Standard Setting/Cut Score Study Report

Test Development Solutions

MDCB – Certified Medical Dosimetrist (CMD)

Standard Setting/Cut Score Study Procedures and Results

Date:
April 23-24, 2019
Chicago, IL

www.prometric.com

Prometric
1501 South Clinton Street
Baltimore, MD 21224

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INTRODUCTION

This report documents the procedures employed to select the standard setting (cut score) study panel, the methods used in conducting the study, and the analyses performed for the standard setting study conducted April 23-24th, 2019 in Chicago, Illinois for the Certified Medical Dosimetrist (CMD) Examination. The reference form for the standard setting was the April 2019 CMD Form.

STANDARD SETTING METHODOLOGY

There are several recognized processes for standard setting. For the Certified Medical Dosimetrist (CMD) standard setting study, Prometric recommended and adopted the Angoff method, supplemented by the Beuk Relative-Absolute Compromise method. The Angoff method requires a minimum of eight subject matter experts (SMEs) to reach consensus on a definition of the minimally-competent candidate. SMEs then read and answer each item in the test and predict the proportion of minimally competent candidates who would answer each item correctly. Resulting ratings are analyzed and discussed with the participating SMEs. The SMEs are given an opportunity to affirm or revise their original ratings. Summing the ratings across items and across SMEs provides a recommended cut score. SMEs are then asked to make specific predictions about the test as a whole. This is the Beuk Relative-Absolute Compromise standard setting method. Prometric facilitated a two-day in-person meeting on April 23-24th, 2019. The results of this process are provided to Medical Dosimetrist Certification Board (MDCB) within this report, with the final cut score to be determined by MDCB.

SELECTION OF THE PANEL OF JUDGES

CHARACTERISTICS

The Medical Dosimetrist Certification Board (MDCB) recruited a panel of judges from lists of certified CMD professionals from their membership listing. A panel of eleven judges completed the standard setting study. Copies of the agenda for the study can be found in Appendix A.

MDCB selected a group of certified medical dosimetry practitioners from a pool of individuals who hold the Certified Medical Dosimetrist CMD credential.

REPRESENTATIVENESS

The panel of judges was composed of five females and six males. Eight judges reported themselves as White, one reported as other, one reported as Asian, and one reported as Hispanic. Eight of the judges reported being medical dosimetrists and all judges hold the CMD credential. The panel reported an average of 11.77 years of experience (SD = 8.76) in the field of dosimetry. More information on the composition of the panel can be found in Table 1. An example of a panel member biographical data form can be found as Appendix B.

Table 1
Selected Characteristics of Panel Members

Panel Member No.	Current Position	Yrs in Field	Highest Degree	Field	Certification/ License	Gender	Age	Race/ Ethnicity	Region of Practice
1	Director of QI	18	BHS	Health Science	CMD, ARRT	F	31-40	Other	FL
2	Medical Dosimetrist	5	BS	Health Science	CMD	F	31-40	Caucasian/White	OH
3	Medical Physicist	24	MS	Medical Physics	CMD, RT(T), DABR	M	41-50	Caucasian/White	MI
4	Medical Dosimetrist	30	BA	Health Science	CMD, RT(T)	M	51-60	Caucasian/White	IL
5	Medical Dosimetrist	10	AAS	Radiologic Technology	RT(T), RT(R), CMD	F	41-50	Caucasian/White	MD
6	Medical Dosimetrist	3.5	BS	Health Science	CMD	F	21-30	Caucasian/White	NY
7	Medical Dosimetrist	17	BS	Radiologic Technology	CMD, RT(T)	F	31-40	Caucasian/White	GA
8	Medical Dosimetrist	5	MS	Health Science	ARRT, CMD	M	41-50	Asian/Pacific American	CA
9	Medical Dosimetrist	8	MS	Medical Dosimetry	CMD ARRT(R), ARRT(T)	M	31-40	Caucasian/White	NC
10	Radiation Oncology Planning	2	BS	Medical Dosimetry	CMD	M	21-30	Hispanic/Latino	TX
11	Medical Dosimetrist	7	BS	Medical Dosimetry	CMD	M	31-40	Caucasian/White	FL

Gender: M = Male
F = Female

CONDUCT OF THE MEETING

Prior to the meeting, MDCB provided panel members with a document describing the purpose and procedures of the cut score study and an agenda for the meeting.

On the morning of the first day, Prometric facilitated a general orientation session with the panel members, which included discussion about the need for a standard setting exercise, and the steps the panel would be taking in conducting the study. Questions and comments on the procedure were entertained with emphasis on the importance of group discussion and participation.

DEVELOPMENT OF THE STANDARD OF MINIMUM COMPETENCE

Following the description of the procedure, the panel developed a standard of minimal competence identifying what a minimally competent CMD would know and what they would find challenging. The test specifications were presented to the panel as a starting point for the discussion and articulation of the attributes of minimal competence. This panel systematically went through the test specifications and identified concepts/content that the minimally competent CMD would know and would find challenging. These discussions resulted in a final standard of minimal knowledge, skills and abilities composed of specific statements about what the candidate needed to know to be considered minimally competent for certification. This statement appears as Appendix C

PRACTICE RATINGS

After the panel agreed on the standard of minimal competence for the certified Medical Dosimetrist, the panel then began the practice ratings of a sample of four multiple-choice test items following a modified Angoff procedure. During the ratings, Prometric repeatedly reminded the panel members that the purpose of rating the test questions was to judge how many of those 100 minimally competent Medical Dosimetrist professionals in the next room would answer each question correctly. They were not to judge average (above minimally competent) Medical Dosimetrist professionals nor were they to judge the amount of knowledge experts would possess. These points were repeatedly emphasized in the general discussion session as well as in panel rating sessions to avoid rating errors.

A sample test of four questions (selected from the actual examination) was rated first. No key was provided and the panel members were asked to answer each item and rate “How many of those 100 minimally competent Medical Dosimetrists in the next room would get this item correct?” Following the rating of all sample questions, each participant’s rating was aggregated and entered into a spreadsheet feedback form and discussed. The answer key for each sample item was given to the panel during the discussion of the practice ratings. The panel members were also shown the percentage correct statistics of the sample items and were instructed how to consider the percentage correct statistics in judging their own ratings and the performance of the candidates who were administered the examination. Panel members were directed to give a second rating following the discussion if they were inclined to change the first rating based upon their discussion of what the minimally competent candidate would know.

RATING OF THE ITEMS

The remainder of the first day the panel members were asked to take and rate (or judge) the remaining items on the 135-item multiple-choice test. The panel was instructed to read each question, answer the question the best they could on a separate answer sheet, and rate each item as to "How many of those 100 minimally competent candidates in the next room would get this item correct?" No key was provided and there was no discussion among committee members. An example of the form used to make these ratings is included as Appendix D.

In addition, the panel members were requested to answer a question that could be employed as a reasonableness check (Beuk, 1984; Breyer, 1993). Panel member estimates were provided on separate sheets of paper and collected. The purpose of this question is to provide a means to evaluate whether the cut score produced from the Angoff procedure is a reasonable cut score consistent with the panel expectations of examinee ability. The Beuk question was as follows: What percentage of exam takers do you expect to pass this examination?

After completing these tasks each panel member's ratings were entered into a spreadsheet and their individual recommendations for the cut score were computed. The group's average cut score recommendation was also computed as was the standard error of judgment and Beuk adjustments (see below) associated with the panel recommended cut. Each panel member's test answer sheet was scored according to the key developed by the MDCB.

Once these processes were completed each panel member received his or her scored answer sheet with the total obtained score and individual cut score recommendation, the rating sheets, and the test booklets. As a 'reality check' following the first rating the judges were asked to look at their recommended cut scores, and their obtained scores on the test, to see if they would have failed themselves on the examination following their first rating. A spreadsheet showing each panel member's obtained score on the examination and their first individual recommended cut score was presented on the overhead screen. (Only the obtained score and cut score were shown; all identifying features of the panel members were removed and the sequence altered to protect the anonymity of the panel members). The mean obtained scores of the panel members and the current panel recommended cut score were also presented on the overhead screen. The members were encouraged to compare their first individual recommended cut scores to their obtained scores and to the obtained and recommended scores of their fellow panel members. Any members who would have failed themselves were encouraged to give special consideration to the discrepancy between their obtained scores and recommended cut scores.

The panel was also presented with the panel recommended cut score, the three standard error of judgment (SEJ) adjustments above and below the panel recommended cut score and the result of the Beuk adjustment after the first rating. The Beuk procedure provides a compromise adjustment between two ratings (a criterion-referenced rating of items and a normative rating of people). Whatever rating the judges agree on more will be adjusted less (Breyer, 1993). If the judges are more in agreement as to what they think the passing score should be (i.e. their Angoff ratings), the adjustment is made in the direction of the passing score judgments. If the judges show more agreement with regard to what the pass rate expectation should be, the adjustment is made in the direction of the pass rate expectation. These results from the first rating are provided as Table 2.

Table 2
Results of First Angoff Rating and Beuk Adjustment

Cut or Adjustment	Raw Score	Percentage of Test Points	Pass Rate of Candidates*
Cut + 3 SEJ Adjustment	91	67%	71%
Cut + 2 SEJ Adjustment	87	64%	77%
Cut + 1 SEJ Adjustment	84	62%	79%
Panel Recommended Cut	80	59%	86%
Cut – 1 SEJ Adjustment	76	56%	90%
Cut – 2 SEJ Adjustment	72	53%	94%
Cut – 3 SEJ Adjustment	68	50%	96%
Beuk Adjustment (Compromise)	91	67%	71%

*Pass Rates are based on a sample 174 candidates

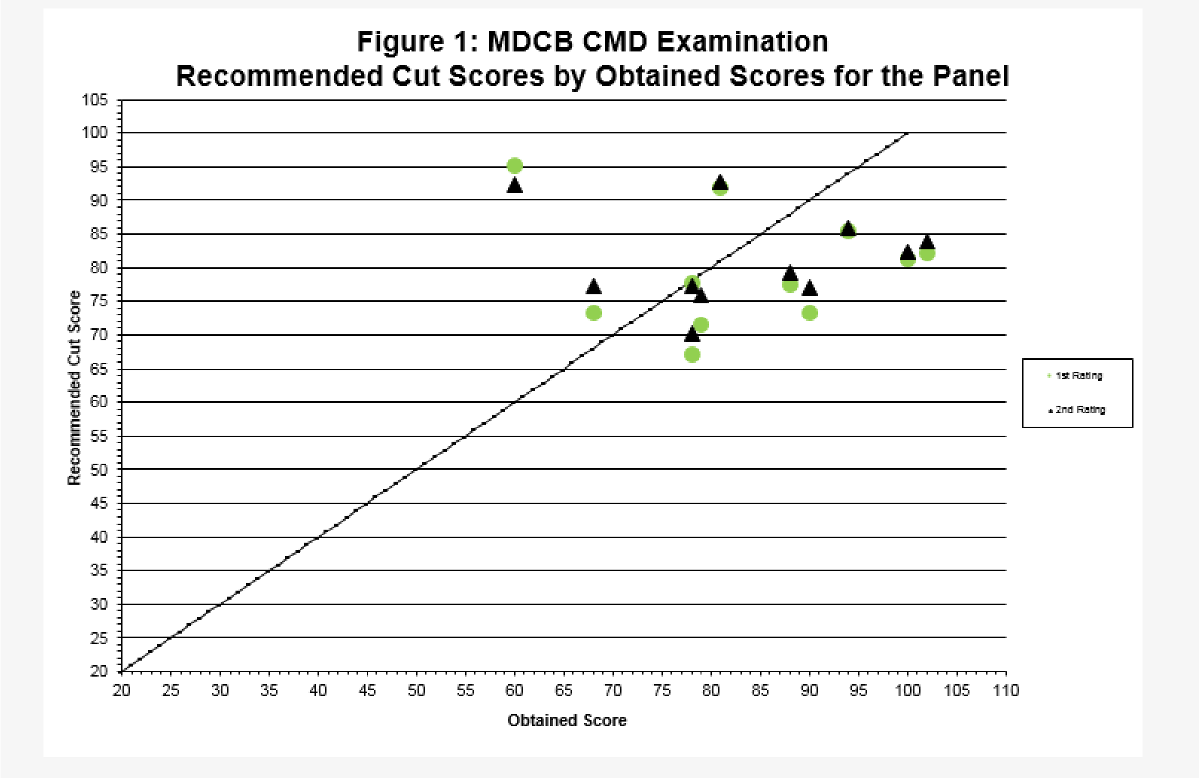
The feedback report containing the panel ratings on each of the 135 items, stored on the computer, was viewed on an overhead projection screen for panel discussion of first ratings. For each item the feedback report contained the key and the frequency of ratings from the panel in categorical intervals of 20 percentage points. In addition, for approximately every 5th item the percentage correct statistic was provided.

The ratings for each item were examined in sequence and the panel was encouraged to discuss their differences in ratings, particularly when there was large variation in the panel judgments. During this discussion panel members were asked to reexamine their original ratings in light of the discussion and data. They were instructed to take into consideration (1) the anonymous judgments of the entire group; (2) the standard of minimal competence; (3) whether they answered the item correctly; (4) the comments of the group, and (5) the percentage correct statistic when provided. Then the panel was given an opportunity to change their rating, if desired, to better reflect the group definition of what the minimally competent candidate would know.

DATA ANALYSIS

ANALYSIS OF TEST SCORES AND RECOMMENDED CUT SCORES

A scatter plot showing the obtained test scores of the panel members (the X-axis) and the panel member's individual recommended cut scores for the first and second Angoff ratings (the Y-axis) is included as Figure 1 (note: this figure uses values of 10 for the origin of the X and Y axis). Almost all of the eleven panel members recommended a cut score lower than their obtained score after their first judgments (these are the points falling above and to the left of the diagonal line in Figure 1). Following the discussion and second rating of items, all had recommended cut scores lower than their obtained scores.



RESULTS OF DATA ANALYSIS

The ratings were entered into a spreadsheet that computed the panel recommended cut scores, reliability of the judges (consistency of the ratings for each judge with the other judges), and the standard errors of the judgments (Shrout & Fleiss, 1979). To enable you to interpret the information which follows, consider the following high-level descriptions of the analyses carried out:

Reliability of Judges (R_{jj})

While there are several different types of reliability, in general, in statistics, reliability refers to the consistency of a measure. A measure is said to have a high reliability if it produces consistent results under consistent conditions. As the name suggests, the reliability of judgment (R_{jj}) offers an index of the reliability of judges' ratings. The R_{jj} assumes that error variance is represented by the deviation of judges' individual ratings from the mean of the panel for each item; true score variance is represented by the variance of the panels' means among the items on the test. The more homogeneous the panel was in its ratings for each item, the higher the reliability of the judges.

Standard Deviation of Judgment (SDj)

The Standard Deviation of Judgment (SD_j) is a measure of the dispersion in judges' ratings. This measure reflects the average amount of differences in the ratings of the panel members. A greater standard deviation of judgment reflects a greater difference in the panel's ratings.

Standard Error of Judgment (SEj)

The standard error of judgment (SE_j) reflects the average amount of judgment errors among the panel members. In statistics, 'error' does not refer to a mistake or deviation from correctness. Rather error in this context reflects a deviation from the (unobservable) 'true' value. The true value is always an unknown because no measure can be constructed that provides a perfect reflection of the true score. The larger the error the less precision there is in a measure.

The first ratings were checked for accuracy of entry and were then copied to a second spreadsheet file. The judges' modifications to the Angoff ratings (second ratings) were then entered into the second spreadsheet and checked for accuracy.

The Angoff ratings from the first and second judgments were analyzed. The reliability of judgments (intraclass correlations of means) for the cut score study results are presented in Table 3 along with their respective standard error of judgments (SEJ) (Shrout & Fleiss, 1979). The reliability of judgments assumes that error variance is represented by the deviation of judges' individual ratings from the mean of the panel for each item; true score variance is represented by the variance of the panel's means among the items on the test. Thus, the more homogeneous the panel was in its ratings for each item, the higher the reliability of the judges.

Examination of Table 3 reveals that there were improvements in agreement between judges from the first rating to the second rating, as evident by the increase in the reliability and the decrease in the standard error of judgment.

Table 3
Consistency of Ratings

Items 1-135	First Rating	Second Rating
Reliability (Mean Intraclass Correlation)	0.80	0.86
Standard Deviation of Judge's Cuts	8.65	7.01
Standard Error of Judgment	3.85	2.65

The final panel recommended cut score and six adjustments (3 SEJ up and down from the recommended cut score) are provided as Table 4.

Table 4
Final Cut Score Decision Table

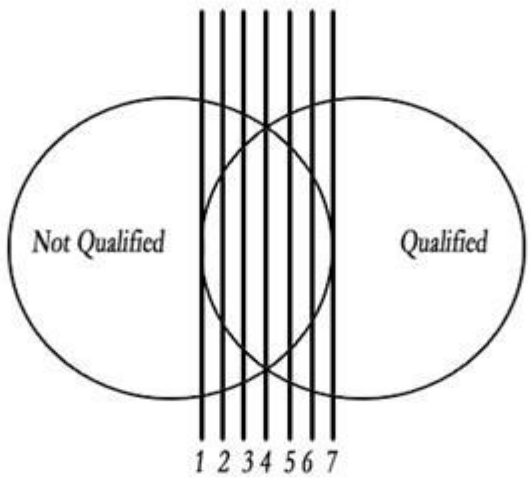
Cut or Adjustment	Raw Score	Percentage of Test Points	Pass Rate of Candidates*
Cut + 3 SEJ Adjustment	90	67%	73%
Cut + 2 SEJ Adjustment	87	64%	77%
Cut + 1 SEJ Adjustment	85	63%	79%
Panel Recommended Cut	82	61%	83%
Cut – 1 SEJ Adjustment	79	59%	86%
Cut – 2 SEJ Adjustment	77	57%	89%
Cut – 3 SEJ Adjustment	74	55%	92%
Beuk Adjustment (Compromise)	91	67%	71%

*Pass Rates are based on a sample 174 candidates

DETERMINING THE FINAL CUT SCORE

When setting a passing score, it is important to understand the issues associated with each of the potential passing scores. The figure below shows two groups of individuals; those who are truly “qualified” (who truly have the necessary knowledge, skills and abilities) and those who are truly “not qualified” (who truly do not have the necessary knowledge, skills and abilities).

Those candidates who truly **do not** have the necessary knowledge, skills and abilities



Those candidates who truly **have** the necessary knowledge, skills and abilities

Pass individuals who may be less than minimally qualified

Fail candidates who may be minimally qualified

Note that the two groups overlap in the diagram above. Because of the nature of testing, it is extremely difficult to separate the two groups perfectly. A normally “qualified” individual may have a bad day and fall into the marginal area. A normally “not qualified” individual may have made an extra effort and fall into the marginal area.

If the passing score is set at position 1, all of the true “qualified” individuals pass, but many “not qualified” individuals (people who should have failed) also pass. If the passing score is set at position 7, all of the true “not qualified” have failed, but many of the “qualified” (people who should have passed) have also failed. By setting the passing score at position 4, some “not qualified” individuals pass and some “qualified” individuals fail. Positions 2, 3, 5, and 6 are also potential compromise points.

When MDCB evaluates the relative merits and drawbacks of the various cut score possibilities, it is important to consider that each possible cut score will have some degree of decision error. Setting a cut score too low undermines the purpose of credential testing by permitting a large number of people who are not minimally competent to practice in the field. Setting a cut score too high helps ensure no true “not qualified” pass, but creates an injustice by preventing a large number of candidates who are minimally competent from obtaining the credential after preparation for the test and its concomitant financial investment.

FINAL STANDARD

The final standard of minimal knowledge, skills, and abilities for the CMD professional and a table displaying the panel recommendation and adjustments, percentage of questions right represented by each possible cut, and pass rates at each possible cut was transmitted to MDCB on May 1, 2019. This standard of minimal competence is submitted for review by MDCB and is included as Appendix C.

It is important to consider several types of information when setting the passing score. The number of judges and the degree to which they represent the test-taking population are important to the success of the study. If the group of judges is not representative of or knowledgeable about the test-taking group, it is possible that the recommended passing score may be subject to bias caused by over- or under-representation of one or more aspects of the population in the committee of judges.

MDCB may choose one of three options.

- If MDCB believes that the panel-recommended cut will pass examinees who meet the standard of minimum qualified, the panel-recommended cut should be chosen as the final cut.
- If MDCB believes that the panel-recommended cut score will pass candidates who do not meet the standard of minimum qualified, adjustments *above* the panel recommendation may be made.
- If MDCB believes the panel-recommended cut score would fail candidates who meet the standard of minimum qualified, then adjustments *below* the panel-recommended cut off score may be selected.

Regardless of the pass score decision, MDCB decision makers must document and provide a rationale for their decision. Prior to selecting the appropriate passing score, the decision makers will be asked:

1. Is the definition for the minimally qualified candidate appropriate? Does it represent the standard for the certification?
2. Were the judges sufficiently knowledgeable of the subject matter?
3. Did the judges have sufficient knowledge about the available study materials?
4. Did the judges have sufficient knowledge about the candidate population to make appropriate judgments?
5. Is this instrument the only criterion for certification? Are other assessments or eligibility criteria part of the requirements?

6. How do the panel members' views of the test-taking population compare with the decision-makers' views of the test-taking population?
7. Which type of classification error is more serious, passing false qualified or failing false not qualified?

On May 1st, 2019 the MDCB board met to discuss the cut score selection. The meeting began with an overview of the standard setting process, followed by a discussion of the potential cut score options. The potential cut score options were reviewed, and the impact of the decision on the test-taking group was considered. A defensible passing score is rooted in a fully informed decision, and must not be based on a desired passing rate. The MDCB board agreed with the standard setting panel, and decided that the panel recommended cut was the appropriate cut score.

Cut or Adjustment	Raw Score	Percentage of Test Points	Pass Rate of Candidates*
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APPENDIX A – MEETING AGENDA

MDCB Standard Setting Study (Cut Score Workshop)
Chicago, IL
April 23-24, 2019

Day 1 (Tuesday, April 23, 2019)

8:30 AM – 10:00 AM	Introductions, Definition of Minimal Competence
10:00 AM – 10:15 AM	Break
10:15 AM – 12:00 PM	Practice Questions and Discussion
12:00 PM – 1:00 PM	Lunch
1:00 PM – 5:30 PM	Panelists Answer and Rate Examination Questions

Day 2 (Wednesday, April 24, 2019)

8:30 AM –1:00 PM	Feedback, Discussion, and Second Rating

MDCB Subject Matter Expert Biographical Questionnaire

Biographical Questionnaire

Subject Matter Expert

YOUR NAME____

STATE OF RESIDENCE____

AREA OF SPECIALIZATION_____________________________# OF YEARS________

1. Number of years of experience as Medical Dosimetrist:___________

2. Are you a CMD: YES____ NO______

3. If yes, number of years: _________

4. Current employment history

(A) Specialization____
Duties/Responsibilities____
Number of Years____

4. Education: Highest Degree_________ Field of Specialization _________________

5. Certification/Licenses (list all that apply)a.________b._______c.________d._________

a. Years certified/licensed_____ c. Years certified/licensed_____

b. Years certified/licensed_____ d. Years certified/licensed_____

6. Personal Data: Please circle the appropriate information to describe yourself.
(Completion of this section is optional)
Gender:M F Age: 21-30 31-40 41-50 51-60 61+

Race/National Origin: African American Asian/Pacific American Caucasian/White
Hispanic/Latino Native American Other

MDCB Examination
Standard of Minimal Competence

Domain	Knowledge	Minimally qualified candidates will know:	Minimally qualified candidates will have trouble with:
1. Radiation Physics			
	1. radioactive decay	why its important, how it applies, concept of half-life	The actual half-life, what different radioactive isotopes decay into,
	2. production of X rays and particle beams	path of an electron into a LINAC, cyclotron is used, synchotron,	knowing what the target is made of, what's in the path of the beam,
	3. characteristics of X rays and particle beams	dmax of a different energy, what the peak looks like for dose deposition curves, characteristics of photons vs electrons vs protons, mass of particles,	
	4. interaction of radiation with matter	photon interactions with bone vs water vs air, transfer of energy from radiation source to the matter, how to calculate equivalent path length,	effective depth, being able to predict which interaction happens most, transfering different heterogeneities,

	5. treatment machine characteristics (e.g., LINAC, MR, proton, photon, orthovoltage and superficial X rays, gamma source)	**LINAC, basics of MR, basics of photon, X ray components for imaging, IGRT aspect of LINAC,**	**orthovoltage and superficial X rays, details of protons, advanced aspects of MR,**
	6. geometric characteristics (e.g., magnification, minification)	**SSD differences, inverse square law, field matching,**	**calculations, radiobiological impact that it can have on treatment,**
	7. radiation measurement	**TLDs, diodes, ion chambers, OSLDs,**	**what OSLs are made of, how each one measures radiation, QA plans,**
	8. imaging modalities (e.g., MRI, PET, CT, ultrasound, SPECT, KV/MV, CBCT)	**how to differentiate between these scans, why you would have an MRI vs CT etc, diagnostic advantages of the modalities,**	**how they are made, how the images are formed, different phases of MRI (T1 vs T2)**
	9. Hounsfield unit conversion to CT density table in treatment planning systems	**why its important, purpose, what it means to the treatment planning system, basic rough scaling of the units, when its appropriate to override**	**the numbers, conversions,**
	10. radiation units (e.g., activity, exposure, absorbed dose, and dose equivalent)	**what the units are and the concepts to convert between them,**	**actually doing the calculations to convert between them all,**
2. Localization			

	1. acquisition of patient data	**how to pull a CT or other image, how much to image/borders, slice thickness and how to choose one over another, motion management,**	**what to plan off of for 4D, what to do if a scan is cut off, post process the image, phase based vs amplitude based**
	2. patient positioning	**appropriate positioning for sites, basic immobilization devices, spatial lengths, how to correct for unusual setups, machine limitations**	**iso shifts,**
	3. patient immobilization and motion management techniques	**basic immobilization devices, common treatment sites, positions, setups,**	**3D visualization, uncommon treatment positions,**
	4. treatment simulations, TPS localization of patient	**marked location vs treatment isocenter, good isocenter placement for standard sites, tatooed vs bb treatment sites, physical vs virtual isocenter**	**different ways that clinics could define the isocenter,**
	5. rigid image registration, deformable registration, image fusion	**difference between rigid and deformable, chain of registrations, DICOM connection, shared DICOM coordinates, purpose of image fusion**	**when to use rigid vs deformable, potential downfalls, which anatomical area to give preference for matching,**

	6. IGRT (e.g., SGRT, CBCT, ultrasound guidance, KV-KV, MV-MV, infrared, fluoroscopy, CT on rails, fiducials)	definition of IGRT, what options are available, identify KV vs MV image,	deciding if an image was done correctly, if any adjustments are needed, when its clinical appropriate,
3. Treatment Planning			
	1. isodose distributions and dose metrics	how to read a DVH, identifying 6MV vs other common dose distributions, conformality, absolute vs relative DVH, what V20 is, QUANTEC data,	V20 vs D20, indicies of SRS and SBRT cases,
	2. site specific clinical oncology (e.g., disease, anatomy, modes of spread, common treatment techniques, dose and fractionation schemes)	standard dose fractionation schemes, common treatment techniques, anatomy,	hypofractionation, modes of spread,
	3. radiobiology (e.g., dose tolerances, hypofractionation, time dose fractionation calculation, BED, RBE, LET)	dose tolerances for standard fractionation, concepts of RBE, what hypofractionation is/why its used,	time dose fractionation calculation, BED calcs, relationship between LET and RBE,
	4. cross-sectional anatomy	identify normal OARs, major landmarks,	advanced contouring, organ level to the spine,
	5. treatment delivery systems machine differences, limitations, and advantages	difference between a TOMO and a regular LINAC, basic difference between photon and proton, when	HDMLC vs SDMLC, mechanical limitations, geometric limitations, dose rates, specific OAR sparring,

		to use an electron vs a photon,	
	6. special treatment procedures (e.g., TBI, TSEI/TBE, IORT, SRS, SBRT)	what the procedures are, why you are using them, difference between SRS and SBRT,	doing the calculations, separation with TBI,
	7. planning methodologies (e.g., forward, inverse, compensator, robust planning)	definition and difference between plannin methodologies,	robust planning,
	8. DICOM data transfer	what DICOM transfer is, concepts,	file transfer protocol from outside facilities, different file types and how it relates to their work,
	9. computer systems management (e.g., archiving and backup, routine maintenance, scripting)	why archiving and backup is imporant, general concept	how to execute it, good standards of practice,
	10. adaptive radiotherapy	definition, why its beneficial	how to evaluate it, how to track/sum the doses,
	11. autoplanning	definition, why its beneficial	evaluating it,
	12. autocontouring	definition, why its beneficial	evaluating it,
	13. implanted devices	recognizing abnormalities on CTs, adapting your plan for it,	determining what the abnormality is,
	14. the accuracy and limitations of IGRT techniques	MV vs KV vs CBCT,	evaluating the imaging,

4. Dose Calculation Methods			
	1. external beam dose calculation and algorithms	**monte carlo, pencil beam, proton, application of all, dose calc vs fluence map,**	**when to use each of them, limitations of calcs and their accuracy,**
	2. effects of beam modifying devices (e.g., wedges, bolus, partial transmission blocks, compensators, MLC)	**basics of wedges, etc, how the isodose distribution will be affected,**	**how to calculate thickness, choosing wedge angle, wedge orientation, custom bolus design,**
	3. special calculations (e.g., off axis, re-treatments, gap calculations, entrance/exit dose)	**theory and basics, when to apply them,**	**doing the calculations, identifying the formula,**
	4. corrections for tissue inhomogeneities and density overrides	**how it affects the beam, there are times when you will have to correct,**	**applying the correct density, when to correct,**
	5. deformable dose accumulations	**concept, limitations,**	**doing the deformable dose accumulations, evaluating the quality, recognizing issues**
	6. sources of uncertainty and limitations in computer-based treatment planning (e.g., effects of dose grid matrices)	**a dose grid exists, it should be changed at certain times,**	**when its appropriate to shrink your dose grid, when to use the correct dose grid size**
5. Brachytherapy			
	1. radioactive source characteristics	**difference between various sources, concepts of decay,**	**specific isotopes, sources, properties, which source is used for**

			which treatment site,
	2. HDR and LDR treatment planning	**difference between HDR and LDR, definitions,**	**specific isotopes, sources, properties, which source is used for which treatment site,**
	3. HDR and LDR delivery systems	**identify an afterloader vs seed implant, `**	**sheilding, planning,**
	4. Brachytherapy treatment device verification (e.g., seeds applicators)	**identify basic applicators,**	**identifying on CT, appropriate positioning,**
	5. secondary/independent calculation	**calculating half-life,**	**doing the calcs, TG43, long and away calculations, point A and point B**
	6. surveying (e.g., background pre and post implant, shielding, bedside dose)	**which survey to use, why you survey, survey meter, when to survey,**	**basic procedure, exposure calculations, specific release criteria,**
	7. regulatory requirements for radioactive sources (e.g., NRC vs state requirements)	**signs should be posted, how they should be stored, how long they can be stored, who has access,**	**difference between NRC and state requirements, transportation requirements,**
6. Radiation Protection			
	1. ALARA and maximum permissible dose equivalent based on NCRP recommendations, regulatory guidelines (e.g., ICRU, NCRP)	**know the common numbers between various populations, definitions and concepts of ALARA,**	**conversions,**
	2. radiation monitoring for personnel and patients	**difference between film and ring badge and**	**how the devices that measure radiation are**

		who wheres them, location of badge,	monitored, how long you wear the badge,
	3. treatment vault shielding requirements	definitions	use factor and occupancy factor, calculations,
7. Quality Assurance and Standard of Care			
	1. TPS commissioning and quality assurance	different types of quality assurance, what needs to be QA,	tolerances, how often to do QA,
	2. clinical data (e.g., plan checks, chart reviews, image reviews)	why we do them, checking plan against physicians script	identifying issues in charts/image reviews,
	3. measurement equipment (e.g., diodes, ion chambers, TLD, survey meters)	these are devices used for QA, what they are,	when to use them, how they measure radiation,
	4. record and verify systems and EMR	they capture information from the TPS, record physical delivery, part of the patients EMR	what potential errors in the EMR could cause issues to the patient, how to navigate the record and verify system,
	5. treatment beam QA measurement and analysis (e.g., IMRT, electron cut out factors)	that QA needs to be peformed, that electron cut out factors are there, secondary calc are need for 3D CRT	Analyzing the QA, knowing when an electron cut out factor is needed, relationship between the factor and the size/shape of the cut out,
	6. AAMD Scope of Practice	the need to abide by the rules, guidelines for non-compliance, where to find it,	when to point out requests that are out of scope,

	7. incident reporting for patient safety (e.g., quality improvement, RO-ILS, root cause analysis, process improvement)	**what is reportable vs recordable, what types of incidents should be reported,**	**specifics of reports,**
	8. factors and limitations of deliverable plans	**field size limitations, patient limitations, machine limitations,**	**remembering the limitations, how to correct,**
	9. QA requirements of simulation and treatment equipment	**frequency of QA,**	**tolerances, QA procedure process,**

APPENDIX D – EXAMPLE RATING FORM

Example Rating Form

Judge: ____ Judge Number: ____________

Number of "minimally competent" MDCB candidates out of 100 who will answer the question correctly.

Item	Ans.	First Judgment	Second Judgment
1	_______	____________________	____________________
2	_______	____________________	____________________
3	_______	____________________	____________________
4	_______	____________________	____________________
5	_______	____________________	____________________