Background

The mission of the American Registry of Radiologic Technologists (ARRT) is to "promote high standards of patient care by recognizing qualified individuals in medical imaging, interventional procedures, and radiation therapy." The ARRT's equation for excellence states that excellence equals education plus ethics plus examination; standard setting is one of many processes within the examination component that ensure it is an accurate reflection of the knowledge, skills, and abilities required of entry level technologists.

This report details a standard setting conducted in March 2023 for nuclear medicine technology, including committee composition, methods, results, recommendations, and any changes to the exam cut score. It is ARRT's primary goal for the exam to reflect the current state of practice and expectations for entry-level nuclear medicine technologists. Therefore, this meeting served to update those expectations from the previous standard setting in 2018.

The ARRT utilizes experts in standard setting, called psychometricians, to train and facilitate a committee of subject matter experts from the field to define expectations, collect data, and make recommendations before presenting the results to the ARRT Board of Trustees. The facilitators provided training throughout the meeting to ensure that the committee was prepared to hold productive discussions, make well-reasoned judgments, and provide suitable recommendations at the meeting's conclusion.

Facilitators:

- Jessica Anderson, ICE-CCP, Director, Test Development, Licensure and Certification at DRC
- Hally Crump, MA, Psychometrician, Licensure and Certification at DRC

The ARRT Board of Trustees reviewed the results of the standard setting meeting and committee recommendations before approving the final standard. ARRT psychometrics staff will ensure the passing threshold for all exams administered on or after the effective date reflect that prescribed level of performance.

Committee Composition

ARRT staff selected individuals from the volunteer database with the goal of maximizing diversity in role, geography, and experience in nuclear medicine technology. When possible, ARRT will bias the volunteer pool towards individuals early in their career as the exam is designed to assess candidates at entry level. In addition, the radiologist assigned to the exam committee by the American College of Radiology is invited to attend. In total, 11 subject matter experts participated in the standard setting meeting. Please refer to the following table for specific demographics of this group.

Table 1. Committee Demographics

Rater	Role	Location	Experience	Credentials
A	Technologist	DE	<1 Year	R.T.(N)(CT)(ARRT)
B	Technologist	AR	1-3 Years	R.T.(N)(ARRT)
C	Technologist	MA	6-10 Years	R.T.(N)(CT)(ARRT)
D	Technologist	OR	11-20 Years	R.T.(R)(N)(CT)(BD)(ARRT)
E	Technologist	FL	20+ Years	R.T.(N)(ARRT)
F	Technologist	OR	1-3 Years	R.T.(N)(ARRT)
G	Technologist	FL	11-20 Years	R.T.(R)(N)(ARRT)
H	Technologist	SD	6-10 Years	R.T.(R)(N)(ARRT)
I	Technologist	TX	20+ Years	R.T.(R)(N)(ARRT)
J	Technologist*	MA	11-20 Years	R.T.(N)(CT)(ARRT)
K	Radiologist	CO	6-10 Years	M.S., DABR, DABSNM

*Committee member J was also serving as an ARRT Trustee at the time of the meeting

Minimally Qualified Candidate

After training regarding the purpose and implications of standard setting, the committee discussed the knowledge, skills, and abilities expected of an entry level nuclear medicine technologists with primary focus on the minimum qualifications that should be demonstrated to earn an ARRT credential. This discussion of the "minimally qualified candidate," who possesses only the knowledge, skills, and abilities required for certification, is important because it allows the committee to come to a common understanding of what is required for the role prior to any data collection activities. Note that "entry level" and "minimally qualified" are not interchangeable terms. Entry level individuals are early in their career with limited clinical experience irrespective of their level of qualification.

The committee began their discussion by reviewing a generic list of knowledge, skills, and abilities approved by the ARRT Board of Trustees (Appendix A). The generic list was derived from past standard settings and contains discipline-agnostic expectations for the well qualified, minimally qualified, and not yet qualified candidate. These descriptions were intentionally designed to provide an initial anchor for the committee and facilitate discussion without imposing specific criteria.

After reviewing the generic candidate description, the committee discussed discipline-specific examples of knowledge, skills and abilities that are representative of candidates at each ability level.

Modified Angoff

The committee performed a Modified Angoff activity (Angoff, 1971) using a recently retired exam form The facilitator provided training to explain the function and intent of the Angoff to the committee and the committee performed a practice activity with a few items to familiarize themselves with the software.

The committee practiced the modified Angoff procedure with an initial set of twenty items. ARRT staff read each item aloud and committee members independently made judgements for the percentage of minimally qualified candidates that would answer it correctly. The facilitator asked committee members to share their ratings and provide a brief rationale for their judgment. The committee discussed these results with a particular focus on the shared definition of a minimally qualified candidate and clarified their required knowledge, skills, and abilities as necessary.

In the first round of the full activity, the committee reviewed and provided individual judgements for each item on the form. The ratings for each item were averaged across all panelists, and those values were then averaged across all items to determine the minimum percent correct needed to pass the test.

After the first round, the facilitator provided the Angoff-derived cut score for the group as well as impact data showing how that score would affect the pass rate of recent candidates. The facilitator then encouraged the committee to discuss their judgments and further clarify their expectations for the minimally qualified candidate based on real-world experiences with candidates during their coursework or clinical training. The committee reviewed 82 items with high disagreement, possessing either a standard deviation greater than 13 or an Angoff value that was at least 15 percentage points higher than overall percent correct.

In round two, committee members reviewed the items again and revised their initial item-level judgments, as desired, based on their discussions during the feedback period.

Table 2. Modified Angoff Results

Percent Correct Cut	Round 1	Round 2
Mean	74.1	71.9
Minimum	65.7	66.6
Maximum	83.0	83.0
Standard Deviation	8.0	9.2

Hofstee

The facilitator asked the committee to answer the following four questions to determine the Hofstee recommendation (Hofstee, 1983):

1. What is the lowest acceptable percent correct on the total test you would be comfortable with in order to pass?
2. What is the highest acceptable percent correct on the total test you would be comfortable with in order to pass?
3. What is the minimum percent of test takers that you would be comfortable to fail?
4. What is the maximum percent of test takers that you would be comfortable to fail?

Table 3. Mean Hofstee Responses

Minimum cut score	65%
Maximum cut score	77%
Lowest fail rate	14%
Highest fail rate	38%

Final Discussion

The committee discussed the results of the two activities and recommendations for the ARRT Board of Trustees. All 11 participants indicated a moderately-high or high level of comfort with their understanding of the Minimally Competent Nuclear Medicine Technologist. The average confidence rating in the appropriateness of the recommended standard(s) was 4.55 (1 = Not very confident; 5 = Very confident), representing a high degree of confidence. The average overall rating of satisfaction with the standard setting process was 4.91, signifying a high degree of satisfaction (1 = Not very satisfied; 5 = Very satisfied).

New Standard and Implementation

The ARRT Board of Trustees reviewed the results and discussed the impact of potential new standards before approving a final standard for the Nuclear Medicine Technology exam.

The board approved a new standard equivalent to 140 out of 200 items on the exam form used for this meeting. The new standard will go into effect February 2025 and remain in place until at least 2028 when the next standard setting is scheduled to take place. The new standard is equivalent to 13 more correct answers on the exam form used for this meeting. ARRT staff expect a future pass rate for first-time candidates around 62% based on the impact data provided to both the board and standard setting committee.

References

Angoff, W.H. (1971). Scales, norms, and equivalent scores. In R.L. Thorndike (Ed.), *Educational Measurement* (2nd ed., pp. 508-600). American Council on Education.

Beuk, C. H. (1984). A method for reaching a compromise between absolute and relative standards in examinations. *Journal of Educational Measurement*, 21(2), 147-152.

Hofstee, W. K. (1983). The case for compromise in educational selection and grading. In S.B. Anderson & J.S. Helmick (Eds.), *On educational testing*, (pp.109-127). Jossey-Bass.

Generic Candidate Description Worksheet

At a high level and applicable to all disciplines, this document describes the knowledge, skills, and abilities of clearly passing, clearly failing, and just barely passing candidates. It includes generic examples of items that they would likely get correct or incorrect.

Individual Standard Setting Committees should refine the criteria for the Just Barely Passing candidate specific to their discipline. In doing so, committee members may want to think of entry level people that they know from the workplace or students that they have taught.

Type of Candidate	Typical Knowledge, Skills, and Abilities*	Examples of items that they should answer correctly	Examples of items that they may answer incorrectly
Clearly Passing (way above cut score)	• Knows more than what is on the exam • Obtains high quality images on all types of patients • Readily identifies common pathologies • Demonstrates problem-solving (critical thinking) skills • Demonstrates strong oral and written communication skills • Adapts positioning or projections as needed for difficult patients • Anticipates needs of the radiologist • Collaborates with healthcare team to provide optimal patient care	• Fundamental concepts of imaging and patient care • Detailed anatomy (e.g., parts of organs vs whole organs) • Common pathology and physiology • Concrete understanding of how equipment works • Presence and cause of artifacts	• Advanced physics • Unusual anatomic variants • Pharmacology • Advanced calculations/formulas • Difficult item types (multiselect, hot spot, ordered list) • Items with multi-level thinking • May blank out on a simple question (random error)

Type of Candidate	Typical Knowledge, Skills, and Abilities*	Examples of items that they should answer correctly	Examples of items that they may answer incorrectly
Just Barely Passing (just above cut score)	• May exhibit test anxiety • Clinical skills greater than or equal to classroom/book knowledge • Possesses limited clinical or work experience (esp. post-primary exams) • Understands basic anatomy and physiology • Can discriminate between normal and abnormal anatomy • Limited knowledge of study indications • Practices quality patient care and safety (not dangerous) • Self-evaluates abilities and knows when to get help • Collaborates with the healthcare team • Unable to explain the "why" (equipment, instrumentation, tube angulation, etc.)	• Patient care • General patient safety • Modality-specific safety guidelines and procedures (radiation, MR, etc.) • Basic image analysis • Definitions • Basic physics • Presence of artifacts • Basic image production items (depending on clinical or lab experience)	• Physics beyond basics • Detailed anatomy (e.g., parts of organs vs. whole organs) • Calculations • Physiology • Cause of artifacts • Correlation with other modalities • Regulatory requirements • QA/QC requirements • Negatively worded items
Failing (below the cut score)	• Demonstrates poor test taking skills • Barely passed other exams (post-primary candidates) • Unable to modify protocols from anatomical programming (button pusher) • Unable to adapt positioning or projection based on patient needs or equipment locations • May not understand indications for exams • Weak anatomy and pathology knowledge • Does just enough to meet requirements • Does not know their own limitations • Does not take responsibility for actions • Language barrier	• Basic positioning • Patient care (general concepts) • Consent for exams • Basic modality-specific protection (radiation, MR, etc.) • Basic anatomy only	• Almost anything • Alternate ways to do a study • How the equipment works

*Certain items in the list of knowledge, skills, and abilities are not construct-relevant (e.g., test anxiety, test taking skills, language barrier) but are never-the-less factors that may impact an examinee's performance on the examination.