduce to 2 mr/hr (similar to questions on previous exam).
26. What is allowable dose to frequently exposed member of public?
27. Dose at 2 cm depth on field prescribed to 6 cm depth with cobalt 60 and 9 MeV electron, electron %DD curve given. 5Gy electron and 40 Gy at 6 cm depth with cobalt 60 no cobalt 60 data given.
28. Target angle of therapy x-ray unit greater than diagnostic unit. (T-F)
29. Target of therapy x-ray unit not transmission type (T-F).
30. Skin dose from superficial unit greater than electron. (T-F)
31. Many simulator questions, can't remember exact questions.
32. Some radio biology questions.
33. The NRC requires a wipe test on linac collimators made of depleted uranium. (T-F)
34. You can drill/screw into a depleted uranium collimator? (T-F)
35. Linac jaw are made from natural uranium? (T-F)
36. Natural uranium is commonly used as jaw material for linacs. (T-F)
37. What provides the greatest contribution to the dose from I-125 implant.
    a. gamma rays
    b. fluorescent photons
    c. auger electrons
    d. beta rays
    e. internal conversion electrons
38. When commissioning a set of new wedges. which of the following must be measured?
    a. wedge factor vs. Depth
    b. wedge factor vs. Field size
    c. wedge factor vs. Off access
    d. wedge factor for the average chamber reading with gantry at 0 and 180 degrees.

Can not attest to exact format on wording of questions but the idea of what they were looking for is stated. I felt it was a fair test and had many appropriate questions asked. I finished with ½ hour to spare. One unique screw up on exam. 2 of the 15 point questions had the correct answer marked in the text booklet, they were marked with a * .

Good Luck

June 21, 1998

Dear Dr. Rosemark:

I took the oral exam in June 1st this year. The book I bought from you provided me with more specific study directions, which helped a lot in my preparation for oral exam. I wrote down what I remembered after the exam and hope this will be a little assistant for future participants.

Overall impressions:

1. Emphasize heavily (being asked by two examiners and a few times) on accelerator principles including:
   how to change dose rate;
   how to change energies;
   the details on banding magnet functions and formulas;
   how to focus the electrons during acceleration and inside the banding magnet path.
2. Details on radiation protection including:
   definitions on misadministration (teletherapy machine and isotopes);
   definitions of W, U, T, and their actual numbers in shielding designs;
   how to measure leakage from the accelerator head (different methods).

The questions I remembered:

- From Cs-137 implant orthogonal films, identify point A, B, rectum, bladder. Why using point A (examiner did not have enough time to ask more questions on Cs-137 implant).
- Model used to estimate the risk of cancer induction by radiation (stochastic and none-stochastic, curves for both).
- Stereotactic radiosurgery procedure, modification of accelerators, how to measure output, TMR, what chamber to use, isocentric or SSD, why.
- Ionization chamber: how it works, draw structure, bias voltages, at what voltage regions chamber is used, how electrons move inside the chamber, what materials are used in the chamber wall and poles.
- I-125/Pd-103 implant difference, which survey instruments are used for I-125 / Pd-103 implant, why, calibration of the survey meters.

- Skyshine: how to shield a old room for new high energy machine, when space is limited what to do (beam stopper).
- Given 30° beam stopper, how to design for scatter and leakage.
- Can use factor be greater than 100%?
- Limits of sources for public and occupational (in continuous or occasional exposure, give specific numbers).
- Design a safe for Cs-137 , what reading you can get when survey.
- Limit for accelerator shielding design.
- Typical survey results of a controlled wall (give number and explain why)
- Can linac output energy be continuous, how the energies being switched from one to the other.
- What is the yield circuit and function...(about different circuit functions).
- Ir-192 calibration, how to check scattered radiation (measure at different distance), what is the typical source strength (~10 mCi).
- Survey instrument difference for Ir-192 and I-125.
- Radiation signs at high radiation area and radiation area, the values define the two area...
- Operation principle of magnetron and klystron, draw the diagrams.
- How bending magnet focus the electrons, why some accelerators do not use bending magnet, how beam is focused without a bending magnet, how 270° bending magnet re-focus the electrons.
- What is the difference between the 6MV electron accelerator and proton accelerator?
- How many dose rate one can get from an accelerator.
- Half beam block and asym. jaw isodose difference, beam edge difference.
- Definition of effective SSD and how to find it (know well on the slope and coordinates).
- Definition of R50 Rp and how to measure Eo and Ep. What is the Rp for 10 MeV electron?
- Definition of misadministration, values for radiotherapy, teletherapym radioisotopes...
- What does annual calibration include?
- How to measure Pion, is it affected by polarity of bias voltage (for photon and electron beam).
- What are the difference of integrated dose for 6x and 18x, which is larger, why, explain the hourglass shaped parallel opposed beam isodose lines and difference for 6x and 18x.
- How to reduce the surface dose of a high photon energy.

- What is the difference of Kerma and absorbed dose? Why both become smaller as depth increase. Why kerma value is greater than absorbed dose at beginning (shallow depth).
- What are the different methods of electron beam matching. What is the typical shift between the matching fields. How to match spine and head.
- What is the energy used for 25cm separation?
- Shielding for scattering radiation (equations).
- Prostate implant procedures in detail.

ABR - Diagnostic Oral Board Questions
June 1st 1998

1) What are your concerns when designing shielding for MRI facilities?

2) What level of static magnet field strength do you shield to?

3) How do you shield for RF?

4) What kind of artifacts could a radio station down the street cause?

5) Describe the process of how an ultrasound image is formed.

6) What is an AEC system use for? How is it tested?

7) What factors influence the axial and lateral resolution in an ultrasound image?

8) A measurement on the opposite side of the wall from a chest bucky yields 10 mR/1000 mAs. If this space is an office space, and you have 60 patients/wk, is there a problem? If your calculations yield an answer that 1/4" of pb is needed, what are your thoughts?

9) In Mammography, what is average glandular dose, and how is it measured?

10) What is absorbed dose, equivalent dose, and effective dose? What are their units?

11) Explain what happens to noise and partial volume artifacts when CT slice thickness changes.

12) Explain image uniformity and how it is measured in MRI. What phantom would you use to measure it?

13) Given maximum heat unit limits on a CT scanner. What mA would you use to calculate shielding due to leakage?

14) Explain how the grey scale is used to generate a CT image.

15) What effect would decreasing the f-stop have on image quality?

16) What effect would increasing screen speed and film speed have on image quality?

17) Explain what a LSF is and how it relates to MTF. Draw two MTF curves, from two components in an imaging system, then draw the composite.

18) Explain the basis for an ALARA program. What elements are necessary.

19) What are the exposure limits for the following:
    1) a person < 18 years old
    2) a pregnant female
    3) an emergency situation

20) Compare the exposure to a patient from a single frame of a fluoro image with that from a film/screen radiograph.

21) What is the importance of a uniform static magnetic field in MRI imaging? What artifacts could arise from a non-uniformity?

22) In MRI imaging what gradients are applied and what are they used for?

23) Given two imaging geometry's (ie. two different SSD's and with different SID's) one which is magnified, the other not magnified but using a grid, compare the dose differences.

24) What safety factors need to be considered in MRI imaging?

25) What effect does field size have on scatter calculations and how is it accounted for in NCRP 49?

26) What is interlaced video, what are its advantages and disadvantages? When is it used? When LIH is used what happens to image noise and why?

27) What rules are typically used regarding imaging female patients? When is the most crucial time?

28) What type of dose to the fetus would you expect from a pelvic image? Is this a problem?

29) What can you say about the risk involved in a mammogram due to radiation exposure? What studies have been done?

30) What two factors can be changed to effect screen speed? What will this do to image quality?

ABR Diagnostic Physics Oral Exam, June 1998
Louisville, KY

General Comments:
The format of the exam is 6 separate oral exams, each a one-on-one with a different examiner. I had heard that you would be lucky to get two examiners who were helpful, two who were not helpful and two who were in between. Instead, all 6 of my examiners were congenial and a couple were downright friendly. Some of them mentioned at the beginning that they would be taking notes and not to take that as an indication that they agreed with or disagreed with my answer - I think this helped put me at ease a little bit.

The other part is that while each examiner had 5 cards with a question on it, these really were just opening questions upon which several follow-up questions were asked.

I had heard that the scoring system was that for each part, the examiner scores your answers as 68, 69, 70, 71 or 72, (an average of 70 across all examiners is supposed to be passing in that area). So, I interpreted many of the follow-up questions to be trying to determine whether I deserved a 71 or 72 (or in some cases whether I deserved a 68 or 69).

Specific Questions and their follow-ups (in the random order that I remember them):

1. What is meant by the Line Spread Function; what is meant by the Modulation Transfer function and what is the relationship between them? How would you measure an LSF? What would that curve look like for a fluoro system? What would a film-screen system look like in comparison? What about just film? If you had to characterize this curve by just one factor, what would it be (10% value)? Why is that incomplete?
2. You measure 120 mR/hr outside a room in which an exam was performed that used 120 kVp, 50 mA and 6 sec exposure time. Is this OK? (This led to a discussion on what the weekly dose would be and what the use of the space where the measurement was made. was it controlled - what would the acceptable dose limits be? What if it were a general office? Is this OK? What would those limits be?) What would you say to your chair to get him/her to spend a little money to get adequate shielding ?(I answered something about ALARA)
3. What are some of the key differences between MR and CT? What does each measure? What are typical values? What are typical image matrix sizes? Why do you need 12 bits to represent a CT image? How are these images displayed?
4. For photostimulable phosphor computed radiography, what are the processes of latent image formation, image readout, image processing and image display/printout? What materials are used for the image receptor? What is an advantage of this system over conventional film-screen? Is it more linear? By a factor of 2? an order of magnitude? several orders of magnitude?
5. What factors should be considered in the design of an MR installation? This led to discussion on protection of magnet from environment and on protection of environment from magnet.
6. How is spatial information encoded in MR? (I ended up having to try and draw a pulse sequence graph in front of an MR expert - yikes!). Where would the rf pulse occur? What patients should be excluded from MR exams (I answered claustrophobics and those with pacemakers). What other types of patients? (those with ferromagnetic materials such as bullets, surgical clips, etc.) What other types of patients? What about pregnant patients? What about those with heart valve replacements? Who would know if these contained ferromagnetic materials?

7. What is the Q factor in Ultrasound? For Diagnostic imaging, do you want a high Q or low Q? What about for Doppler? Does the Q affect resolution of the system at all? In what way (axial or longitudinal?). How does the time between pulses (PRF) affect axial resolution?
8. The GI question - A upper GI exam is being performed with the following parameters, comment on the appropriateness of each one: a) 125 kVp, b) .3 mm focal spot, c) .5 mm added filtration, d) 50 mAs, detail screen, e) 72 inch FFD.
9. two researchers at your institution are proposing research protocols using CT. One uses a single slice through the liver, while the other scans the length of the liver. What dose will you report? How will you make this assessment? How will you measure the dose? Would you report Effective Dose (NCRP 116?) Which one would have the higher dose? Why? What is the effect of just scanning one slice of the liver as opposed to scanning all of it?
10. What are UNSCEAR, BEIR, NCRP and ICRP and what is their advisory roles?
11. In considering leakage radiation for shielding calculations, what factors have to be considered? How is this different from scatter? Is the nature of the radiation different between scatter and leakage (yes because leakage must be a harder beam having some through the tube shielding only - by definition). Would you use the same tables in NCRP 49 for leakage as for scatter?
12. Explain the differences between nonthresholded linear and thresholded linear dose response models. (I had to draw these curves at least twice and maybe three times in the course of the exam). Why are there different models? Do they correspond to different effects (I said nonthresholded linear was used to model stochastic and thresholded linear was used to model deterministic effects). What would a linear quadratic look like? What are these models based on? What about hormesis- what would it look like? Is there strong evidence for hormesis.
13. Something about the energy dependence of an ion chamber - what is it and how to correct for it? How do you calibrate an ion chamber (send it to a calibration lab?).
14. What is the effect on CT radiation dose of: a) SNR, b) slice thickness, c) patient size
15. Explain how exposure is linear with mA and supralinear with kVp. What is the physics behind this? Is x-ray production more efficient at higher kVp than lower?
16. A room originally installed in 1979 had biplane radiography and under table fluoro. It is being redesigned to be a cardiac cath lab. Is the current shielding adequate? (What would be the relative exposure/workload between these two set ups? What is the current shielding? Do we know? Have the regulations changed since 1979 as far as exposure limits are concerned? (Yes, the public exposure limit has changed from .5 rem/yr to .1 rem/yr).
17. You are asked to calculate the conceptus dose for a woman who underwent a pelvic CT exam without knowing she was pregnant. what would you do? How would you estimate this dose? (CTDI for typical pelvic exam would be 2 rad to skin and 1 rad to center - estimate that dose fetus would be somewhere between 1 and 2 rads). What effects would you expect? What advice, if any, would you give her physician?
18. There was no question explicitly on the various exposure limits for workers (5 rem/yr) and for the public (.1 rem/yr, etc.), but it came up in several follow-up questions.
19. One question on AEC- what its purpose is and how you would test it. How would you test it for mammo (different thicknesses, different kVp, etc.)

20. There was a question about kVp accuracy and repeatability. Does being off by 1 kV matter? Would it matter more at high kV or low kV? Why? What about at mammo energies, would one kV matter? How does being off in kV affect the image? How would you measure kV repeatability?
21. What is a contrast detail phantom and how should it be used? Give an example from any modality you like (e.g. radiography). What would the phantom look like if the AEC were to underexpose the image?
22. Describe the following CT artifacts and their causes: a) ring, b) star, c) streak. This also led to a series of questions about what artifacts are present in the brain (cupping artifact).

Design of Radiation Installation

1. An exposure rate of 200mr/hr is measured at a distance of 50 cm from a Tc-99m generator. How would you estimate the thickness of lead required to shield the wall behind the generator? This wall separates the radioisotope lab from a manned telephone switchboard.

2. Discuss selection of appropriate assay devices for identifying, monitoring and quantifying: a) amount of radioactive contamination and b) dose exposure levels for the various work areas in the nuclear medicine laboratory.

3. A nuclear medicine exam room contains one scintillation camera. How much shielding is necessary in the wall between this room and a secretary's office?

4. Discuss methods for reducing radiation exposures received by nuclear medicine technologists while performing clinical nuclear medicine procedures on patients.

5. A department of Nuclear Medicine in a metropolitan hospital is conducting studies with Xe-133 and releasing the recovery xenon through a hood to a discharge point on roof of the building. The velocity of gas flow is 233 linear ft/min through a hood opening of 3.5 ft*ft. What is the maximum permissible weekly discharge?

6. There are two SPECT and four Planner cameras with one large room or four small room. Discuss the advantages and disadvantages of each floor plan.

7. MRI and SPECT are next to each other. What's the influence from one to the other, why and how to shield?

8. Shielding design for a Tc-99m generator

9. Facility design consideration related to the effect of an adjacent MR system on a gamma camera and vice versa.

Calibration of Radiation Equipment

1. Discuss the problems associated with the calibration survey instruments for use in nuclear medicine.

2. Discuss the sources and magnitudes of error involved in the determination of the left ventricular ejection fraction from a cardiac-gated blood pool study

3. What is a gamma variate function? Give an example of its use in nuclear medicine studies.

4. What performance measurements are prescribed by NEMA for scintillation camera, and how would you carry out these measurements?

5. What instrument calibration and quality control measures are necessary for SPECT with the rotating gamma camera?

6. Sources and magnitudes of errors involved in the determination of the left ventricular ejection fraction from a cardiac-gated blood pool study.

Radiation Hazard Control

1. A patient is treated for a brain tumor with I-125 seeds. When the seeds are removed, It is discovered that one of them is ruptured.
What test should be performed on the individuals who have worked with the seed and the patient?
The patient's thyroid is hot. Discuss how one would estimate the activity in the thyroid. How would the absorbed dose to the thyroid be estimated?
What limitations are there to using a gamma camera to perform a whole body survey of the patient?

2. What constitute a misadministration of a diagnostic dose? A therapeutic dose? Is 100 uCi of I-131 instead of I-125 a misadministration? Vice versa?

Discuss two methods for the assessment of the amount of I-131 remains in a patient after administration of a therapy dose.

4. A patient undergoing a gastric emptying study is mistakenly given an oral dose of 100mci of Tc-99m DTPA instead of 100 uCi.
a). Does this constitute a misadministration? What regulatory agency should be notified?
b). What steps can be taken to minimize the radiation dose to the patient?
c). Suppose efforts to purge the activity from the patient fail. Approximately what is the external Exposure rate at 1 meter from the patient? Can this patient be kept in an unrestricted hospital Room.

5. A patient who had 200mci of I-131 was placed in a private room. How would you estimate the dose to a patient in the next room without going into the room and measuring? The dose rate at 1 meter from the patient is 44 mr/hour. The specific gamma ray constant for I-131 is 2.2R/mci/hr at 1 cm. What dose rate in the next room constitutes a problem? What would you do if this value were exceeded?

6. Discuss the risk v/s benefit of Iodine thyroid therapy for a pregnant patient in different period.

7. Children patient had misadministration with an Iodine therapy dose. Estimate the activity and dose in his
thyroid . What's the procedure to limit the damage?

8. Proper ventilation to accommodate a possible accidental release of Xe-133.

9. Methods to quantitatively evaluate the level of Xe-133 in a room following a spill of Xe-133

10. Verifying the adequacy of operation of a Xe-133 trapping device
11. Typical exposure levels around a nuclear medicine department in the context of ALARA

12. Procedures for autopsy of a deceased patient follow a recent administration of 150Mci of colloidal Au-198 intraperitoneally.

Radiation Dosage

1. Describe the assumptions upon which the absorbed fraction method of internal dosimetry is based and discuss the errors that these assumptions introduce in the calculation of does for any specific patient.

2. A 5-year-old patient is given 2 mCi of microaggregated albumin tagged with Tc-99m for a liver scan. Assume 80% the activity taken up by the liver and the remainder distributed uniformly in body. The

biological half-life of microaggregated albumin is assumed to be 4 hours (liver) and 2 days (whole body). Using material supplied in provided tables, what is the dose to the liver?

3. A patient weighing 70kg is given a dose of 15 mCi of P-32. Calculate the initial dose rate, the dose after complete decay. Assume that the effective life of the isotope in the patient is 9.5 days and that the isotope is uniformly distributed throughout the patient.

4. Given the physical data for the decay schemes for Xe-127 and Xe-133, How would the use of either affect relative patient dose?

5. A patient with metastatic cancer is investigated by a Tc-99m pyrophosphate bone scan. Marked uptake of the radiotracer is observed I the heart. What additional data might you seek? Discuss what inferences you might make from this observation.

Equipment

Discuss one method of attenuation correction for a positron emission tomography system and one method of attenuation correction for a SPECT, Which is more accurate?

Discuss how a multi-channel analyzer works.

Why are modern gamma cameras superior to their early predecessors?

Discuss the important performance characteristics of SPECT system.

Describe how an equilibrium-gated cardiac study is acquired.

My experience with the oral exam of ABR is that it is easier than I thought. I was short of time and not very well prepared. I was prepared to go back Louisville next year when I headed on to Louisville on the airplane. The questions were fair, some of them are easy, and some others are difficult. I didn't answer every question well, as a matter of fact, there are two or three questions I had totally no clue, totally didn't know the answers, because I didn't study them. So I tried to make up some answer based on the logic reasoning in my head, and which was a strategy encouraged by the doctor who gave the orientation. All the examiners are very friendly and nice, and they tried to guide me to the correct path if I missed it at the beginning. To me, the toughest one is Dr. Borras (a woman). I was surprised that I passed her part! Overall, I feel that the grading is relatively easy.

The following are the questions I remembered. They are not the exact sentences written on the cards, but the meaning is basically the same.

Dr. Fullerton

What is the head leakage of a megavoltage LINAC? How do you measure it? What instrument would you use?

What is " Pencil beam spread function" ? What is "Kernel" ? What is the advantage of using kernel and convolution to calculate the dose?

What is CT number? Hounsfield unit? Why CT is the standard modality in radiation therapy departments for 3D treatment planning? Give two examples on how CT number can be used in 3D treatment planning.

A patient just had brachytherapy treatment and stayed in the hospital. What would you do for radiation safety? What is the dose rate limit to the adjacent room?

How do you calibrate output factor based on the TG21 protocol?

Dr. Barish

How do you change the dose rate of a megavoltage linear accelerator? What is going on inside the LINAC when you change the dose rate?

What is polarity effect? How do you correct it? How does the polarity effect change with beam modality and beam energy? Who has the highest polarity effect?

How does a DRR image reconstruct? What parameters would effect the spatial resolution and contrast resolution of a DRR image?

Dr. Payne

Describe " GreenGlass" effect in parallel opposed beam treatment. For a 25-cm patient thickness, how does the GreenGlass effect change with beam energy?

Describe a linear accelerator. What component is the power? Where does electrons come from? What are the components inside the treatment head?

What is " Acceptance Testing" ?

Dr. Borras (a woman)

Draw a diagram to show the components of a videocamera based electronic portal imaging device. Give the mechanism of the device and how does it work.

How do you calibrate electron beams? What do you need to pay attention to? What is the difference between the cylindrical ion chamber and the parallel plate ion chamber?

What device would you recommend to a radiation therapy department for personnel radiation monitoring? How do you verify the specification given by the manufacture?

Electron beams. What do you need to measure? What device can be used? What are the advantages and disadvantages of each device?

Dr. Banerjee

What is "Timer Error" ? How do you measure timer error? How do you correct it?

The same room used for a lower energy LINAC is now considered for the installation of a higher energy LINAC. You don't have any more space. What can you do? What needs to be considered when a 6 MV room is used for an 18 MV? What change needs to be done on maze?

How do you calibrate a brachytherapy source? What instrument do you use? What factors need to be considered?

May 30, 1999

I took the oral exam for Therapeutic Physics on May 17, 1999 in Kentucky. My exam schedule was as follows: 1:00 PM, (2 hour opening), then 3:30 PM, 4:00 PM, 4:30 PM, 5:00 PM. I prayed and boned up on my neutron knowledge during that 2-hour gap. I ended up not being asked any questions on neutrons.

I stayed at the Executive Inn because Executive West was full. My recommendation is that you book a room at the Executive West where the exam is held if rooms are available. The two inns are separated by a wide.....highway whose crosswalk signals are not too reliable. The other place I recommend is the Hampton Inn, which has a more modern decor and is located on the same side of the street as the Executive West.

This year is the first year that we were examined by five examiners vs. six. Each examiner asked questions in the five categories listed in the ABR pink booklet. This is also the first year that we faced questions in the new category titled "Image Acquisition, Processing, and Display". The majority of us were not completely prepared for this category although we were told of the new category.

The questions I could recall are as follows:

1. How does electron gain energy in a standing waveguide linac? Where do the electrons come from? Where is the anode if you consider the gun to be the cathode? What's the difference between an electron vs. a proton accelerator? (This last question caught me off guard.)
2. What is grid ratio? Bucky factor? Is an anti-scatter grid used in (1) simulator imaging (2) fluoro imaging (3) magavoltage portal imaging (4) electronic portal imaging?
3. What instrument would you bring for I-125 vs. Ir-192 implant surveys and why?
4. GYN implant (no film shown): The examiner asked me to draw a picture to show him where Pt A, Pt B, and the uterus is. How to convert mg-hr to cGy per hour at pt A?
5. What protocols would you use to do acceptance testing on a new treatment plannning system? (TG 23, 40, 53).
6. I was shown an AP and lateral pair of films. What are you treating? (I said prostate.) What else would you use these sim films for? Where's the rectum and bladder?
7. How do you calibrate GM detector or an ion chamber? (2 pts per scale)
8. In irregular fields, dose is calculated based on Primary + Scatter. Where can this break down? (inhomogeneities?)
9. HDR-How do you calibrate HDR equipment? (ck activity, timer accuracy, position accuracy, etc.)
10. Skyshine
11. What is wedge angle (not wedge factor)? What do the isodose curves look like? How to construct a 45 degree wedge?

12. How to calibrate an electron beam (TG21: I wrote out the D_{med} equation and explained the variables.)
13. What is DRR? Why do you use it (for CT sim)?
14. How do you treat breasts? (use of asymmetric jaws, wedges)(Does your computer take into account the collimator rotation and how?)
15. What models are used to predict the effects of radiation? What model is the currently accepted model? Where does the data come from that support that model? (Hiroshima?) Could you derive the lower dose regions of the linear non-threshold model? (yes, through radiobiological experiments?)
16. What's the last five things you do on acceptance testing for a new linac? (symmetry/flatness/profiles, CAX PDD, tray/wedge factors, OPFs, calibration of the beam?)
17. Define "contrast" vs "spatial resolution". How are they different between megavoltage beams vs. imaging x-rays?
18. You discover 14% overdose after patient finished treatment. What do you do? How do you prevent this for the future? (chart ck, record and verify system, diodes, etc.?)
19. Desirable linac characteristics for treating with SRS.
20. How to decrease skin dose to patient treatment with blocks using high energy photon beam? (increase distance between blocks and patient skin surface; use MLC if available?)
21. Electronic Portal Imaging. Draw a flow chart box diagram to show how it works. (He changed the question to a question on "portal imaging" since I was stumbling on this.) Where do the electrons come from that expose the film? (Compton electrons from photons interacting with the grid?)
22. SRS-How do you tests for gantry, couch, and collimator rotation about an isocenter? What commissioning data do you need to collect to begin SRS treatments? (profiles, OPF, PDD? I mentioned TG 42 and using the right equipment for collection of small field PDD, OPF, and PDD.) Is OPF normalized to 10 x 10 cm^2 square field? (yes?) Since d_{max} becomes shallower for smaller fields, where is OPF measured at? (d_{max}?)
23. Another question on SRS: What QA tests are necessary for SRS?
24. How to design a barrier for stray radiation?
25. 10 x 10 cm^2 electron field is blocked down to a small field. How does this effect d_{max}, PDD, OPF, ...How to calculate monitor units required?

After the oral exam, I realized there were points when I got stuck that I should have stated the fact that besides researching the problem myself, I would contact and consult the experts for the right solution. Bottomline, by the grace of God, I found out I passed on May 24, 1999. Needless to say, I was a happy camper. Attached is a list of books that I found helpful in studying for my orals. Good luck!!!

a:\abr99

Author	AAPM Report #	Book Name
Rosemark		ABR Notebook (89-98=8yrs)
COH		Annual Calib reports of Co-60/simulator/linacs
COH		Shielding calcs
BJR		British Journal of Radiology-Supplement Number 11-1972
BJR		British Journal of Radiology-Supplement Number 17-1983
TG-21		A Protocol for the Determination of Absorbed Dose from High-Energy Photon and Electron Beams-1983
TG-23		Rad Tx Planning Dosimetry Verification-1995
TG-25		Clinical Electron Beam Dosimetry
TG-27	19	Neutron Measurements Around High Energy X-ray Radiotherapy Machines
TG-28	24	Radiotherapy Portal Imaging Quality
TG-30	23	Total Skin Electron Therapy-Technique and Dosimetry
TG-34		Management of Radiation Oncology Patients with Implanted Cardiac Pacemakers
TG-35		Medical Accelerator Safety Considerations-1993
TG-36		Fetal Dose from Radiotherapy with Photon Beams-1995
TG-39		Calibration and Use of Plane-Parallel Ion Chambers for Dosimetry of Electron Beams-1994
TG-40		Comprehensive QA for Radiation Oncology
TG-41	41	Remote Afterloading Technology
TG-42	54	Stereotactiv Radiosurgery-1995
TG-43		Dosimetry of Interstitial Brachytherapy Sources-1995
TG-53		QA for Clinical Radiotherapy Treatment Planning
TG-55		Radiochromic Film Density-1998
TG-56		Code of Practice for Brachytherapy Physics-97
TG-59		High Dose Brachytherapy Treatment Delivery-1998
	53	Rad Info for Hosp Perso
Medical Physics Handbook 17		Linear Accelerators for Radiation Therapy-Greene
Greene		Medical Linacs
Hendee		Medical Radiation Physics
Horton		QA in Radiotherapy Physics
Karzmark		A Primer on Linac
Khan		Radiation Physics
Klevenhagen		Physics of Electron Beam Therapy
		Medical Physics Data Book
Metcalf		Physics of Radiotherapy X-rays from Linac

NCRP 49	Structural Shielding Design and Evaluation for Medical Use of X-rays and Gamma Rays of Energies upto 10 MeV	
NCRP 51	Radiation Protection Design Guidelines for 0.1-100 MeV Particle Accelerator Facilities	
NCRP 69	Dosimetry of X-rays and Gamma-ray Beams for Radiation Therapy in the Energy Range 10 KeV to 50 MeV	
NCRP 79	Neutron Contamination from Medical Electron Accelerators	
NCRP 102	Medical X-ray, Electron Beam and Gamma-ray Protection for Energies Upto 50 MeV (Equipment Design, Performance, and Use) (1988)	
Purdy	Advances in Radiation Oncology Physics (AAPM Monograph #19)	
Waggener	Handbook of Medical Physics, Vol 1	

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1999 ABR Oral Exam

Radiation safety

1. Discuss the two radiation risk models from NCRP 91 (relative and absolute).
2. What is dose equivalent and effective radiation risk factors? What are the radiation risk weighting factors for various organs?
3. Discuss shielding considerations for a brachy patient. What is exposure limit to an adjacent room?
4. A 6 MV linac is being replaced with an 18 MV linac. What are the shielding ramifications?
5. Discuss film badges and how to check a commercial service.

Imaging

6. Portal imaging screens. What kind? One or two and why?
7. What types of EPIDS are available?
8. Discuss TV-based EPIDS.
9. How are CTs used in 3D-RTP?
10. How are DRRs generated and used? What parameters affect quality?

Calibration

11. How would you calibrate an HDR?
12. How do you calibrate electron beams?
13. Effective point of measurement for cylindrical chamber and why. When do you use a cylindrical or a parallel plate chamber?
14. Discuss the polarity effect. What causes it and how do you correct for it?
15. What do monitor chambers in a linac measure and how do you test them?

Equipment

16. A service technician wants to decrease the current to the magnetron by 8%. What would this affect?
17. What are acceptance testing procedures and specs?
18. Discuss timer errors and end effects.
19. How do you verify target or effective target position for photons and electrons?
20. How do you measure leakage and what are the limits? What if there is a hot spot?

Patient dosage

21. Draw the dose distribution for parallel opposed beams. What are the effects of energy and separation?
22. How are wedge angles defined? Wedge factors? What materials are used to make them? How do you check if they are centered properly?
23. Discuss pencil beam algorithms.
24. Draw a typical DVH for a target and a normal structure. What if the DVHs for a critical structure from two competing plans cross? Which would you select?
25. Can't remember.

Oral reexamination for Nuclear Medical Physics on Radiation Safety category on November 7,1999.

1. Sewer Disposal; Monthly (not annually) Average Concentration; Radioactive hazard Vs biochemistry hazard; Materials excreted or removed from the human body not regulated.
2. Procedure of autopsy for a patient had 200 mCi I-131 within 48 hrs.
3. NRC state Vs agreement state; Definition of byproduct material.
4. I-131 inpatient room prepare and patient released procedure based on four kinds of calculation.
5. How to give a in service to new employee with no knowledge about radiation Vs as a refreshment to occupational worker.
6. Typical radiation exposure rate in different areas of NM. Other areas may deal with patient with radioactivity (cardiac nurse, ultrasound tech, epilepsy staff etc,).
7. I-131 shielding and storage. Leading to shield for a Mo-Tc99m generator.
8. DOT transportation Index; Package receive procedure.
   Xe-133 release to unrestricted area and ALARA. Room design for Xenon procedure.

Design a waste decay area and discuss other waste disposal methods.

Examiner: Dr. Feldman
Dr. Wilson

2000 oral exam – ABR

5 examiners, 5 questions each from any of 5 categories. This year, one of the examiners had the questions pop up on a computer screen. That way things like DRRs, graphs, images could be displayed. This was great. Gives a visual cue, and since many of the diagrams were straight out of textbooks, it just keys the brain straight to that chapter. Very surprised that there I didn't get any TG-51 questions, but I didn't get any SRS or HDR questions either. Every single question I got, I had seen in the last 5 years of this book, although the wording may have changed, and the follow up questions vary per examiner. So, nail the questions in the last 5 years, answer the questions directly, and completely, without getting off on tangents (and thereby into trouble), and you will be golden. As rumored, the hotel really is a dump, but convenience outweighs it. If you are coming from the west coast, and wind up with a 7AM test time, you may wish to give yourself an extra day to acclimatize to the time zone change. Not that you'll sleep the night before anyway.

Categories were: R = Rad Safety, I = Imaging, D = Dosimetry, C = Calibration, E = Equipment.

Hendee, William – competent, v.nice. This was computer exam.
C.1. Shown TG-43 brachy equation. What are the individual parameters? In detail.
D.1. Shown 2 DVH's w/ PTV, bladder, rectum lines. What are they and which is better. How do you create one? Why useful, when not?
E.1 Shown figure (from Karzmark) showing 18 & 6 MV energy switch SW accelerator. Asked how it works, why to use it, what other methods for changing energy on a dual accelerator are available.
I.1 Shown a CT and MRI of a brain met w/ Gad. What are they and what are the advantages? How are CT's made and used in TPS with respect to pixel info, e.g. geometry, mu, density. How to calibrate mu and test the geometrical accuracy/linearity of MRI and why.
R. 1. Shown a hospital room with a Ir-192 implant patient, including doses at various pts./distances, 2 mR/hr at nurses office next door, 7mR/hr at patient room next door, 0.2 mR/hr at corridor, 60 mR/hr at bedside. What are your instructions to nurses, where posted, instructions to visitors, any problems with occupancy of adjacent rooms at those exposure rates?

Hubbard, Lincoln– Nice enough, apparently a diagnostic guy, mildly helpful.
C.2. Define and describe Kerma and exposure. Relate them. What are units.
D.2. Ran out of time (doesn't count against you, but gives more weight to other questions for that category).
E.2. Name and describe two methods to get dual energies out of an accelerator.
I.2 Define Grid ratio and Bucky Factor. Wouls you use a grid in 1. Sim cassette, 2. Sim fluoro II 3. Port, 4. EPID?
R.2 You find a 10 mR/hr source lodged down toilet or in trash headed for landfill. What are the repercussions? Do you involve NRC?

Bourland, Robert. Primarily a diagnostic guy but knows stuff.
C.3. CT based dosimetry corrections – calibration of HU, basis and use.
D.3. Absorbed dose in the lung, near and beyond. 1D vs. 2D vs. 3D. What do you discuss with MD concerning their use?
E.3. Physical, Clinical and radiation safety aspects of Ir-192, Cs-137, I-125. Asked for HVLs, T1/2, E, use, chemical composition, how manufactured.
I.3. Film characteristics of MV vs. KV
R.3. Better to use Narrow beam vs. Broad beam measurements for calculating primary barrier thickness?

Ibbott, Geoff. Very nice, calm, gives nothing away, quickly probes for trouble spots. Great poker face.
C.4. Define Rp, dmax, R50, Eo, Ep including equations, diagrams, DI shift correction, DD L/p corrections.
D.4. Mediastinal AP only field. Full length cord block. Energy. Dose to cord, how to compute, block Tx.
E.4. How do physical and virtual wedges work? What are relative merits?
I.4. Discuss the relative merits of CT in planning.
R.4. Discuss the choice of, use of, and certification and validation of vendor of personnel monitoring devices.

Shaltoni, Robert. Very knowledgeable. Very thorough.
C.5. What are flatness and symmetry, what are acceptable values? Electrons vs. Photons.
D.5. Describe the devices used in Electron profile measurement. When would you use one over the other?
E.5. What does the applied voltage do in an ion chamber? What are reasonable levels for various dose rates? What governs the choice of that voltage for that chamber?
I.5. Draw and describe a liquid Ion Chamber EPID, from chamber to monitor. What kind of image post-processing is or can be applied?
R.5. List the factors which go in to calculating a primary barrier thickness.

To:
From: Peter Rosemark <rosemark@ucla.edu>
Subject: ABR exam
Cc:
Bcc:
Attached:

>
>Peter,
>
>I am writing to thank you for the study notes, they assisted me greatly in
>passing the oral exams. I categorized all questions from the past 5 years
>then systematically reviewed topics under each examination category. I
>started on January 1st reading all TG reports, and major texts on each
>category. As the exam date approached I began focusing on each question and
>rehearsing in my mind how I would address the questions. All but 2 or 3
>questions were equivalent or very similar to previous study questions. One
>that I did not anticipate was how to commission Solid/plastic water. The
>other was what doses are expected from tandem sources relative to oviod
>sources to points A. Four of the examiners used note cards while Fifth used
>a computer screen for interactive questions. Computer questions that I
>recall were:
>
>1. examine a floor plan for a brachy implant room and comment
>2. look at TG-43 formula and comment on each parameter and tell where/ how
>values are determined
>3. Look at SRS single arc isodose and tell direction of arc. Then comment on
>critical structures.
>
>Again, Thanks!
>

June 8, 2000

Dr. Rosemark,

Here are the questions and topics I was tested on in the ABR Therapy Physics orals. Sorry it took a while to get these to you, I went on vacation a few days after the orals.

Radiation Safety:

1. Shielding for brachytherapy rooms. Differences in shielding for HDR, low dose rate, I-125 or Pd-103, Cs. What if offices are next door.
2. Absorbed dose limits for radiation workers and public. When do you film badge radiation workers? Nurses? Other staff?
3. Shielding requirements for accelerator rooms. Very general. Explain skyshine.
4. Exposure limits for release of permanent brachytherapy cases. What if a seed is ejected? Recommendations for radiation safety given to patients upon release.
5. Neutron measurements for a new accelerator.

Imaging

1. Describe how a liquid ionization chamber EPID works. How is the signal formed? How is the image formed? A to D converting.
2. Desribe bucky factor, grid ratio, film-screen combinations.
3. How is a double exposure port film taken? Why is it done this way?
4. Describe what a DRR is. How is it formed? What about divergence? How is CT data used?
5. How to QA flouroscopy on simulator. How often should kVp and mAs be checked?

Equipment

1. Desribe how a magnetron works in detail. What currents do they run at?
2. Describe the difference between an magnetron and a klystron. In what types of machines would you find these in (high vs. low energy, different vendors).
3. How do bending magnets work? 90 vs. 270 degree. Singly achromatic vs. doubly achromatic.
4. How does a HDR unit work? Does it have a end effect? How do you measure it?
5. How do you measure head leakage? When do you do this?
6. What order do you do an accelerator acceptance test? What are the basic first 5 tests and how do you perform them?

Calibration

1. Describe a plane parallel chamber. What is it primarily used for? Why? How is it different from an extrapolation chamber? Diffence in usages?
2. How do you calibrate a brachytherapy source? Describe the TG43 formalism (each term).
3. What do you use to calibrate a HDR source? Are there alternative ways? What is the foam for in the re-entrant chamber?
4. Describe Pion. How is it measured?
5. How to measure off-axis ratios and output factors for irregular fields. Clarkson.
6. How to QA newly bought solid water?

Patient measurements

1. Shown two arc plans, one done with sagittal arcs, one with transverse arcs. Which is which? Why one over the other in this case for radiosurgery?
2. Draw isodose lines for parallel opposed fields. What if energy is changed? What if patient separation is wrong, how to correct?
3. How do you use a DRR in treatment planning. CT sim vs. conventional.
4. How to figure monitor units for an electron treatment? Measurements needed?
5. What is a misadministration? What is a recordable event? What do you HAVE to do for each? What should you do? This lead into some other questions about regulations, and the NRC vs. agreement states. What does the NRC regulate? What do states regulate?

I have a word of advice for those going in the future. I stayed in downtown Louisville, only a $7 taxi ride from the Executive West, and in a much nicer area. I didn't run into anyone I knew before the exam, so there were no distractions. And the area downtown is very nice, so if you're tired of studying, you can take a nice walk, or go to a museum, etc. There are also plenty of restaurants, from real nice to Subway and McDonalds for a quick bite. Lastly, I stayed in a new, modern hotel with a nice pool, hot tub, and exercise room, so I could release some stress. The Executive West seemed old, dank, and dark. I would advise people to consider staying downtown, I'm glad I did (this add was not payed for by the Louisville chamber of commerce).

Good Luck to all those who might read this. Stay calm, its not as bad as you think it might be, but you sure as heck don't want to do it over again.

2000 ABR Board Questions in Therapeutic Physics

1. Identify structures on linear accelerator. (waveguide, energy switch, electron gun, ...)
2. Place controls on plan of room layout. (consider length of baffle, direction of beam, distance from isocenter)
3. Shielding considerations for energy > 10 MV.
4. Identify inhomogeneity correction for breast plan by recognizing isodose curve patterns. Segmentation ?
5. Define image "segneitation" for 3D planning. Pg 279 Khan book Fig 12.1
6. Draw block diagram for TV/Camera based EPID.
7. Explain "kernal" and describe algorithms for electron beam calculations.
8. Characterize machine spec's for doing stereotactic radiosurgery.
9. Describe instruments used to survey both I-125 and Ir-192 patients. (draw out ionization curves)
10. Explain Ngas, define Pwall (give number factors)
11. Draw beam profile for 12 MeV electron.
12. Shield for scatter energy at pair-production levels.
13. Describe QA tests for stereotactic radiosurgery. → TG54 AAPM
14. Define "Kerma" and compare with absorbed dose curve.
15. Define "misadministration" levels and follow-up actions.
16. Describe chambers to be used for various electron energies.
17. Compare TG-21 to TG-51 protocols. (Problems & Considerations)
18. Draw out flattening filter for 18 MV, and material used ..., and explain how it affects beam flattening and off-axis factors.
19. Describe all compensators used for missing tissue compensation and how they affect isodose distribution.
20. Draw out chain of events machine components for typical fluoroscopic room.
21. Describe each part of a typical Geiger counter and compare with Farmer chamber / electrometer. (Look at "townsend balance" diagram in Johns & Cunningham book)
22. Describe instruments and methods used to survey for neutrons in & out of the room. ("active" vs. "passive detectors)
23. Head leakage tolerances for 25 MV & Co-60.
24. Maximum permissible limits for people in contact with I-131 patient. (What about expired patient ?)
25. Confirm through calculations the proper shielding under ALARA for occupational workers.
26. How to measure "Virtual source" for photons and electrons. (similar triangle methods)

I took my orals June 2001. I found the questions extremely fair. The examiners were encouraging and I did not feel that any were trying to intentionally fail me (including one that I found to be the most aggressive).
The format involved 3 examiners had computer screens while 2 examiners had the traditional cards. Starting in 2002 the ABR orals will be computer based only. For the cards, I was handed a card and instructed to read either only the first part of the question or the entire question. For the computer screens, the examiner used a bar scanner to scan a bar code to bring up an image. At the bottom of the image was the typed question associated with that image. Follow up questions on the topic did occur.
I found the Orals Section notebook very useful for studying. I'm pleased to say I passed.

Examiner 1
1) Mechanical isocenters of collimator, gantry, and couch: definition, tolerance, acceptance testing, commissioning
2) Radiation/ light field congruence
3) How to calculate dose/MU from irregular fields
4) Describe the II on a fluoro unit
5) Concerns for switching from a low energy room to a high energy room

Examiner 2
1) Images of 2 accelerating structures
2) Image of the dose/kerma curve and questions associated with it
3) Image of a DVH
4) 2 images of the same anatomy to discuss contrast, noise and spatial resolution
5) Image of a patient with in erythema

Examiner 3
1) Brachy sources: source strength and TG43
2) Sc
3) 2 ways to calculate MU from PDD at extended SSD
4) Can't remember. DRR?
5) Patient dose > 14% different from prescription. What do you do?

Examiner 4
1) Image of a block diagram of an accelerator
2) Image of an electron field interacting with a heterogeniety in a phantom
3) Image of a proton beam spectrum
4) Image of a chest wall treatment setup
5) Image of a door of a 6MV linac

Examiner 5
1) Image of a klystron
2) Image of a tandem and ovoid treatment using HDR
3) Image of a transverse contour with isodoses; asked what treatment technique using
4) Image of a film used in radiation therapy
5) Image of a block diagram to determine where to put a linac in a designated room

Radiation Therapy Questions from the ABR Oral Exam given in June of 2001

1. Shown an image of a room (with no dimensions), outside walls are labeled: corridor, earth (or under ground), control area, etc. How should a linac be situated in this room? Occupancy and time factors considered for all walls.

2. Shown an image of a tandem and ovoid treatment. What is being treated? What kind of treatment is this? What radioactive substance is used? What is the metal shield in the middle of the film? (Rectum shield)

3. Shown an image of a door: what sort of sign should be on the door to the linac room? Simulator? Are they the same? Conventional x-ray room? Room storing radioactive materials?

4. What are mean equivalent doses for skin, gonads, eyes, bone marrow?

5. Shown an isodose distribution: tumor above cord, cord has received 50Gy (this dose surprised me too). Shown two possible plans for continued treatment: which is better? Cord dose is obviously critical here.

6. Shown a picture of a cross section of a standing wave guide and a traveling wave guide: What are they? How do they work? Which type of wave guide does the linac at your facility have?

7. Shown a picture of a Klystron: what is it? How does it work? Power output?

8. Shown a depth dose curve of the build up region: why does radiation behave like this? (I was tempted to respond with rigorous care: "Only God can answer this question...and he is unavailable for comment at this time..." I resisted this temptation and advise that you do likewise) Why is there a build up region? What is the difference between dose and kerma? Where is kerma at a maximum? What dose a kerma curve look like?

9. Shown the image of a treatment room with a certain orientation for the linac (incidentally this is the same room which lacked a linac in question #1 above) What is WUT for each wall?

10. Shown the image of certain thimble ion chambers: How do they work? What kind of detectors are they?

11. What are the requirements for a linac which is to be used for stereo-tactic radio-surgery?

12. How does a liquid EPID system work?

13. Shown an images of films from a tandem and ovoid treatment: what is be treated? How is dose delivered? Length of treatment? HDR vs LDR.

14. Shown two images of the same film with different contrast: how are they different? How might one improve the quality of the images?

15. Shown a sagittal image of the prostate with volumes marked: identify GTV, CTV, PTV and IV.

16. Asked about film response in MV and diagnostic ranges: contrast, resolution improving image quality. How can we as physicists explain the difference in response between the two ranges? (Consider interactions: Photoelectric, Compton, etc.)

17. How do you convert depth ionization to depth dose?

18. How would you calibrate a machine with TG-21? List all factors and know approximate values and significance of each factor? (Incidentally there were no questions on TG-51, but this is likely to change. I recommend knowing both protocols in rigorous detail.)

19. Shown two fields with wedges and a hinge angle of 90 degrees: what anatomical region is being treated? What wedge might be used? What will the distribution look like? Draw the 100% line? What line are you likely to treat to?

20. Discuss out put factor: Sp, Scp and Sc; how are they related to one another? How are they measured or derived?

21. How does a simulator work? Give a schematic drawing of its basic components and explain how they work.

22. Shown an isodose distribution of two lateral fields on a neck: what is being treated? Asked about glands (salivary) which were being spared in the distribution.

23. How do you evaluate a personnel monitoring service? How do you choose one?

24. Shown two images: one produced on an 18MV Linac the other by conventional x-ray: why is the hip replacement easier to see in the former film than in the latter?

25. How would you design a wedge for RT? Material? Wedge angle?

Good luck. Remain confident, this is an exam you can pass.

Below is a list of questions that I remember from the 2002 ABR Oral Examination in Therapeutic Radiologic Physics. Note that during the course of examination, more related questions would come up. Often, the more intimately familiar with the subject the candidate is, the deeper the examiner digs with subsequent questions. And, presumably, the deeper this process goes, the higher the score for the question.

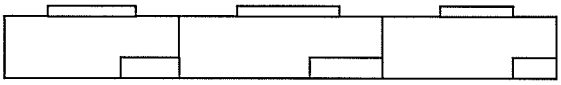
I found all the examiners to be very nice and helpful, and the test to be quite fair. There was more diagnostic content on the test than I had anticipated. I used Dr. Rosemark's collection of questions before the test to identify areas in which I needed to concentrate my studying, although I did study everything I felt relevant to therapeutic medical physics. Thankfully, I passed!

QUESTIONS

- Two radiographs (could be digital) of thoracic region brought up on screen. Discuss differences in contrast & resolution and possible causes of differences.
- Pick out a CT QA ion chamber from a collection of IC's and discuss characteristics of IC and CT dose.
- Diagram of a Fluro system from x-ray tube to monitor. Explain each component. (note that there were multiple fluro/II questions (at least one from each examiner), covering the gamut from rad safety to technical details, to image quality analysis)
- TG-43 dose formalism. Be familiar with each term.
- Shown isodose lines of a H&N treatment with electrons, recognize as electrons, etc.
- Design shielding for an HDR room.
- Recognize diagram of and discuss parallel plate chambers, design, use, P_{repl} for, etc.
- Two ways of changing energies in a dual photon energy linac.
- Diagram of skewed photon intensity fluence just downstream of target in linac head. Discuss causes, outcome, etc..
- Calculate patient dose from a diagnostic x-ray unit. (f number, etc.)
- Discuss dose from a flouro unit, protection from it, and ways to measure it.

- Electronic diagram of a simulation unit. Identify and explain the automatic exposure control, and automatic brightness control, etc.
- Discuss virtual, enhanced dynamic, and universal wedges, how do they work, MU calcs for, etc.
- Discuss film dosimetry
- Discuss effect of field size, SSD, etc. on electron dosimetry.
- Identify and discuss CT vs. MRI images. (more than one of these)
- Testing of a treatment planning system, electrons, photons.
- Contours of femoral heads, prostate, bladder, rectum. How were they generated, how are they used, what are acceptable dose levels, etc.
- Where do radiation dose limits come from, how were they arrived at.
- Questions on MLC's. MU calcs, transmission through & between leaves, different types of, e.t.c.
- Three methods for handling hetrogeneities with TPN dose calculation algorithms are given. Discuss these, and discuss dose calculation algorithms, the dose calc algorithm used at your facility, and how it handles hetrogeneities.
- A CT scout film was brought up on screen. Describe what it is, what it's used for, what slice thickness/seperation, e.t.c.

The following are bits and pieces of questions that I remembered from Spring 2002 ABR exam.



1. About are patient rooms (2nd Floor). What must you consider for doing LDR/HDR in the center room? Discussed standards and limits. What would happen if one room was an office.
2. Shown a Klystron tube. How does it work? What voltage does it use?
3. DVH and discussion on maximum dose, 30% dose to organ, etc.
4. MRI images. T1/T2 images—Difference between them, difference between MRI/CT
5. KERMA – Dose curve.

1. Same diagram as shown by first examiner. ALARA related questions.
2. MRI/CT fusion. Why and how?
3. Brachytherapy TG43 equation. Discussed parameters.
4. Stereotactic isodose .lines on a CT. What direction are the arcs?
5. ??can remember??

1. SIM/Port film images where shown. Asked..what type images and how where they taken. Discussed difference between high/low photon interactions.
2. Dose response models/theory.
3. PTV, GTV, CTV and IV for external beam prostate plan.
4. Picture of waveguides (traveling and standing waves). Talked about energy switch methods.
5. Annual calibration requirements.

1. Parallel plate components/tri-axial cable/guard ring
2. Age Dose Response Curve
3. PTV, GTV, CTV question
4. TG51 equations/describe terms
5. How is rendering/DRR production accomplished?

1. DVH discussion. What plan is better based on DVHs?
2. Wave amplification for accelerator guide/again energy switch discussion occurred.
3. Two treatment plans compare and discuss.
4. Shielding question.
5. QC item—Trend of daily outputs. Any trends a concern. If so what would you do?

Peter,

It is the time to get back to you. The ABR Notebook is a great guide for the oral examination. Even though it doesn't cover all the subjects, it indeed provides hits for the main subjects on which the oral examination is based.

This year there were five examiners for each candidate, few of them are diagnostic and most of them are therapy physicists. Each candidate was given a bar code slip which had five bar codes. Each examiner took a bar code from the slip and taped to a score sheet. He/she then scanned a question book containing all the questions selected for this year oral examination. Right after a question was scanned, the computer monitor showed up a graph, picture or image with the questions in subtitle. All questions were displayed in the computer screen. I think all candidates were examined for the same set of questions, so the results can be evaluated fairly. You may be asked one or more questions from the same category, totally there were five categories. Each examiner gave a score of 68, 69, 70, 71 or 72 based on the answer the candidate gave for the question or questions given in each category. After you finished all the oral questions, the scores for the questions from the same category were averaged and you must get at least 70 for each category to pass the oral examination. The ABR scoring system gives a greater margin to pass the oral examination. If you screw up one question in one category in one examiner, you can still pass the category if you do well in the other four questions in the same category from the other four examiners because ABR averages the scores. Even if you screw up five questions, one in each category, you will still be fine if you can hold up for the rest of the questions. It is very encouraging in such a way ABR examines the candidates.

I finished the examination on Monday and received the notice from ABR on Friday. I am pleased that I passed the examination. My suggestion to future candidates is that more diagnostic questions will be seen on the examination due to the trend that more diagnostic images are used in setup and treatment planning. The candidates should also study those subjects, don't give up on them.

The following are the questions that I can remember in the examination.
Examiner 1

- Room shielding for HDR unit.
- Description of kerma versus absorbed dose curve.
- Head and neck treatment planning.
- Parallel-plate chamber in TG-51.
- How to improve DRR image quality.

Examiner 2

- Film H and D curve.
- Wedge type and definition.
- Radiation exposure level around simulator.
- CT and MRI image uses.
- Influence of collimator on beam profile.

Examiner 3

- Show a treatment plan and ask what kind of treatment is that.
- Prostate external beam treatment planning.
- Fluoroscopic imaging chain.
- Brachytherapy dose confirmation.
- MLC design and configuration.

Examiner 4

- Accelerating structures for low and high energy beams.
- Dose calculation on external beam.
- Total skin irradiation and total body irradiation..
- Fluoroscopic output control.
- CT scanning parameters.

Examiner 5

- Superficial dose calculation.
- CT image features.
- Problems causing skin reddish.
- Dose calculation algorithm of your treatment planning system.
- Radiation safety concerns for implant patients.

Hi Dr. Rosemark,

As I have promised, I am sending you my recollection of ABR oral exam questions. I hope it will help other physicists to prepare for their exam, because your ABR Study Guide has proved to be a valuable guide to me.
It's amazing that I can write down most of the questions shortly after my exam. In contrast, I could recall only 4 or 5 questions a week after my Ph.D. defense!
In my opinion, the ABR oral exam is not that hard - if you have worked in a clinic for a couple of years and have reasonably prepared for it.
Half of the questions you would have learned from your work, while the other half you have to learn from reading the books and AAPM/NCRP/ICRU reports.
For example, the best way to to learn how to setup 3-field breast treatment is to go to the sim room and talk with the therapists while watching them to do the simulation. However, working in a clinic 8 hours a day, 5 days a week does not help you with the question such as "How does a linac produce two photon energies?" The answer to this question would be so easy if you have read Karzmark's book or his review article on medical accelerators.
My point is, to be able to pass the board, you have to work in the clinic to gain clinical experience, and you have to study to understand the theory behind it.
As a candidate, you are expected to know a little bit of everything, for example, external beam, brachytherapy, LDR/HDR, stereotactic, total body, total skin, radiation protection and shielding design, etc, etc, etc ...
And, don't forget physics of diagnostic imaging.
Of course, it is impossible for you to master all the special procedures before taking oral exam, but at least you should have read about it, or have heard about it, or have seen others doing it.
I spent quite a lot of time reading AAPM Task Group reports, however, in my exam I did not get any machine QA questions, no acceptance test, no commissioning, no TG-21, 51, 40, 45, 35, 53, ... I have downloaded and read most of the TG reports. Some of them are notoriously loooong.
I thought I would get at least one or two questions on TG-21 and TG-51, or maybe a comparison of the two, since more and more centers are switching from TG-21 to TG-51. I also studied TG-61 for kilovoltage calibration. No, nothing on absolute dose calibration. (That does not mean other candidates did not get these questions.)
Overall I felt I was well prepared. I knew I did pretty well in most part of the exam, however, "how do you measure CT dose" caught me off guard!
I admit I was not prepared for imaging physics as well as for therapy physics. I mainly relied on the knowledge I learned when I was a graduate student in an imaging research laboratories.
If I were to do it again, I would spend a little more time reading Johns & Cunningham and/or Christensen's book for diagnostic imaging.
Looking back, I think I probably learned a lot more in the past two months than in the past two years!
Anyway, my exam was on Monday June 10, and I received the result in the mail by the end of the week. As you may already tell from my writing (and, as I expected), I passed!
Once again, thank you for your valuable Study Guide.

2002 ABR Oral Examination Questions

Starting this year, all questions were displayed on computer screens - no more cards. I had 5 examiners, each asking 5 questions - one in each category. Occasionally I was asked to write down an equation or draw a graph on a piece of paper.
All the examiners were very nice, very courteous, and helpful. Definitely, they were not there to get you. If I could not answer a question, s/he would try to give me a hint. This way they can tell whether you really know nothing about it or you know it but just could not answer it correctly.

My examiners were:
Drs. Marsden, Niroonmand-Rad, Sohn, Weinhous, and Ritenour

Dr. Marsden

1. a graph, showing a cross-section of an ion chamber

? what kind of chamber is it?
? name the parts in the chamber labeled 1, 2, 3.
? why this chamber is ventilated? why not seal it?

2. a floor plan:
3 patient rooms, on one side of a corridor, the room in the middle has a window and a bathroom, plan to use this room for brachytherapy.
? what are considerations on shielding?
? what dose levels to corridor and adjacent rooms?
? what about window?
? what if this room is on the 10th floor?
? what source is used for HDR?
? what is HDR source energy?
? can you use a sim room for I-192 HDR?
? can you use a Linac room for Ir-192 HDR?

3. a graph, kerma vs. dose

? explain/discuss the graph
? what is kerma?
? why kerma decrease linearly?
? why dose first increase and then decrease?
? what is electronic equilibrium?
? why kerma < dose beyond dmax?

4. two graphs:
a 3D contours of CT slices, prostate, rectum, bladder
an AP beams-eye-view, with DRR
? what is it?
? how DRR is generated?
? how do you improve DRR quality?
? how energy affect image quality?
? what is window and level? contrast and brightness?

5. ???
(can not recall this one)

Dr. Niroonmand-Rad

1. a photograph of 6 or 7 ion chambers
a well chamber
a parallel chamber
2 cylindrical chambers
2 "pancake" chambers
another strange looking chamber

? what are these?
? which one would you use to measure CT dose?
? how do you measure CT dose?
? what is CTDI? How do you measure it?
? how the reading related to patient dose?
? how do you estimate patient dose in a diagnostic procedure?

2. three graphs of a linac head
electron beam exits from accelerating wave guide, hitting target
graph 1, e- beam hits target straight down at the center
graph 2, e- beam hits target at an angle
graph 3, e- beam is a little off the center of the target
? what cause it?
? how do you tune it?
? the equation for bending e- beam in a magnetic field?
? what is that thing below the target? [flattening filter]
? what is it for?
? what is it made of?
? what is photon fluence looks like?
? what is flatness, symmetry?

3. two diagnostic x-ray images of the lung
there is a slightly difference in image quality
? which image is preferred?
? what cause it?
? how do you improve it?

4. a list of dose calculation algorithms
Batho
R-TAR
E-TAR
delta volume
differential (something??)
convolution/superposition
differential pencil beam

? which algorithm does your planning system use?
? explain how it works
? wrote down the convolution equation
? briefly describe other algorithms

5. a photo of AP pelvis
serious skin reaction in the inguinal nodes region
? what is being treated?
? what cause the injury?
? what energy do you use?
? what modality do you use?

Dr. Sohn

1. the computer displays the TG-43 equation

? what is it?
? explain each term
? what is kerma strength?
-

2. two pelvis treatment plans
a 4-field box
a 2-field parallel opposed

? what is being treated?
? can you tell it is GYN or prostate?
? is patient prone or supine?
? what are critical structures?
-

shown another 2 sets of pelvis plans
a 4-field box
a 6-field comformal

? how many beams?
? which plan is preferred?
? discuss these two plans
? what energy do you use? why?
? what energy do you use for head and neck? why?

3. kerma vs. dose
[exactly the same question that was asked by Dr. Marsden]

4. a graph of fluoro system

? identify x-ray tube, image intensifier, ...
? how does x-ray image intensifier work?

5. MLC

? tell me about MLC
? discuss focused vs. rounded leaf ends
? inter- and intra-leaf leakages
? how do you measure these leakages?
? what are the typical values?

? tongue and grove

Dr. Weinhous

1. three graphs of wedges

? discuss conventional, universal, dynamic wedges
? how do you obtain a dose distribution of a 10 degree wedge?
? how wedges affect skin dose?
? how field size affect skin dose?
? how field size affect wedge factors?
? how do you measure dose profile, wedge angle?
? where you may want to use wedges?

2. a graph of fluoro system,
x-ray tube under the couch/patient
x-ray beam shoots up

? in what cases do you use fluoro?
? where fluoro is most heavily used?
? how do you monitor personnel dose?
? which case personnel receive most dose?
? where do you place your TLD/film badge?
? what kVp do you normally use for fluoro?
? what is average keV?
? where do you expect to see more scattered photons? at 90 degree, 45 degree, or 135 degree scatter?
? how do you measure scatter dose?
? what chamber would you use?
? someone suggested a pressurized ion chamber. would you use a pressurized chamber for this measurement? why? and why not?

3. electron beam

? how do you measure e- beam cut out factor?
? how do you use film to measure e- beam cut out factor?
? what happens if the field becomes really small?
? how will dmax change?
? how will output change?
? what is Rp? how is it related to nominal e- beam energy?

4. a graph of 2 H-D curves
one for diagnostic chest x-ray film
one for mammogram film

? what is H-D curve?
? what are the axes of the graph? and the units?
? what does optical density mean?
? identify different regions in the H-D curve
? why these 2 curves are so much different?
? why their characteristics are desired for their applications?

? how do you calibrate film dosimetry?
? what film do you use for therapy verification?
? plot your film calibration curve
? is this an H-D curve? why not?
? what are the axes?
? at what dose do you see the curve getting saturation?
? at what dose will you get density of 1? and density of 2?

5. CT and MRI brain images for SRS

? what are these two images? which is CT and which is MRI?
? what are they for?
? why do you need 2 images for planning SRS?
? which image gives you correct geometry, spatial accuracy?
? which image you can see tumor better?
? how do you delineate the target?
? what would you do if you are not satisfied with image fusion?

Dr. Ritenour

1. a diagram of x-ray/fluoro system
an ion chamber is located behind the patient
a photodetector is behind the image intensifier
both feed-back, via a switch, to an op-am integrator
output of the integrator is compared with a reference voltage
the result feed-back to control the x-ray tube
? what this ion chamber is for?
? what does this electronic circuit do?
? what is the purpose of this circuit?

2. a CT scout image

? what type of image is this?
? how is it obtained?
? what is it for?
? what is the major difference of this and a sim film?

3. a pregnant woman on the couch, supine, AP beam

? how do you estimate dose to fetus?
? what information do you need to estimate fetal dose?
? would change 100 kVp to 85 kVp help reduce fetal dose?

4. two graphs of standing wave forms,
one for accelerating an 18 MV beam, with uniform max amplitude
of standing wave throughout the guide;
one for accelerating a 6 MV beam, which begins with a few cycles
of large amplitude of sine waves, then small amplitude waves
? what is this?
? how dose your linac provide 2 photon energies?
? what are other methods to obtain dual energies?

5. TBI, lateral technique

? what is this?
? what is being treated?
? what disease?
? what other diseases?
? why shield the head?
? what prescribed dose?
? how many fractions?
? what is beam spoiler for?
? how does your institution do TBI?
? do you participate in any clinical trials?

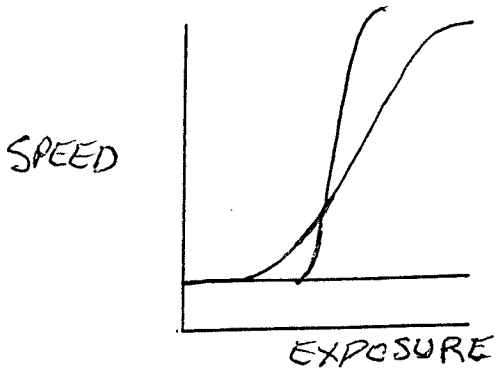
ABR DIAGNOSTIC ORAL BOARD – June, 2002

The format has changed a bit since the last addition of your diagnostic oral questions (1998). There were 5 examiners each in a different hotel room with a computer. You sit down for 30 minutes with each examiner and he will bring up one question at a time (5 I think), with pictures of graphs, curves or x-rays. You will have to read aloud the questions below the pictures and answer them. Of course these questions lead to a hundred others. I believe I have included all of the pictures that I covered, and many of the questions that were asked.

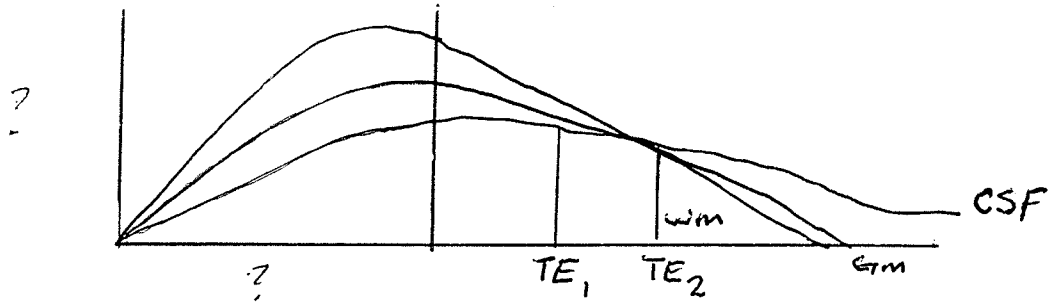
Although there were several questions from past exams, there were many, many new ones, especially about MRI. I believe they wanted to watch you review each picture and see how or what conclusions you draw. This should help everyone better prepare for the orals.

1.

Why Can't you see the left side? What type of transducer is this?
Why is it not as bright at the bottom. What can you do to correct this?



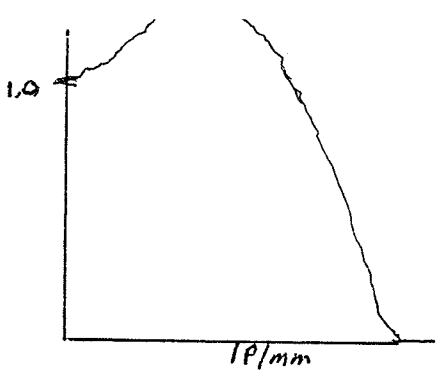
2.
General questions about the Characteristic Curve. What is another name for it.
Where did the H & the D come from? Talk about base plus fog, latitude, speed.

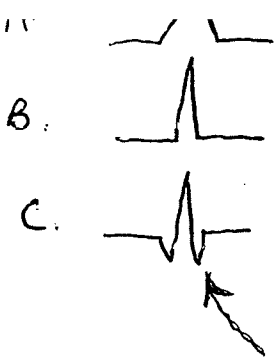


3.
Questions about this curve. What happens after several pulses. What does it show up best. Is it a T1 or T2?

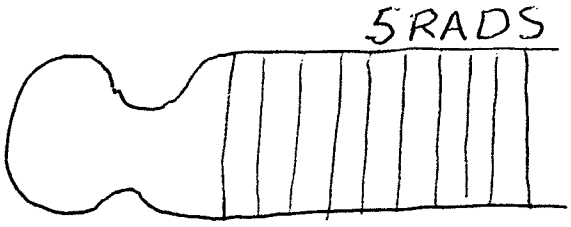
4.
Several pictures of a MRI spine. Asked to talk about it. I said it was of the C-spine area and it was a sagittal cut. He asked if it was T1 or T2 weighted.

5.
How to determine if AEC and ABC is working on a fluro unit. Had to draw a Picture of MTF curve for the focal spot.

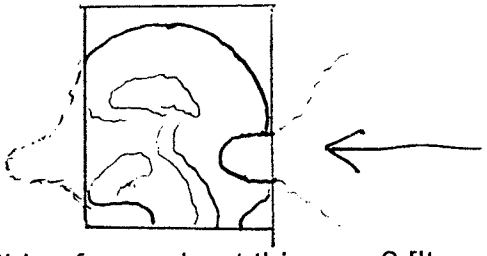




6.
Picture of MTF from a CT scanner. How can it be more than one. Which one on the right relates to the MTF on the left. What are The things in picture C? (side lobes)



7. Questions about dose from picture above. What is the dose you would report? What if the index was changed. How do you calculate a dose from a CT unit? Give the equation for the CTDI. What does the FDA say about this? If it is a spiral scan, how do you get a 360 image from a partial scan?



8. Do you see anything funny about this scan? [It was a picture of alising What is another name for this and why does this happen?

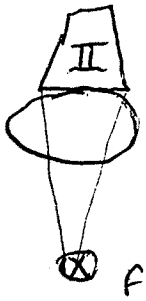


Fig.1

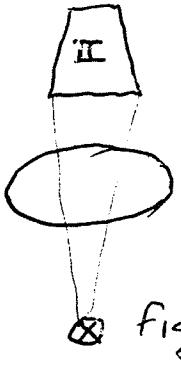


Fig.2

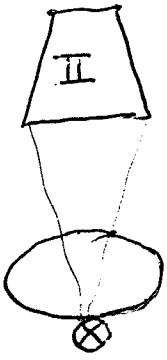
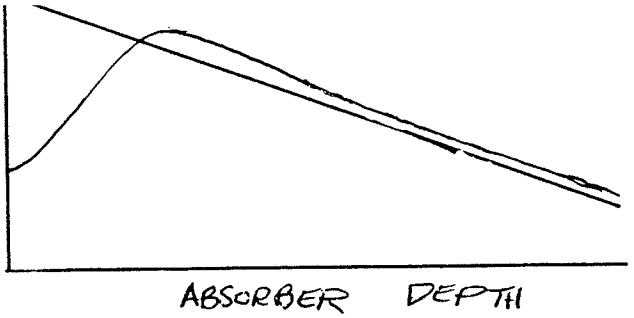
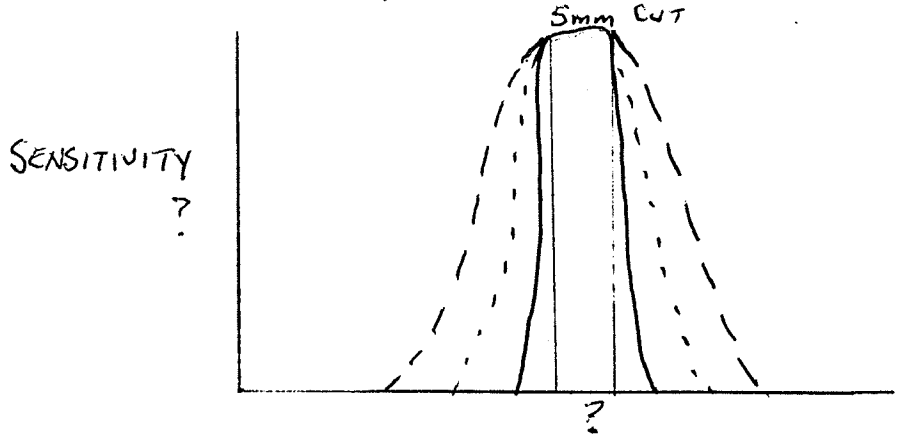


FIG. 3

9.
Which figure gives highest skin dose? If you want a mag image what do you do – either #1 push the mag button or #2 move the patient. Which would give a higher dose and why?

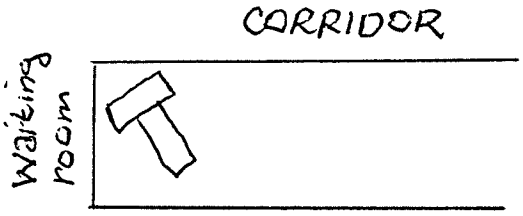


10.
Kerma All kind of questions about the curve above. What does it stand for.

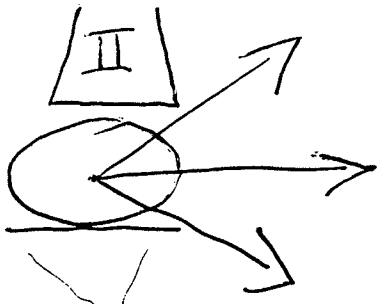


___ Axial P.=1
..... 180 P=1.5
------ 36 P=2

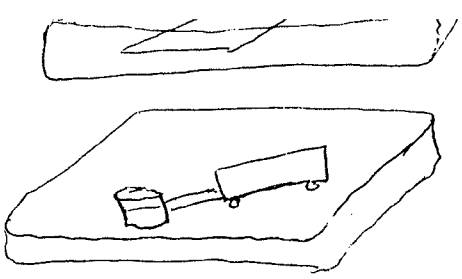
11. What is this? What does it show, What does it mean?



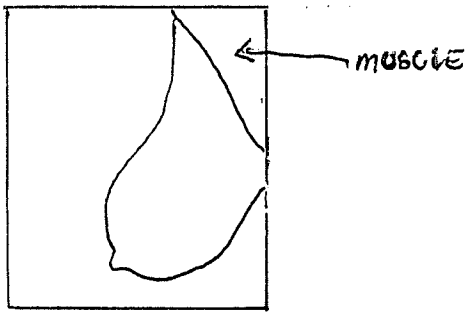
12.
How to shield for this? Typical workloads, thickness, Workload is mA-min per what?



13. Questions about the above picture. All questions about scatter and angles. What would you tell a Doctor if he was really concerned about his readings? How would you shield for this? (lead curtains and movable shields)



14.
A photograph of a mammogram machine with Aluminum on the plate. I was asked to talk about the picture. What were they measuring? How to measure it. What were typical values. How many readings do you take per measurement. He wanted to know about what type of chamber it was (parallel plate) and how it worked.



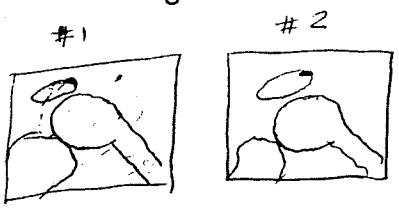
15.
A mammogram x-ray. He wanted to know what I would do to improve the picture. I said I would remove the muscle and include more breast tissue and use a more correct technique. He wanted to know what I would check, we talked about AEC and how to check it, how to check kVp accuracy. The he wanted to know what else could be checked if it was still too light – he was looking for inaccuracies in the processor.

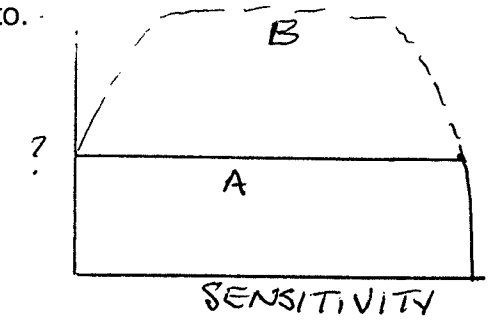
Chest	6	100	72"
Abd	10	80	40"

A slide with about 10 techniques

16.
He wanted to know if these were typical techniques. If this was done using film screen and then CR, what would the dose be. [Using the same technique the dose from one to another would be the same] He wanted to know about the image differences and all about photostimulable phosphor, What was it made of and how does it work. What are the advantages and disadvantages.

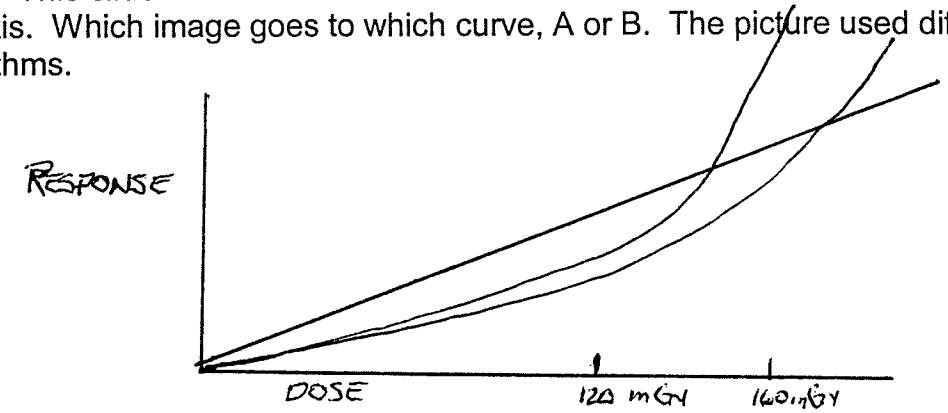
17.
A photograph of an acrylic CT abd. Phantom. Talk about the picture. What's going on. What are the phantoms made out of and what size are they. What about the chamber. Where do you take readings. Which readings are higher. What is the thing that the chamber is connected to.



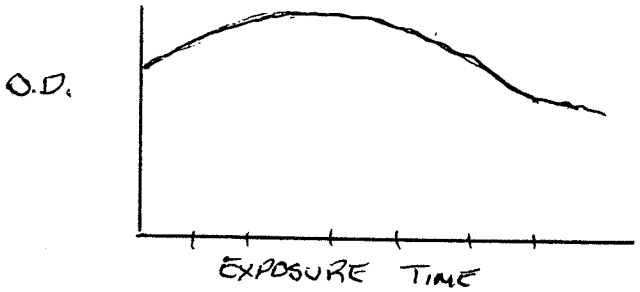


18.
Two images of the same lateral knee. One had more contrast and much more detail. This slide had a curve associated with it. I can't remember the values on the axis. Which image goes to which curve, A or B. The picture used different algorithms.

19.

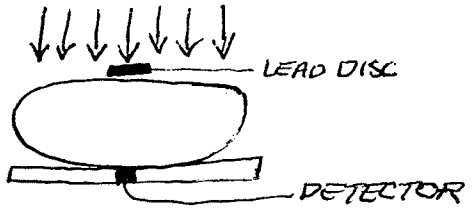


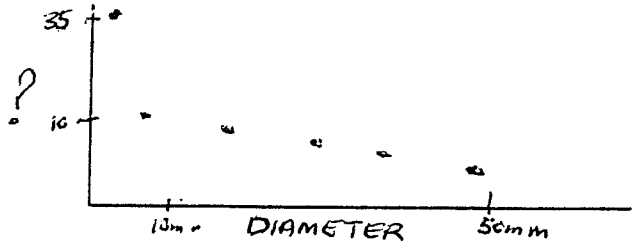
Where does the information from the above curve come from? Which do you shield to and why? What are the curves based on? Why is the effect of a large acute dose worse than a chronic dose?



20.
Two curves. What kind of curves are these {one was the reciprocity failure curve} Talk about that and is it a problem. Why does it happen?

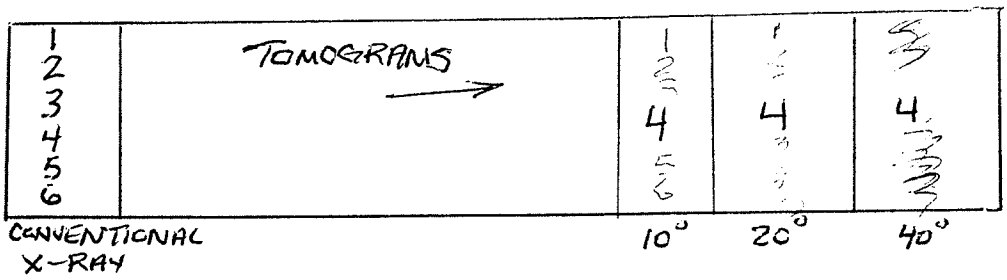
The second was a curve of film sensitivity vs. time of development. When would this be a problem? [mobile mammogram where you can't develop the film immediately.] He asked me what was the emulsion made of.



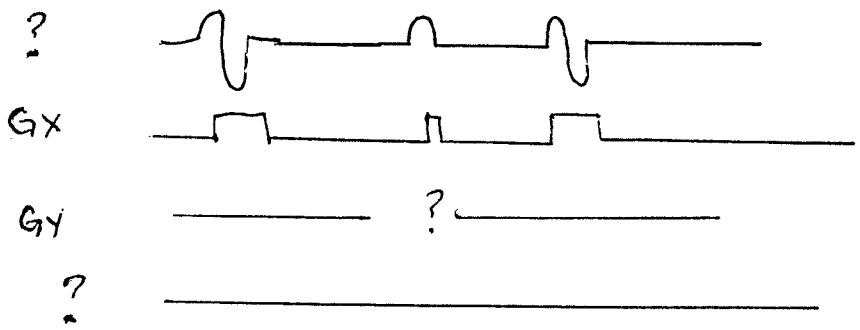


21.
What does the detector see with each increasing diameter lead? Using the "beam stop" method. The diameter increases. What information can you get From this curve? [It shows scatter ratio- 25 more scatter, 35-10=25] ?

22. Two images of an x-ray. Which one used a grid? What is a typical grid? About how much increase in dose is it when using the grid? This is a picture of an angiogram. He said you can also get contrast from an image like that if you make area of interest over the contrast and background. One image was much sharper than the other.



23.
What is this a picture of? [Tomogram phantom] Describe the phantom and how it works. What is the most common tomographic pattern? Tell what you see from the pictures above. [They focused on the #4, the larger the scan angle, the more blurring]



24.
Talk about the above. Tell everything about it. Is it a T1 or T2 weighted? Draw an spin echo diagram. How do you use phase to encode MRI signals?

Dr. Rosemark,
Thank you for the study booklets. I found them very useful. Below are my oral questions from the 2002 ABR boards. The questions represent what was asked of me to the best of my recollection. The questions may not be the exact questions that were on the computer monitor but reflect the examiner's continued line of questioning. Be aware that some of the questions were tailored to me only after determination of my clinical experience. For example, the questioning on the Adac TPS only came about after the examiner determined that I had an Adac at my clinical site. My advice is to be very familiar with whatever it is you use at your own clinical site.

1. Picture of TBI setup with patient sitting on level surface, knees drawn up, irradiated from side, entire head blocked. What is the treatment volume? What are they treating? What are they trying to irradiate, where do they harvest the bone marrow?
2. Picture of Fluoroscopy imaging chain. Identify each part (tube, couch, image intensifier, ABC, etc.). Where is the quantum sink?
3. Dose kerma curve and associated questions.
4. Wedge questions. Draw the isodose lines. What is a dynamic wedge, enhanced dynamic wedge, universal wedge? Where would you measure wedge factors? How would you commission a dynamic wedge? Would you use measured profiles or "golden" data for dynamic wedge profiles in the TPS? What are wedge factors a function of (field size, etc.)? How would you obtain and use off-axis factors? What are the open PDDs for a 6 MV and an 18 MV beam? (This PDD question may not have been part of this wedge question, but it was asked at some point)
5. Picture of transverse MRI and CT of brain. What are they? How would you use them? Why not use MRI for treatment planning? Why is the CT useful for treatment planning? How do you obtain a CT number vs. electron density curve? What does it look like?
6. Picture of 6-8 different probes including a well chamber (most of which I have never seen). What are they? What are they used for? Which one would you use to measure CT exposures? How would you calibrate a brachy seed? How would you calibrate a brachy strand?
7. Picture of a four field and six field prostate. Identify the critical structures. When and why would you use one over the other?
8. List of different inhomogeneity corrections. What are they? When are they used? List the strengths and weaknesses of each.
9. TPS question. Explain how a convolution superposition algorithm works. Draw the collapsed cone that the ADAC uses to model primary fluence reduced by flattening filter. Draw the dose deposition kernel. How is it obtained? How much data do you need to model it? How do you model various parameters … i.e. electron contamination, energy spectrum, etc.?
10. Identify the parts of an Image Intensifier .
11. Picture of an 80 kvp and 100 kvp beam incident on an abdomen. How do you get dose? What if the patient is pregnant, how would you determine the dose to the fetus?
12. Picture of an MLC. Do you have an MLC? What are the different ways to construct the ends? How much radiation is transmitted through the ends of the leaves? How much leakage through the leaves? How do you measure it?

13. Overhead schematic of a treatment room for shielding questions. What are the max permissible exposures limits to various areas outside the treatment room e.g. a corridor, an outside sidewalk, a console area.
14. A couple of questions later… same schematic as 13. How would you shield for HDR? What is the wall thicknesses? How do you calculate shielding thicknesses? What is the formula for shielding? Is a simulator room adequate for HDR shielding?
15. Two pictures of accelerator structures with standing waves. The standing waves in the second picture were reduced in amplitude in the downstream section of the waveguide. What are these pictures? What kind of waves? How are they produced? What are some other ways to change energies?.
16. Picture of a CT scout film. What is it? How is it obtained?
17. Picture of a parallel plate chamber? What is it? Identify various parts. Where is the exact point of measurement? When would you use it? Why? Where is the guard ring? Why is there a guard ring?
18. Two pictures of AP neck with different isodose lines. Why are the isodose lines different? (one of the pictures was of a tracheotomy, I think,) What structures would you be looking to spare?
19. Picture of an AP pelvic treatment with areas of erythema. What could have caused the erythema?
20. 3 pictures of an electron beam hitting a target, one at the wrong angle and one off-center. Questions about the steering that could cause this, then questions about what the distribution would look like for each the pictures
21. Explain every term in the TG-43 dose formalism.
22. Picture of 2 H&D curves. What are the axes? Which one is the mammography curve? Questions about contrast and dynamic range. What would the H&D curve for V-film look like? How would you use V-film clinically? How would you construct the H&D curve for V-film? What software/hardware would you use?.

Good Luck
Arlie Walker

ABR – Oral Exam in Radiologic Physics 2002

The oral exam was at the Executive West Hotel in Louisville, Kentucky. The fourth, fifth, and six floors of the hotel are blocked off for the administration of the oral exams.

The test consisted of five half-hour sessions. For each session, you are assigned a hotel room and an examiner. At the back of the room, there are two chairs and a computer on a desk. The examiner has a laser scanner (like at the grocery store). Before each question, he scans in the appropriate bar code. At that point, the corresponding question and image(s) appear on the computer screen. Some of the images are of rather poor quality.

Each examiner asks questions on all five topics:

1. Radiation Protection and Patient Safety
2. Patient Related Measurements
3. Image Acquisition, Processing and Display
4. Calibration, Quality Control and Quality Assurance
5. Equipment

Ideally, they should spend about 5 minutes on each topic. The questions are preset by the ABR, but the examiners often stray from the original script.

One recommendation that I would give is to stay somewhere other than the Executive West. This hotel is really rundown and cheap. I arrived a day early, and spent the first night in downtown Louisville at a beautiful hotel (Camberly-Brown) for the same price as the Executive West. The night before the exam, I stayed at the Executive West. The room reeked of smoke, and the bed was as hard as a rock. I should have stayed downtown and taken the $10 cab ride to the Executive West on the morning of the exam.

Most of my preparation for the exam was based on answering old questions from exams for the past 5 or 6 years. This was a tremendous help, and provided me with a great deal of guidance on what the ABR is looking for.

At the exam itself, four out of the five examiners were very pleasant and helpful. The fifth examiner seemed out to get me. I definitely learned that the examiner can make or break the exam for you. Thankfully, I passed on the first go. I received the results three days after the exam. Good Luck!

The questions that I can recall are:

1. Two CT Images side by side (The images are the same CT slice with different windows and levels).

    What is the difference between these images?

    Define window and level?

2. Picture of a klystron (from Kahn).

    What is it?

    How does it work?

    At what frequency does a LINAC operate?

    What are the advantages and disadvantages of a klystron versus a magnetron?

    Which vendors use which?

    What is use on your machines?

3. Picture from Karzmark's "Medical Electron Accelerators" p. 192.

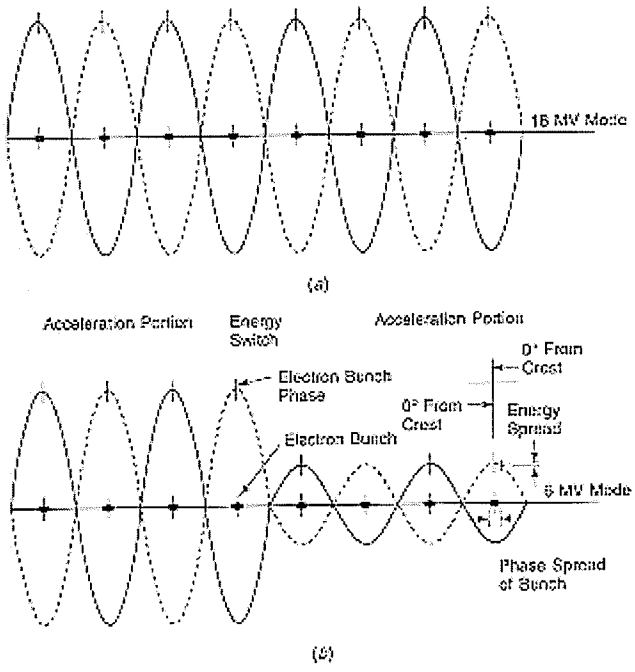


FIGURE 11-1 • Electron bunch phase with energy switch. The dashed wave is 180° of phase later in time than the solid wave. (*a*) 18 MV x-ray mode and (*b*) 6 MV x-ray mode.

What is this showing?

How is the energy changed in a dual energy LINAC?

What are the alternative means of changing energy?

What is used in your machines?

Which vendors use which technique?

Note: Karzmark's text is out of print, yet the ABR seems to expect all examinees to be very familiar with it. I find this somewhat annoying.

4. Shown two prostate plans. Axial, sagittal, and coronal images with isodose curves.

What is the field arrangement for each? (One was a 6 fld, one a 4 fld)

What are you treating?

What are the advantages and disadvantages of these 2 approaches?

What other techniques are used for treating prostate?

6. Plot shown (from Hall?). The plot compares the cost of radiation protection versus potential for biological damage, both as a function of dose. It is the type of plot that might be used in a cost/benefit analysis to determine the appropriate levels of permissible dose.

What is this plot?

What does it show?

Explain different extrapolations in the low dose region. (One is linear no-threshold, one is linear-threshold, one is superlinear, one actually shows negative damage (hormesis?) in the low dose region).

7. Show two prostate DVHs side by side. Which is better and why?

8. Show picture of MLC transmission versus MLC location.

   Explain.

   Why does the MLC interleaf transmission track the MLC position?

   Explain tongue and groove.

   What is the transmission for jaws? MLCs?

   What QA is needed for MLCs?

9. How do you perform patient specific QA for IMRT?

10. Shown two MRI brain images. (One is T1 other is T2).

    Explain the difference between these images.

    How can you differentiate T1 and T2 weighted images?

    Why is MRI useful for planning?

    What are the problems with using MRI for planning?

11. Question on image fusion. A fusion is shown with overlying checker patterns. The square in the checker pattern alternate between CT and MRI.

    What is this?

    Why is image fusion useful?

    Why would both modalities be needed?

12. Shown isodose curves on axial, sagittal, and coronal brain images. They are from a linac-based stereotactic radiosurgery plan.

What are the arc paths?

How can you tell?

A second set of isodose curves are shown.

What arc paths are used in this case?

How might you combine these two plans?

13. Shown side by side photos of a traveling-wave waveguide and a standing-wave waveguide.

What are these?

How can you tell?

What are the differences? Advantages and disadvantages of each?

Which is use in your machines?

Which vendors use which approach?

14. Shown a table of values from an annual QA report. For each measure, the table shows the expected value, the measured value, and the ratio of the two. The table includes PDD, TMR, etc.

Are these values acceptable?

What would you do about the values that are unacceptable?

Change the planning system data?

Double check with another physicist?

15. Shown a series of measurements from morning QA.

Are these values acceptable?

What are the action levels in your clinic?

What do you do if you exceed these levels?

At what point would you stop the treatment of patients?

What is your action level for electrons?

How do you establish a morning QA program?

16. Schematic of linac room surrounded by a corridor, hallway, and control room.

Discuss workload and its calculation in this case.

What is the dose limit for each area around the room?

Instantaneous limit? Weekly limit? Yearly limit?

What is a controlled area? What areas are not controlled areas?

17. Schematic of an LDR brachytherapy room. Patient rooms on either side with a window on side and a hallway on the other. This picture was shown by 2 different examiners who asked a whole variety of questions.

    What levels are acceptable at each location in the picture?

    What areas are controlled areas?

    How would ALARA be applied?

    Given the following dose levels at the following locations, what would you do?

        Recommendations.

    What would you do if the dose rate in the adjoining room was 7 mR/h?

    What if the dose rate was 6 mR/h at a chair where visitors sit?

        How long could visitors stay?

18. Depth dose curve. Shows build up region, peak at dmax, and exponential falloff.

    Why is there a dose build up?

    Where is true electronic equilibrium achieved?

    What is KERMA? How does it compare to dose?

19. Shown TG43 brachytherapy dose calculation formula.

    Explain each portion of the equation.

    Plot g(r) for Ir-192 vs. I-125.

    At what distance can a line source be approximated as a point source?

20. Shown TG51 formula for photons and electrons.

    Explain each component.

    How is beam quality determined for TG51.

    How is M_{raw} converted to M?

21. What is the measurement point for photons and electrons for TG21?

22. Shown a plot of (#of cancer per 1000 people) vs. age. The expected values at each age are plotted along with two different predicted curves.

    Explain. (Note: One plot was the absolute risk model the other was the relative risk model. See Eric Hall's book for details.)

    Define the absolute versus relative risk models.

    Identify which curve is which. Why?

23. Cell survival curve.

    Explain the elements of the curve.

    Explain alpha over beta ratio etc.

24. Plot showing photoelectric versus Compton versus pair production as a function of atomic number of material and energy of photons. Explain.

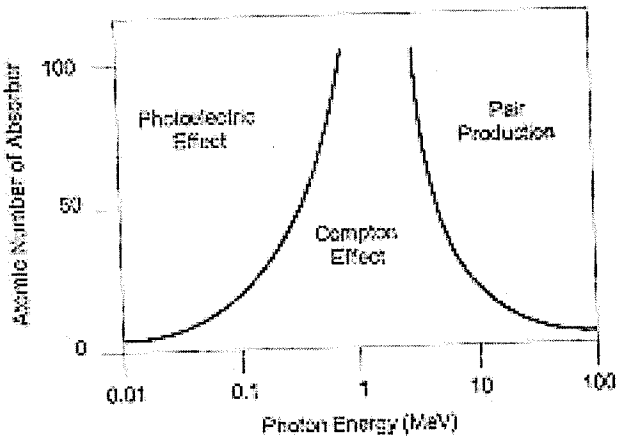


Figure 6.5. Relative Importance of Principal Interactions

25. Explain the advantages of a 270 degree bending magnet as compared with a 90 degree bending magnet.

26. Shown a schematic of a parallel plat ionization chamber with arrows pointing to a series of different components.

Explain what the arrows are pointing at.

What is the function of the guard? What is its effect on the field pattern?

Oral reexamination for Nuclear Medical Physics on Radiation Safety category on November 7,1999.

1. Sewer Disposal; Monthly (not annually) Average Concentration; Radioactive hazard Vs biochemistry hazard; Materials excreted or removed from the human body not regulated.
2. Procedure of autopsy for a patient had 200 mCi I-131 within 48 hrs.
3. NRC state Vs agreement state; Definition of byproduct material.
4. I-131 inpatient room prepare and patient released procedure based on four kinds of calculation.
5. How to give a in service to new employee with no knowledge about radiation Vs as a refreshment to occupational worker.
6. Typical radiation exposure rate in different areas of NM. Other areas may deal with patient with radioactivity (cardiac nurse, ultrasound tech, epilepsy staff etc,).
7. I-131 shielding and storage. Leading to shield for a Mo-Tc99m generator.
8. DOT transportation Index; Package receive procedure.

Xe-133 release to unrestricted area and ALARA. Room design for Xenon procedure. Design a waste decay area and discuss other waste disposal methods.

Examiner: Dr. Feldman
Dr. Wilson

2003 ABR Oral Exam Questions, Radiation Therapy Physics

QUESTION: Shown a picture of a klystron. Explain the principles of operation. Familiarize yourself with specifics; including accelerating voltage, currents, power output etc. Discuss the waveguide (not the accelerating waveguide) and why it is pressurized with SF_6.

QUESTION: Shown a picture of a 4 field chest wall treatment (left tangents, oblique supraclavicular field and a medial strip used to treat the internal mammary nodes). Explain how field junction/divergence issues are solved (i.e. table kicks, independent jaws, gantry breaks, etc). Discuss clinically relevant issues (e.g. the use of bolus, critical structures, electron/photon weighting for the IMN field).

QUESTION: Shown a diagram depicting a 6 field total skin electron irradiation. Explain the benefits of such a setup. Be prepared to discuss clinical specifics (e.g. dose prescription, fractionation pattern, dose inhomogeneity, energy, energy degraders, photon contamination, any required special physics measurements).

QUESTION: Shown both axial and coronal views of a head and neck treatment delivered via conventional techniques (opposed laterals + bilateral supraclavicular field) and IMRT. Be prepared to identify each treatment and discuss the relative advantages and disadvantages of each method. Be prepared to discuss clinically relevant issues (critical structures, cone downs etc.). The question led to a discussion of IMRT in general. Familiarize yourself with intensity maps, objective functions, cost functions optimization algorithms, translators, QA, etc..)

QUESTION: Shown a diagram of a GTV, CTV, PTV, IV etc. Discuss each. Also know that certain quantities also has an analogous term for normal structures (e.g. CTV and CSV).

QUESTION: For at least two questions, I was shown two diagnostic images of varying quality. I was asked to provide possible explanations for the difference in quality. I provided several explanations (e.g., energy differences, the use of grids, improper development techniques, large vs. small focal spots, etc.) In order to prepare for a question similar to this, I would recommend you study the entire imaging process and isolate each variable and its effect on image quality.

QUESTION: Shown a CT/MRI fusion. Discuss the advantages of each imaging modality. Discuss methods of performing image fusion. Discuss ways to evaluate the quality of the fusion.

QUESTION: Shown a diagram of the accelerating structure and treatment head of a linear accelerator. Be prepared to discuss the principles of electron acceleration and energy switching. Also be prepared to explain the function of each element in the treatment head.

QUESTION: Asked to discuss several shielding/radiation related issues. For example: What field size do you use when calculating the attenuation of primary barriers? What field size do you use when determining scatter for secondary barriers? At what energy is head leakage the dominating factor for secondary barriers? What is the typical door thickness/composition? What are the dose limits for the public, radiation workers, uncontrolled areas? What are the posting requirements for radiation areas, high radiation areas, very high radiation areas? State occupancy factors.

QUESTION: Shown a picture of several detectors. Asked which to choose in order to measure CT dose. Asked why you would not use the other types of detectors. Also, what other equipment would you need to perform the measurements.

QUESTION: Shown a graph depicting the incidence of cancer vs. age. Superimposed on this graph were the predicted cancer rates using either the absolute or relative risk models. Discuss the absolute and relative dose models. Asked where we get risk estimates for radiation induced cancers?

2003 ABR Oral Exam Questions, Radiation Therapy Physics

QUESTION: Asked several questions related to the change in depth dose versus field size. Be prepared to discuss collimator and phantom scatter. Be prepared to discuss the effect of collimator scatter on the buildup region. Also, discuss the principle of lateral electronic equilibrium.

QUESTION: Shown a graph of the Compton cross section and the corresponding energy transfer cross section as a function of photon energy. Be prepared to discuss.

QUESTION: Shown a graph of a depth dose curve. Asked to fill in the KERMA and collision KERMA curves. Asked to provide equations showing relationships between these quantities. Discuss why we don't calibrate in the buildup region, and why we do calibrate at 10 cm using TG51.

QUESTION: Asked to perform simple calculations using PDD and TMR.

QUESTION: Asked to describe the concepts behind Dose, Dose Equivalent, Effective Dose Equivalent, Total Effective Dose Equivalent, Mean Equivalent Dose. Be prepared to discuss LET, RBE and radiation weighting factors. Be prepared to discuss and provide tissue weighting factors.

QUESTION: Asked to discuss the principles behind static, universal and dynamic wedges. What are the advantages/disadvantages of each? How do you design a wedge?

QUESTION: Shown a diagram of a parallel plate chamber. Discuss the construction of the chamber. State the relative potential of the anode, cathode and guard ring. When is a parallel plate chamber recommended?

ABR Orals - 2003

Here are the questions – I wrote these down right after the exam.
Note that this was the first year where all questions are computer based.

Examiner 1 (friendly, helpful):

1. Figure of shielding cost vs. total lifetime dose (Y1 vs. X) and radiation biologic damage vs. total lifetime dose (Y2 vs. X) – these were plotted on the same graph. Asked to identify threshold points on these curves – this had to do with radiation dose models, such as the linear-no threshold model (LNT) and the quadratic dose model.
2. Image of standing wave guide (SW) and traveling wave guide (TW). Asked to identify and explain.
3. Figure of a DRR for a virtual simulation – asked about field borders, structures, etc.
4. Two x-ray images of different quality. Asked how you would improve the quality.

Examiner 2 (not friendly, nor helpful):

1. Image of a parallel plane chamber. Asked to explain the design and the purpose.
2. Shown the equation for dose for TG-51. Asked to explain each parameter.
3. Shown a 6 field and 4 field prostate treatment plan – asked to identify differences in the plan in terms of conformality – which structures are spared more, etc.
4. Figure of two curves relating to relative and absolute dose risk models.
5. Shown an excel sheet with a bunch of values, PDDs, output factors, wedge factors, etc. for an annual QA with differences also shown from the commissioning values. Asked to discuss whether or not the differences were in tolerance. Hint: Memorize TG-40.

Examiner 3 (friendly, helpful):

1. Image of 2 different CT images – one with a lung window and the other a bone window. Asked to identify differences in the image.
2. Picture of a brachytherapy room with dose rates at various locations – asked whether or not the various levels were acceptable. Asked about the procedures for handling emergencies, nursing instructions, etc. (Read the brachy task group on this).
3. Shown a picture of a SW vs. TW wave guide. Asked how you would do energy switching and about advantages, etc of each.
4. Given 2 treatment plans with DVHs for PTV and OAR. Asked which plan is better.
5. Shown an excel sheet with morning QA values. Asked if the no.s were in tolerance. What would you do if they were not? (Again, TG-40)

Examiner 4 (not at all friendly but will help guide you if you are heading the right way):

1. Shown images of a T1 vs. T2 weighted MRI brain scan. Asked questions relating to the various structures and why they show up dark or light? (Review the MRI stuff).
2. Shown a picture of a room and asked about how you would shield it for regular brachytherapy?
3. Same picture but now how would you shield it for HDR brachy?
4. Figure with curves showing kerma vs. depth dose. Discuss details of these concepts.
5. Picture of a Klystron. How does it work? Discuss details about frequency, power input/output, etc.

Examiner 5 (very friendly, very helpful):

1. Shown a treatment plan of a radiosurgery dose distribution in the axial, coronal and sagittal views. Asked about beam arrangements, field sizes, etc.

2. Shown the equation for TG-43 – discuss details on all the factors.

3. Shown a figure on image registration of MR/CT. Asked to discuss the figure and methods of image registration.
4. Shown a room and asked about how shielding would be done for HDR (very similar to the question from Banerjee)? Hint: be sure to discuss the ALARA concept in shielding.
5. Figure of intra-leaf leakage vs. MLC field size, showing that it increases. Asked to explain.

June 2, 2003 ABR Therapy Physics Oral Exam Questions

Examiner 1:

Shown CT scout image, what modality is this image, what is it used for?

- Explain how CTs used in constructing DRRs, explain details re:DRRs.
- Example lateral pelvic field, is the DRR the same for SAD setup vs SSD setup?
- Define CT#, HU, how are they used in RT planning?

Shown kerma and dose curve, explain.

- (Points to portion of curve beyond dmax) If you put an ion chamber right there, which are you measuring, kerma or dose?
- How do you convert this reading into dose?
- Led into TG-51, discuss how you do it.

Shown AP chest field with cord block, discuss factors affecting cord dose (energy, block width), how many HVLs are your blocks? Which beam has sharpest penumbra of Co-60, 6X, 10X, 18X? (he was pushing towards 10X but seemed to cut some slack when I told him I'd only worked with 6X/18X)

Shown diagram of flouro beam incident on patient

- In which directions is scatter greatest, smallest?
- How is this situation different interactions-wise from therapy beam scatter?
- What are maximal sidescatter and backscatter energies?

Shown CT-MR fusion images from ADAC, explain what this is, how you do it, why do you want to fuse CT-MR? Does this appear to be a good image fusion?

Examiner 2:

How/what would you estimate gonadal/fetal dose for a woman with breast ca receiving tangents + e- to a TD of 60 Gy?

- Where do you find guidance on this?
- What can you do about it?
- What dose levels would cause you to be concerned about fetal risks?
- What are the magnitudes of the risks?

Ir-192 vs Cs-137 vs I-125: Discuss physical and radiological properties, radiation safety aspects, uses, clinical aspects.

Brachy patient (Cs-137) needs a CT after applicators are loaded, how do you handle it? Would your answer be different if the implant were an Ir-192 sarcoma implant? How/why?

Photon and electron cal depths for TG-21 and TG-51, discuss some details about how you do TG-51. What are the differences between TG-21 and TG-51, procedure and physics-wise, discuss rationale for replacing TG-21 with TG-51.

What are the differences between a diagnostic CT unit and a dedicated CT-sim unit (table top, bore size maybe, lasers, virtual sim software perhaps)

Examiner 3:

Shown simplified diagram of arrangement of TSET fields on cylindrical phantom.

- Do you recognize this, what is it?
- What diseases are treated with TSET?
- What e- energies are used?
- Discuss dosimetry, PDDs of TSET beams.
- What areas are underdosed with TSET, what do you do about it (e- boost or orthovoltage boost)

Shown CT-MR fusion images from ADAC, explain what this is, how you do it, why do you want to fuse CT-MR? Does this appear to be a good image fusion? This was essentially the same question as before but with a slightly different picture, this one was of a stereotactic CT with an MR). The discussion led into a few basic SRS questions, what are tolerance doses for brain, fractionated and single fraction SRS?

Shown diagram of Ir-192 LDR implant brachy room with dose rates in mR/hr.

- Do you see any problems (there are at least one or two)?
- What would you do about it (empty adj. room, add temp. shielding?
- What is missing from this diagram? (notation of portable shielding)
- How would you calculate stay times for nurses?
- What are your nursing instructions?
- What are applicable dose limits?
- Discuss dose limits for pregnant radiation workers (how does it work administratively)

Shown e- beam in tissue which encounters a slab bone inhomogeneity.

- What happens dosimetrically?
- What can you do to make it better?
- How thick does the internal shield have to be?
- Discuss backscatter dose enhancement on the superficial side of the inhomogeneity.
- What e- energy would you recommend to treat a 2cm thick buccal lesion with?

Shown diagram of klystron, magnetron. What are these, what are the pros and cons of using each in a linac? What physically happens in your linac when you program up an e-beam? One foil or two scattering foils, what are they made of, what does the first and what does the second foil do?

Examine 4:

Shown radiation damage vs dose curves.

- What are curves a-d? (LNT, hormesis, supralinear, threshold)
- Discuss each curve
- Where did the data come from to generate these curves?
- Why is the low-dose region labeled as "uncertain"?

Shown picture of cylindrical and pancake ion chambers. What are these, what is each used for? Where is the effective point of measurement for each?

Shown TG-43 equation (which had a minor error in it, it's supposed to be dose rate at r, theta not dose at r, theta). Explain each of the terms. How would you do TG-43 dosimetry for a Cs-137 source? How do you do it for other sources?

Shown CT-MR fusion images from ADAC, explain what this is, how you do it, why do you want to fuse CT-MR? (third time I got this question)

Shown schematic of e- beam going through linac, through treatment head, and out.

- Why is there such a thing as the virtual source for electrons?
- Have you ever measured the VSD?
- How would you /did you do it?
- How do you or do you use the VSD clinically?
- How do you calculate electron beam MUs at your institution?

Examiner 5:

Shown White I, Yellow II, Yellow III rad material shipping labels. What are these, when do you need to use each (transport index and surface readings)? Are you the RSO at your facility? He seemed to back off a bit when I answered "no".

Shown CT cut of H&N neck area with isodoses, the parotids and cord were outlined.

- What part of the body is this, what type of disease are we treating?
- What are the critical structures? Point out the target (it was also contoured so pretty easy).
- What type of beams were used to generate this isodose distribution? (Obviously IMRT due to "donut hole" of dose around the cord and "dips" in the high dose areas around the parotids).
- Do you do IMRT – discuss your IMRT QA briefly.
- Discuss IMRT in the H&N region vs IMRT for the prostate (localization, organ movement, critical structures, beam arrangements)

Shown anatomical drawing of female thorax with nodes.

- Indicate where the SCLAV, axillary, and internal mammary nodes are located.
- How do you treat each of these say with a four or five field technique?
- Treat to what doses?
- How do you treat the IMC?

Shown three scenarios (simple diagram which I now see is Figure 7-15 on page 126 of Karzmark's book) of e- beam entering 90 degree bend magnet.

- Discuss the effect of each situation on e- beam flatness and symmetry.
- How would you try and fix it (examiner seemed satisfied with me explaining which pots to tweak and how I adjusted steering once on a Varian machine).
- Does a 270 bend magnet focus the beam differently than a 90 degree magnet, which is better?

ABR June 2003 General Comments:

All examiners were friendly, polite and not intimidating. All but one was fairly interactive. He provided little feedback and his follow-ups were limited. The others explored in more depth or breadth based on my comments. Overall the exam was as expected and not too difficult. For me, there were a couple of gotchas. I had almost no clue for Question 1, Examiner 2.

Questions

Examiner 1

Q1. Layout of three patient rooms in a row (same side of corridor) on a hospital floor: Center room identified as location of brachytherapy. Center room has window. Define ALARA and discuss ALARA in terms of this scenario. Discuss the use of this room for LDR Ir-192. What are acceptable doses outside of the room. What type shielding would be used, if any?

Q2. 2 Pictures: Left Klystron, Rt Magnetron. What are they? What is the difference between the two? What is the difference between LINACs that use magnetron & klystron? Advantages/disadvantages. About how big are they?

Q3. Axial Brain MRI & CT (SRS frame pins) of approximately same cut. What are these images? How are they used in RT. What are advantages/disadvantages of each for RT. Can you calc dose on MRI? What do you need to do to verify doses calculated on MRI? What are your concerns?

Q4. Port filming. Why? How often. What dose/MU given? What type of film is used? What dose gives O.D = 1 for this film. What other film do you use in the department. What is the fraction of total dose from port filming? Should this be included in the total dose to the patient?

Q5. Discuss the effect of voltage on ion collection efficiency. How do you check this for an ion chamber? Is it greater or less than one? Approximately what value is P_{ion}?

Examiner 2

Q1. Orthogonal AP/LAT films… poor quality. Bladder marked. 2 curved applicators with seed markers in them. Lateral film show a great deal of curvature on the appliance (a tandem?), there is radio opaque object near the rectum. What is this procedure; describe the objects and relevant structures in the images. This one got me. Did not recognize the appliances due to my limited HDR experience.

Q2. Diagram of RT room with maze. Note maze wall is a line with no thickness… confusing at first. Gantry rotates toward maze and corridor to left and park to the right. At bottom is the control room and on top is another park/garden. Discuss beam arrangement in room, use factor, occupancy factor, dose limits in each area. Recommend an improved layout for the room.

Q3. TG-43 dose calculation equation. Discuss each term in the equation. What happens to geometry term when you assume a point source? How does your TP system handle this? How does TP system handle Cs-137 needles?

Q4. Crude diagram of slow wave-guide with open disk in the middle. Below is sin wave of field voltage. Discuss propagation of wave and electrons in structure. What happens to microwaves at the end of wave-guide. Describe the recirculation system? What is the difference in the two wave-guide structures? Is recirc system under vacuum?

Q5. Radiobiology cell survival curve plotted SF vs. dose. 2 curves, one for High LET one Low LET radiations. Discuss all parameters marked. Final D_0, n extrapolation number, D_q . Discuss the two curves and their shapes. Why are they shaped this way.

Examiner 3

Q1. Right out of Karzmark… 3 pictures of electron path spread in a 90 degree bending magnet. Discuss spread in bent beam due to distributions of energy, lateral position and particle path divergence.

Digressed … draw and discuss beam profile at dmax and at depth. How do you characterize this? What is the definition of flatness and symmetry? What is recommended tolerance?

Q2. Right out of the textbook. Plot of KERMA and Dose vs depth. Discuss curves. Why does dose build up… etc. Describe TCPE and what causes it.

Q3. Compton scatter x-section plotted as a function of energy. The following variables were plotted vs. energy. σ, σ_{tr} , σ_s. This plot caught me off-guard and I did not recognize the subscripts immediately.

Q4. Two chest radiographs. Lt is blurred rt is clear. Which is better and why? What is causing the poor image quality? How might it be fixed?

Q5. Diagram of TG51 Beam quality measurement for high-energy photons with Pb foil in place. Why the Pb foil? Great detail paid to the Pb foil. Known electron spectrum vs. unknown.

Examiner 4.

Q1: Isocentric breast tangent set up with wedges … wedges nearly invisible on screen. Describe how you would plan this? What energy? What wedge angle? Without wedge where will the hot spot be? Where will it be with wedges? How hot will it be? How hot is acceptable? What if you have a thick-breasted patient and the spot is too hot or the distribution is not uniform? How high an energy should you use? What about high-energy photons say 18/25 MV?

Q2. Discuss conventional wedges, universal wedge and dynamic wedge. How do they work? What are adv and disadv of each? What is the dose to the contralteral breast from each? Is this significant?

Q3. AP double exposure Pelvis port film. AP BEV IMRT verification film. What are these images? Why would you take them? Why double exposure. How do you verify BEV film for IMRT?

Q4. What is the physical or biological meaning of point A and point B in a Tandem & Ovoid treatment? Draw tandem and ovoid on AP & LAT projections. Are ovoids above or below the OS? Draw in Point A and point B. Are there any other points of concern? What are they? Identify them on your sketch.

Q5. Axial brain with checkerboard of CT & MRI. What is this image? Why is it used?

Examiner 5.

Q1. How you acceptance test a treatment planning system for photons and electrons? How do you evaluate 3D dose distributions?

Q2. Describe an ion chamber used for photon dose measurements. What is the collective volume? What is the wall made of, what is the electrode made of? Can you use parallel plate chamber for photons?

Q3. How do you commission wedges for TP system. How do you verify?

Q5. How do you calibrate a LINAC for electron and photon dosimetry?

ABR Oral Exam Questions for Therapeutic Radiologic Physics, June 2004

Examiner 1:

- Compare and contrast linac and simulator operations, led to discussion of beam flatness and the material flattening filters are made of.

- A head and neck plan shown. Identify (and discuss) GTV, PTV, and critical structures.

- Two port films shown, one static field and the other an IMRT one (hard to identify at first), led to IMRT QA discussion.

- Linac diagram shown, identify flattening filter, what does the beam intensity look like without the filter.

- Diagram of an orthovoltage room shown. Discuss shielding requirements for the room and the factors used in shielding calculations.

Examiner 2:

- Photon beam quality specification in TG-51. How do you cross-calibrate a parallel-plate chamber against a cylindrical chamber. What beam (photon or electron) and energy would you use?

- How is the DRR generated? Led to DRR QA.

- What is image registration and fusion? What are the five imaging modalities that can be fused?

- Shielding calculation formulas for megavoltage facilities.

- Are the 12 MeV beams generated by two linacs equal? Discuss.

Examiner 3:

- Three lung plans shown. What is the difference between them? Homogeneous vs. heterogeneous, led to discussion of kernels and how the inhomogeneity correction affects them.

- You take over a clinic and discover that the linac calibration is off by 15%. What would you do? What could have contributed to this, methods, TG-21/51 factors, etc?

- What are mean dose equivalent, effective dose equivalent, weighting factors. Which organs have higher weighting factors and why.

- Would you purchase an MR-Sim? Discussion of CT/MR differences, treatment planning using MR only.

- Questions on radiation safety for brachytherapy patients, nursing instructions, visitor instructions, etc.

- Three P_{ion} curves shown (from TG-21), which one is for continuous, pulsed, and pulsed-scanned beams?

Examiner 4:

- Shown a breast plan, discuss how to improve it (changing the wedge angle, electronic compensation, etc.)

- Shown the diode diagram (from Khan's book), explain how the diode works, discussing of various factors affecting diode and TLD response

- Shown the isodose lines for an electron beam, explain contraction of isodose lines, explain the same for photon isodose lines

- Explain the advantage/disadvantage of physical, dynamic, and universal wedges, lead to discussion of EDW QA

- Explain how to measure dose in the buildup region

Examiner 5:

- Explain QA aspects of brachytherapy using Cs-137, Ir-192, and I-125, including HDR QA

- Explain when each of these applicators (or a combination of them) is used: Tandem, Ovoid, Cylinder, Dome, and Ring

- Shown the diagram of a microtron, explain its operation in detail

- What would you do if the delivered dose to a patient were off by more than 14% from prescribed dose (NRC and state regulations)?

- Shown port film and DRR, explain the difference, identify gold seeds present in the images

ABR Oral Exam 2004

The following questions were asked on my ABR oral exam, to the best of my recollection. Of the five examiners, four were generally very nice and helpful, including one who offered every candidate candies! Only one was not helpful, and he made no effort to stop me when I veered off course. To the future candidates, try to avoid spending too much time on a question you do not know the answer to. The examiner may not keep track of time, and you may not have enough time to answer the questions you are familiar with later. I generally found the exam to be quite fair, but too clinical, and not enough physics. This is especially true on imaging. I was quite prepared to answer how each image modality and equipment work, how to do image reconstruction, and questions related to image processing etc., just like the examining topics displayed on the ABR web site. But as you will see below, the questions asked were quite different than what I had expected and prepared. On the other hand, radiation biology questions were in previous exams, but not in my year. Personally, I think that radiation biology should be included as one of the examining categories.

Finally, a word about the hotel, Executive West, where the exam was held. The hotel is right by the Louisville airport. I could still hear planes taking off or landing at 2 am. Someone told me later the airport was also a hub used by the UPS. So if you are a light (or nervous) sleeper, and your exam appointment does not start at 7 am, you may want to consider staying elsewhere.

Examiner 1:

1) Shown 2 MR images. What types are they? [Since I could not get past the part identifying the T1, T2, or proton density weighted with or without contrast, I never got around to answer the remaining questions.]
2) Shown isodose distribution on a head using 3-field conformal (Ant, 2 wedged laterals). What can be done to reduce the dose to the eyes?
3) Shown a color picture of a linear accelerator. Identify all the highlighted areas that the beam travels, and how each works. [The quality of the drawing was not very good. So take your time before you blurt out an answer.]
4) TG-51 questions: 18 MV and %dd(10)x vs %dd(10)pb. What's the purpose of using the 1 mm Pb foil? Where should it be placed? What if you use 2 mm Pb foil instead, what would happen to the dose? Other related questions.
5) Shown a bunker. Where would you place an 18 MV linear accelerator? What would be the minimum dimensions of this bunker? What should the door be made of? Where should the HVAC ducts be placed?

Examiner 2:

1) Shown checkered image of a CT-MR fused image. Identify it. Why do we do fusion? How do you perform fusion? What information does CT give and MR give? Can you plan on MR images?

2) Shown a PDD curve of a 10 MV beam. What causes the buildup? Does your treatment planning system model it? How accurate is it?
3) Shown a patient room adjacent to two patient rooms, next to a corridor and a window. Can we use the room for prostate brachytherapy? What are the dose limits in the other areas?
4) Shown an annual QA report. It contains tables of PDD, output factors, wedge, tray factors etc. Is there a problem? (PDD at 10 cm of two different field sizes were off by 4.4% and 2.2%.) What are you comparing? What is your state requirement? What could cause this problem? What do you do? Why do you think the 2% tolerance is acceptable?
5) How does the pressure influence your ion chamber reading and why? If you suspect that the barometer in your clinic is not accurate, can you call the local airport to verify the reading? What are the factors that could alter the reading between your clinic and the airport? How is the airport barometer calibrated vs. yours?

Examiner 3:

1) Shown a patient room adjacent to two patient rooms, next to a corridor and a window. Some question about using it for Ir-192 brachytherapy. Discuss the ALARA concept. Why don't we just shield the room such that other rooms would only get background dose? What are the legal limits? Any exception? What about pregnant women entering a room below the limit? Can you use a room for HDR originally designed for a simulator?
2) How do you measure the leakage of an 18 MV linear accelerator? Which instruments? Where to place detectors? Should the collimators be open or closed? For neutrons too?
3) Shown two isodose distributions of a head and neck case using an anterior beam. What kind of beam? [Electron.] What is the difference? If the cord has already gotten 45 Gy, which beam would you prefer? How do you shift the isodose lines anteriorly? [Looking for 2 answers here.] What is the limit of the cord dose?
4) Shown a block diagram of a TLD reader and adjacent apparatus. Identify the components. How does TLD work? How does the TLD reader work? Draw a glow curve. What does the PMT do? What is the unit of the final output reading? How do get the output reading from the glow curve? How would you use TLD to measure the dose a patient gets?
5) Shown a diagram of portal with three different colors. What are the definitions of GTV, CTV, and PTV? Identify them on the diagram. What does the radiation oncologist draw on the CT? What about the isodose line he chooses?

Examiner 4:

1) Shown two H&D curves without labels. Identify the curves, the axes, and the typical range of values. What's the definition of optical density? What is the speed of a film? Which one is faster? What do you use them for? Which films do you use for port? For verification? Amount of MU's delivered for various types of films.
2) Shown three radiation labels - White I, Yellow II, and Yellow III. What are they used for? The limits? What is the value called if we make a survey measurement a meter away? [Transportation Index, of course!] Where would you find these labels? Take

for example I-125. What's the half-life? Energy? How is it shielded? Which label would be on the shipping package? Compare with Ir-192.

3) Shown a diagram of a Klystron. Identify the components. What does it do and how does it work? What is the power output? How much is it? What other type of competing design? What is its power output? What are the advantages and disadvantages of each?
4) Shown two orthogonal images. Identify which direction the images were taken. What are the images for? Identify the treatment apparatus. [Tandem and ovoid.] Can you tell just from the film whether this is HDR or LDR? What is the metal plate by the tandem for? Why does the first dwell position in the tandem not loaded? What are point A and B? Identify various structures. What is the balloon with the point marked "b"?
5) [I can't remember if this is a question by itself or a follow up question.] How would you calibrate an HDR Ir-192 source? What instruments, why? What is the unit of reading? What is the typical activity of a new HDR source? What happens if you receive one with an activity larger than stated, say 10 Ci? What is the half life of Ir-192? How does the source arrive? What about Ir-192 for LDR?

Examiner 5:

1) Shown 2 images of 3-D conformal isodose distribution of a prostate plan. Identify which energy for which plan used. What other types of prostate treatment available? How would you treat a high risk prostate patient say GI 8, PSA 20?
2) Identify various structures of the brain/head and neck on a CT and an MR image. Structures like nasopharynx, maxillary sinus, turbinates, external auditory meatus, and retropharyngeal space!?? [I would hate to fail imaging because of this question!]
3) Shown isodose distribution on a stereotactic radiosurgery brain plan on axial, coronal, and sagittal slices. How was it planned, using which delivery method? Other types of treatment delivery? How does MLC delivery differ than cone, and which one is better? What are the critical structures you want to spare?
4) You made a purchase of a "Solid Water" phantom. How would you QA it for use? How do you extract the electron densities? What about using it for electrons?
5) Shown a picture of a room with a patient getting LDR Ir-192 treatment, and adjacent rooms and corridors, etc. There are numbers in various locations in the room and adjacent rooms, representing the survey meter reading in mR/hr. What is the legal limit? What to do with the rooms above the legal limit. What is your advice to the patient, the nurses, and the visitors? Should the visitor be wearing a detector? What kind?

ABR 2005 Orals Questions

1. Anatomy questions: where is the temporal lobe, optical nerve, chiasm, lens, carotid artery…?
2. An H/N IMRT plan, asking what is GTV, CTV. What are the critical organs, prescription dose etc?
3. Two lung plans: one with and the other without inhomogeneous corrections, ask which is which. What the common way of doing inhom corrections? What you did in your institution? What is the advantage (adv.) and disadvantage of each method?
4. A TG21/51 questions: what is P_{repl}, what's that correction about, how that was used in TG21 and TG51?
5. Discuss the adv. and disadv. of the shielding materials: Pb, Steel, Polystyrene, Earth
6. A Pilot scan: what is it, how it is acquired, is it a real image, why usually pilot longer than the treated range?
7. What use factor, occupancy factor (OF)?.. Any difference for OF in restricted/unrestricted areas?
8. A nurse with 10mg Cs137 source in her pocket for 8 hrs, assuming the pocket is 0.5cm from skin. Estimate the risk to the fetus if she is pregnant?
9. CT/PET fusion, why fusion? Any other ways of fusion? Any other sites of fusion besides brain?
10. Dmax vs. energy for photons, PDD vs. SSD for photons …
11. Another anatomy question: where is prostate, bladder, rectum, urethra, pubic symphasis.
12. A magnetron question works, what KV it uses, the frequency of the RF? Which machines usually use it?
13. Another magnetron question: if a magnetron is replaced by a new one, will the beam flatness/symmetry more affected or the depth dose etc.?
14. The monitoring chambers in Linac, how they monitor the beam output, flatness, symmetry. How these quantities were defined? Where is the flattening filter?
15. Cs LDR: assuming a nurse's office next door, another regular patient's room next door, how to shield? Nurse's instructions, visitor's instructions?
16. An Ir ribbon LDR question, similar to question 15.
17. QA for Cs, I, Ir HDR.
18. Electron treatment with 1cm bolus to depth of mucosa, what energy should use? How to shielding for tissues behind mucosa. Any other concerns?
19. Discuss ALARA, low dose radiation damage models.
20. A survey meter, how to calibrate? Where it will be used? …
21. A parallel plane chamber, where is the effective point of measurement? Why need guard?
22. A hip metal replacement CT image, discuss the imhomgeneity correction.

2005 ABR Oral questions on Therapeutic Radiological Physics

Examiner 1:

1, Text question: how do you set up a QA program for HDR remote afterloader? What tests do you need to do? And why are these tests important?

2, Picture showing sketch of Varian linac, with arrows pointing to SW, energy switch, and electron gun. What are these? What different configurations are available for each of these components?

3, Two lung films, one sim film, one port film. Recognize and explain why different? Asking for the basic interactions photoelectric vs. Compton dominance at different energies.

4, Text question: if the delivered dose is 14% higher than prescribed dose, what should you do?

5, 3 images, two TRUS with seed positions and isodose lines, one post-implant CT with seeds. Ask to recognize and explain what is the difference between the two TRUS images? (Peripheral loading vs. uniform loading)

Examiner 2:
1, Picture of X-ray tube, with lots of arrows point at different components inside, asking what are these components? This one knock me off. I am not familiar with X-ray tube. And he asked me can you tell it is a diagnostic tube or an orthovoltage therapy tube? I don't know.

2, port film vs. BEV IMRT verification film of prostate. Ask to recognize. How can you tell it is BEV IMRT film? Is it reasonable?

3, Head and neck IMRT plan. Ask to recognize GTV, PTV, and OARs.

4, How to estimate the workload in shielding design? How IMRT affect the workload estimate?

5, picture of dose vs. kerma. Explain the relationship, why dose greater than kerma below dmax? What happens when the curve reach the exit point? (build down)

Examiner 3:

1, Picture of DVH, show the DVH curve of lesion, lung, and heart. Ask how do you construct a DVH, what dose DVH mean? What is D90 of the target, of the lung, etc. How do you use DVH in the treatment planning? Is it useful?

2, 2 CT images with different window and level? Ask is it the same image? What is the difference? Why you want to use different window and level? How many gray scales on these images?

3, text question: what is skyshine? When do you need to consider it? How do you estimate the skyshine effect?

4, TG-51 and Pd filter. %DD10, and %DD10pb. Why use Pb filter?

5, text question: how do you do QA for independent Jaw? How do you measure output factor for an asymmetry field?

Examiner 4:

1, How do you do radiation protection for Cs-137 patient? What is your instructions to nurses? To visitors? How often do you calibrate Cs-137, how often check leak test, how often do inventory check?

2, plate ion-chamber in the linac head? What is it used for? Is it sealed? How do you know it is functioning properly?

3, Checker image. Why do image fusion? PET image? What is the material used? How is it imaged? Does the detector rotate?

4, Picture show an irregular field, two points shown in the field? How do you do hand calc of the dose to these two points? Which one get higher dose?

5, TG-51. %DD. Pion. How to calculate Pion, and what is the typical value?

Examiner 5:

1, Describe ALARA principle. How do you use this principle in the facility design?

2, Picture show 3 diode. Ask what is it? How is it used in clinic? What are the characteristics of this device?

3, IMRT head plan. Ask to recognize the structures, eye, optic nv, chiasm, brainstem, etc. What are the dose constraints to these structures?

4, How do you do an acceptance test of a new linac? What are the first 5 steps?

5, Picture show Electron PDD. Ask to identify what energy electron it is? Is there any problem with this curve? How will the PDD changes with oblique incidence?

June 12, 2006

Examiner #1

1) Displayed on the computer was a picture of a photon beam divergence profile with half of its field blocked.
   a) In which cases would you use such a beam arrangement?
   b) Draw / describe the isodose distribution for this arrangement
   c) Explain the scattering effects that occur.

2) Displayed two PDI vs Depth plots for a photon and an electron beam respectively. (Taken from TG-51)
   a) Describe what's being shown?
   b) Which one is which?
   c) Explain the rationale for shifting the profiles and indicate the shifting require in each case.
   d) Explain the rationale for using a cylindrical ion chamber for these measurements and in addition to a shift correction whether other corrections are required.
   e) Explain the rationale for d_{ref} and its relationship to the PDI profile.

3) Explain the production of a photon beam
   a) Physics behind it and the role of scattering.
   b) Purpose for using a flattening filter.
   c) What's meant by flatness and symmetry and at which depths are these measurements performed?
   d) Draw the beam profile that you would expect to see at dmax, 10 cm depth and 20 cm depth.
   e) How would the beam look like without going through a flattening filter (draw it and explain it)?

4) Describe the field size needed for primary shielding calculations.

5) Displayed on the computer two images, one from a BEV and next to it a port film image
   a) Explain the concept of a DRR. How are they generated, factors that influence DRR image quality.
   b) Why are DRRs needed and how are they used?
   c) What factors contribute to the port film image quality?

Examiner #2

1) Displayed on the computer were two side-by-side CT images of the chest depicting the lungs and the heart with two different isodose distributions
   a) Provide an explanation for the difference in isodose distribution
   b) How would you account for inhomogeneities in an independent dose calculation?
   c) How would you experimentally test the dose calculation provided by your treatment software that involves inhomogeneities?

2) Displayed on the computer were a total of nine images, three images per row of an axial, coronal and sagittal head and neck. This was a question regarding image fusion.
   a) Provide the modality used to generate each image set
   b) Rational for image fusion, why is it used primarily for CNS cases?
   c) How do you carry out an image fusion? Are you familiar with any image fusion algorithms?

3) a) What's involved in the QA of a Cs-137, Ir-192 and I-125 brachytherapy sources?
   b) What kind of monitoring device would you bring if an I-125 prostate seed implant is being performed? Why?
   c) Similar question as (b) but for Cs-137 and Ir-192 sources

4) Displayed on the computer was a photograph of a LINAC head with a front pointer along with a second pointer mounted on the treatment table.
   a) What's this setup for?
   b) What's the definition of the mechanical isocenter?
   c) What's the displacement tolerance for the isocenter?
   d) Assuming that the front pointer and its base are misaligned, how would you find the mechanical isocenter?

Examiner # 3

1) In the context of radiation treatment planning, what's image segmentation?

2) Define dose equivalent, mean equivalent dose and provide weighting factors for gonads, bone marrow, breast and skin.

3) How do you check the LINAC dose? (hint: linearity)

4) Displayed on the computer was a schematic of a diode with arrows pointing at different components of it?
   a) Describe the diagram (hint: basic solid-state detector theory)
   b) What type of detector is described in the diagram and what is it used for?

Examiner # 4

1) How do you change the dose rate in a LINAC?

2) In a standing-wave accelerating waveguide, which cavities contribute to the electron acceleration?

3) a) In a radiation oncology clinic, who are the personnel required to wear radiation badges?
   b) What kind of information can you get from a radiation badge?
   c) What's the annual equivalent dose for the public and for radiation workers?
   d) If you change employers, can the RSO in your new place of employment request radiation exposure information from your previous employer?

4) Displayed is a picture of a LINAC.
   a) Provide a description of the components shown.
   b) What's phase velocity?

Examiner # 5

1) Displayed is a picture of a LINAC.
   a) Provide a description of the components shown.
   b) Is this a dual photon energy machine?
   c) What kind of a bending magnet does this LINAC use and how does this bending magnet work?

2) Shown a picture of an orthovoltage unit inside a treatment room
   a) What kind of shielding is needed for this machine? Explain in detail

3) Displayed is a photon beam traversing a flattening filter
   a) What is the flattening filter made of?
   b) Purpose
   c) Draw the beam profiles at dmax, 10 cm and 20 cm
   d) Draw the beam profiles if the flattening filter is misaligned with respect of the photon beam trajectory.
   e) According to TG-40, what is the recommended flatness and symmetry and reference depth for measurement?

4) Displayed is a CT image of a male pelvis and next to it a sagittal schematic drawing of the same region. The bladder is highlighted by contrast and the rectum is quite visible in the CT image.
   a) Correlate the organs displayed in the CT image to its corresponding location in the schematic.
   b) Identify the bladder, rectum, ilium, acetabulum, femoral heads, pubic symphysis
   c) Identify the prostate and seminal vesicles.

(Warning: Be aware of tricks, for instance the image shown may be of a patient who had a prostatectomy)

2006 ABR Radiological Physics Examination.

Finally I have the pleasure to contribute to this generous and valuable effort, one that I have made a great use of and I strongly recommend to keep doing for ever! I am very thankful to those individuals that sat there and wrote what has become this valuable resource. Here is my compilation of what I remember from the test, and some advice.

a) Start following and answering this question compilation from 2006 down to 2000 or 1999. Start today, after you read this one! Do it! The exam requires a lot of reading, but not, and believe me, not memorizing. Reading will give you a good armamentarium to answer back the follow up questions.
b) The examiners will lead you to reasoning rather than asking you for memorization. In general they are all great people with the best intentions. Very courteous, very friendly, some more helpful than others, but all very fair and knowledgeable. If one fails, it is because of one´s poor preparation for the exam. There is no bias on the mind of those examiners, you bias yourself if you are not well prepared.
c) Read, read and read until you can get a language, a proficiency level with which you can call yourself a professional in this field.
d) Use Khan´s book, he always will put you on the right direction regarding references and ways to get deeper in the subject. Read Khan from cover to cover and, again, to get deeper in an issue. Follow his references.
e) Metcalfe and Hendee books are also very important for modern approaches to Convolution/Superposition, Montecarlo, TLD´s.
f) Get to your local library and get Karzmark, Nunan and Tanabe book, and Greene book. These two are a must for answering linac related questions.
g) Get the Van Dyk books (Volume I and Volume II) they are also a great compilation of the new technologies used in radiation oncology, I found there many answers to questions that appear in the “Rosemark files”.
h) Get familiar with HDR units, applicators for HDR units, Varian and other vendors training diagrams, use your local linac serviceman for gathering manuals and diagrams. Get familiar with SRS treatment and equipment. Which machine uses which type of waveguide, MLC, wedges, etc.
i) Questions: the main question was always general or very specific, but in the majority of the cases I got follow up questions, let them ask you for follow up questions. Don´t give all at the beginning of the question. Off course, I have heard this before, but you get “trained” and learn how to answer as you go from examiner to examiner. At the end you become a professional board candidate: you understand the rules of the game, you withhold something, you bring them to your field of knowledge. Don’t hesitate to be honest and say: I have to be frank with you, I haven´t use this or that particular equipment, procedure, technique at all, etc., all I know I know it from reading. They are not going to disqualify you due to the fact that you haven´t been exposed to the subject. But you must show that given the opportunity, you would´ve performed as a qualified medical physicist.
j) Have a pleasant environment and stay AWAY from the Executive West Inn. It has been seriously improved, but the atmosphere there doesn´t contribute to

concentration. There are plenty of hotels nearby, just crossing the street, but those ones are also FULL with candidates: radiologists, radiation oncologists and physicists. I stood at the Hampton Inn, 200 meters away from the Executive West. The atmosphere was like the one at the Executive West. Advice: rent a car and go to another place at least three to four miles away.

k) The Executive West (in which the exam is held) is located three miles away from the Airport, near Kenctucky Six Flags amusement park (no noise because of this). If you leave in the Western part of the country, arrive a three to four days before your exam. It helps to catch up with those three hours ahead of the Easteners.

l) Medphysboardpreparation yahoo group is another powerful tool. Don´t hesitate to become a member. There are a lot of good people out there helping and putting questions and answers: example Mr. Govinda Rajan, Mr. Thomas Warner, etc.

Questions:

1.- Given a room with a patient with Ir-192 interstitial implant and several dose rates: side of the bed 60 mR/hr at 40 cm, then half a meter farther away 2 mR/ht, 20 mR/hr at the feet of the bed, 7 mR/hr in an adjacent room, 2 mR/hr in nurses station, 0.2 mR/hr at the corridor. What is OK and what is wrong, what information is missing, how would you handle the situation in which a patient will stay in the adjacent room.

2.- Given an axial CT cut at the level of the mandible identify GTV, CTV, PTV (define as per the ICRU definition all of them. Which one are Organ at Risk, and why: submandibular salivary glands and cord. Tolerance levels of the organs. Is it an IMRT plan (yes, it was), how it is done, and describe a how it is done doing conventional RT.

3.- Given a CT slice at the prostate level, pelvis was treated up to 4500 cGy, how is generally treated and up to what dose the boost (six fields VS seven fields and why?). IMRT? 3D conformal? Pros and cons of each.

4.- Given a CT and MRI images side by side, identify which is which and what type of information can you get from those. Why the MRI one discriminate the soft tissues better than the CT one? Why is so bright the tumor (it was a T1 with Gd contrast)? How does th Gd acts to generate the contrast.

5.- Klystron diagram: explain the parts, principle of rf power amplification, compare it to a magnetron, which accelerators have one or the other type.

6.- Given a linac dissection, explain the parts that were selected: target, secondary collimators, accelerating structure, is it SW or TW, it was SW because you could see the side coupling cavities, resonant cavity frequency, principles to switch energy. Identify the energy switch, flattening filter, carrousel with flattening filter for lower energy and scattering foils for electrons, where the MLC would be positioned in a Varian linac, where in a Siemens and where in an Elekta.

7.- Given a block diagram of a TLD reader, explain the parts, the principle of operation of the photomultiplier tube, what are you measuring, what TL means, what is the end result after the readout, how do you calibrate TLD´s, how do you test their linearity.

8.- Given a picture with oblique incidence of electrons (30 degress and 15 MeV) why do the isodoses are almost parallel to the surface? How can you determine the energy if it wasn´t written there from the scale of the graph? Remember this three basic relationships that holds, and very well indeed, in Varian linacs and I learned from Khan´s book: dmax is approximately located at 0.46 times Energy at the power of 0.67, also that d90% is approx. E/3.2 and d80% is approx. at E/2.8.

9.- Explain the break down of the assumption that the primary and scatter components can be treated separately. Under what assumptions does it holds? When does it break down (interfaces, heterogeneities, build up region). (Be careful with this question it was the hardest for me in this test)

10.- The classic question: barometer broken and you have to call a local airport for pressure. What kind of pressure you would often get as an answer from the airport? Do you care? What and how do you correct that pressure? I tried to make a joke and told them I would go to Radio Shack and get a digital barometer, they answer back laughin: Radio Shack was closed at that time…. So don´t forget that the Airports gives you Sea Level Corrected Barometric Pressure. An the pressure drops approx. one inch of mercury per every 1000 feet of altitude. This means they add to they barometer local pressure a correction for the altitude above sea level at which that barometer is located.

11.- Why do you have to correct the readings of a an unsealed ion chamber by the local pressure? Can one use a sealed chamber with TG51 or TG21. The vendors don´t manufacture sealed chambers for absolute and relative beam dosimetry. Why? And why it is preferred that the linac monitor chamber is sealed?

12.- A picture of a Fletcher type applicator. Identify it. Is it an HDR applicator? How did you recognize it? How do you do acceptance test and commissioning of the applicator? How often do you do QA? Points A, points B, doses prescribe to them. Other relevant points (Bladder and rectum points). Why are you concerned with the dose to the points B?

13.- One MRI and one CT side by side. Identify optic chiasm, lenses, optical nerves, ethmoid sinuses, nasal septum, etc.

14.- Three cuts of brain section: one axial CT slice, one Coronal multiplanar reconstruction and one Saggital multiplanar reconstruction. There was a pretty circular isodose distribution on the axial one, no low dose isodose level on that one. On the coronal one there was a bow tie like distribution, more symmetrical in that cut than on the saggital. On the saggital it was more oblique. What was the angle of the treatment? Definitely it was not parallel to the axial cut. It was sort of a coronal arc and a smaller posterior inferior arc.

15.- 6 MV linac vault and it will be upgraded with an 18 MV machine. Concerns, how to shield, primary, secondary barriers, materials, you can not put more concrete. Then what material if no more concrete can be added?

16.- QA for a LDR brachy sources. How do you do a leak test (explain in detail. From the alcohol swab swiping to the NaI well chamber, its calibration, etc, expected removable activity, etc.) Do you live in an agreement state? What are your local regulations. How do you keep control of the LDR sources, posting on the door, postings inside the room (here he was looking for signs related to the telephone number of RSO and physicists, book keeping practices, proper color legend of sources, etc.) What kind of label comes on your container when you receive an HDR Ir-192 source? What kind of label when you ship it back? (Know the Transport Indexes!)

17.- The TG51 equation for high energy photon calibration was displayed: explain each term, explain how to obtain kQ (the factors inside kQ), explain how do you obtain the beam quality, what about high energy. What about the recommended chambers for this energy. Why Depth Ionization curve can be considered like the Depth Dose curve in photons. Can we say the same for electrons? Why not.

18.- The classic one in which a PDD for MV photons is shown: Identify the parts, where does TCPE ocurrs? Why is it there? KERMA? Is it collision KERMA the one you are explaining or total KERMA? Then where the total KERMA will be? Why KERMA has that shape? What approximately is the mean range of secondary electrons for that 6MV, 18 MV? Define KERMA collisional KERMA, is there a radiative process? Is it important in water at 6MV?

19.- Considerations for shielding the device on the picture. It was an HDR unit. Nominal activity of the source, average energy, HVL in lead, HVL in concrete, approx. how thick concrete, door, half life of the source.

20.- Discuss the graph of detriment VS dose equivalent and Cost of the protection VS dose equivalent that appear on Hendee´s imaging book. Identify the curves, the parts of the graph, tell them that this is a way to optimize a protection, the way to follow under sound scientific bases the ALARA principle, etc. Hendee´s discussion on the issue in his book is very good.

Un fortunately I can recall anymore from the test (I should have written 25 questions here), but my memory is not helping me now.

I prefer to remain anonymous, but I whish you all the best.

Sincerely,

A person that really is thankful to this great compilation.
June 15, 2006