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ABSTRACT

The specific role, function, and qualifications for six jobs in diagnostic radiologic technology (excluding physicians and health physicists) were delineated through task analyses. The levels are not job titles but can be described in terms of function. Among other duties, the Level I position provides nonspecialized assistance to radiologic personnel; Level II develops, reproduces, indexes, and files x-ray films; Level III performs routine radiographic procedures; Level IV carries out specialized radiographic procedures requiring knowledge and understanding of more complex and sophisticated procedures and equipment; Level V provides supervision and coordination of ancillary personnel; and the Level VI position uses management skills to provide for the development and appreciation of departmental policies, budgets, and long range planning. Based on detailed job descriptions and justification for this hierarchy, a national advisory committee decided that the development of a proficiency test is most appropriate for the Level III position. A criterion referenced test has been developed to measure competencies for on the job performance which reflect what is learned in active work experiences or through other than formal academic programs. The construction of the test, the development of a guide for curriculum design, recommended policies and procedures for credentialing the Level III position, and the potential use of audiovisual materials for proficiency listing are described. (EVH)

DELINEATION OF ROLES AND FUNCTIONS OF DIAGNOSTIC RADIOLOGIC TECHNOLOGY PERSONNEL AND DEVELOPMENT OF PROFICIENCY TESTS

Final Report

Bureau of Health Resources Development

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EDUCATIONAL TESTING SERVICE
PRINCETON, NEW JERSEY

FINAL REPORT

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June 28, 1974

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for

Division of Associated Health Professions
Bureau of Health Resources Development
U.S. Department of Health, Education, and Welfare

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CONTENTS

Part 1:

OVERVIEW OF PROJECT ACTIVITIES AND RESULTS

Definitions of Job Levels in Diagnostic Radiologic Technology

An early activity in the project involved the definition of all job levels in diagnostic radiologic technology with the exception of specialists such as physicians and health physicists. All levels were articulated in order to provide career ladder perspective on the job level targeted by the Advisory Committee for test development.

Previously published task analyses located with the assistance of the Advisory Committee were used as input material. These included materials provided by the American Registry of Radiologic Technologists, the American Society of Radiologic Technologists, the University of California at Los Angeles, the U.S. Civil Service Commission, the U.S. Air Force, and the U.S. Navy. A radiologist-radiologic technologist consultant team assisted ETS staff in drafting statements describing six job levels in diagnostic radiologic technology.

The six levels were structured cumulatively; i.e., a person at a given level is to have the knowledge and skills required of all subordinate levels as well as those specified at the given level. No job titles were assigned to the various levels in order to avoid the confusion arising from possible variation in the meaning of particular titles. The Advisory Committee reviewed the draft statements and suggested several changes which are reflected in the final version described in Part 2 of this report.

Delineation of Roles, Functions, and Responsibilities of Diagnostic Technology Personnel

The specific content character of each of the six job levels was delineated through similar procedures. The Advisory Committee concurred in recommending that the listing should reflect the roles and functions which are both appropriate and currently applicable at those levels.

Draft listings of roles and functions for each of the six levels were prepared with the assistance of consultants and using the previously published task analyses mentioned earlier as a reference. In a subsequent Advisory Committee meeting, it was decided to divide the Committee and Observers into small study groups to critique and edit the individual sections of the draft listings. The study groups were formed on the basis of detailed familiarity with the requirements of the occupations. The revisions prepared by the study groups were subsequently reviewed by the Committee as a whole. The resulting document is included in Part 3 of this report.

Development of Proficiency Tests for Level III Diagnostic Radiologic Technology Personnel

The Advisory Committee recommended that, among the six levels defined, proficiency test development is most appropriate for Level III personnel. In comparison to the other levels, Level III is characterized by both: a) a large number of specific technical roles, functions, and responsibilities and b) the necessity for a significant amount of pre-entry preparation. Other levels lack either a) above or both a) and b).

Documents specifying examination content and ability requirements were developed for Level III. Throughout the test development process, the objective was to produce measures of competence for on-the-job performance which reflect what is learned in actual work experience or through other than formal academic programs.

The Advisory Committee provided nominations for a six-member Examining Committee which was charged with drafting test specifications for Advisory Committee review encompassing abilities required, content areas and relative weights to be attached to each area. The test specifications were designed to coincide with the definition of Level III and the Roles, Functions, and Responsibilities for Level III described in Parts 2 and 3 of this report. The final specifications used for test development are described in Part 4 of this report.

The Examining Committee was also responsible for producing illustrative examples of questions for outside item writers, nominating and assigning item writers to specific content areas, reviewing draft questions for suitability and to eliminate inadequacies, specifying types of questions, and amount of time to be allowed in taking the examination.

ETS test development specialists' responsibilities included psychometric review of test questions, assembly of tests according to the approved test specifications, and providing guidance throughout the test development process.

The test specifications included seven major content categories with differential weights as shown in Part 4. Content area weights were manifested in the tests by setting the number of test questions in a category approximately proportional to the weights; i.e., the larger the category weight, the larger the number of questions assigned to that category. In four of the categories, viz., Radiation Protection, Technique and Quality Control, Positioning, and Radiographic Equipment, the number of test questions were judged to be sufficient to yield reasonably reliable part scores. These subscores will be useful in providing information to candidates about content areas in which they may lack proficiency.

Four parallel forms of the proficiency tests were developed. Each form contains 230 multiple-choice questions, with a number of questions in each form accompanied by pictorial and graphic content. Each form is linked with the next by virtue of a common subset of test questions to provide the basis for equating across forms.

Each test form was criterion referenced through the use of two independent teams of judges and the Credentialing Subcommittee of the Advisory Committee. Each team consisted of a radiologist and a radiologic technologist. One team was very familiar with the work of the project, consisting of two members of the Advisory Committee. The other team had no previous involvement with the project so as to provide an independent perspective. Each team met in separate geographic locations and did not communicate regarding their judgements.

The teams were asked to make two kinds of evaluations concerning individual questions in the proficiency tests. The first was to identify which specific task(s) or knowledge requirement(s) listed in Part 3 of this report is being measured by each test question. The purpose of this assignment was to provide a basis for demonstrating the specific relevance or relatedness of the test to the job of a Level III incumbent at the time of entry. Questions which could not be so linked would not be included in operational scoring of the tests.

The second evaluation consisted of determining which test questions must be answered correctly in order to demonstrate ability to meet a minimum standard of on-the-job performance competency at the time of entry into a Level III position. Questions surviving this evaluation plus the evaluation described in the preceding paragraph would be included in a minimum competency scoring key for the proficiency test for entry-level Level III personnel.

The two independent sets of evaluation results showed a high level of agreement between teams as well as consistency with prior expectations in that the large majority of questions survived both types of evaluations. Where disagreements between teams regarding question inclusion in a minimum competency scoring key occurred, these were resolved by the Credentialing Subcommittee of the Advisory Committee.

To provide additional information about the tests, a trial administration of one test form was conducted on several hundred currently practicing diagnostic radiologic technology personnel at diverse job levels, education levels, amounts of previous experience, employment settings, and geographic locations. This data base has provided means for correcting faulty items, establishing the adequacy of test reliability and providing additional evidence concerning test job-relatedness.

Development of a Guide for Educational Curriculum Design in Diagnostic Radiologic Technology: Level III

The entry-level roles, functions, and responsibilities delineated for Level III personnel in Part 3 of this report were translated into a draft educational topical outline by ETS staff working collaboratively with a consultant specializing in the training of radiologic technology personnel at this level. The draft version was reviewed by the Advisory Committee. The resulting revised Guide is incorporated as Part 5 of this report.

Recommended Policies and Procedures for Credentialing Level III Diagnostic Radiologic Technology Personnel

The recommended policies and procedures delineated in Part 6 of the report were drafted by a Credentialing Subcommittee of the Advisory Committee and subsequently reviewed and amended by the full Committee. These recommendations provide alternate pathways to recognition as an acceptable entry-level provider of Level III diagnostic radiologic technology services.

The recommended passing scores described in Part 6 were determined on the basis of an absolute standard of minimal competency which is independent of the test performance of any individual or group. Thus the standard reflects competency to perform rather than relative standing within a group of examinees who may or may not be competent to perform.

The Committee adopted the position that theoretically, examinees should be required to answer 100% of the questions designated as minimum competency questions. Practically, however, it was recognized that an allowance must be made for measurement error inherent in any tests. There is a high degree of assurance that individuals scoring below 85% on the total test do not meet minimum competency standards in all respects.

The part score standards set at 75% reflect the recognition that part scores are less reliable than total scores, and that for a person of given ability, achieving passing performance on all of a series of separate test parts is less likely than achieving passing performance on a single measure.

The use of a priori absolute passing score standards as opposed to normative standards does not permit advance control of the proportion of candidates who will pass the test. As a consequence, the resulting proportion passing can be less than the proportion passing using a normative standard. "After the fact" analysis of actual examinee data suggest this possibility. Given the job

relevance and aptness for measuring minimal competency of the test questions and the adequacy or allowance for measurement error, such analyses can be helpful in pinpointing areas of content which need strengthening through changes in formal educational curricula, continuing education programs, and/or further on-the-job experience.

Potential Use of Audiovisual Materials for Proficiency Testing in Diagnostic Radiologic Technology

The purpose of this report (Part 7) is to present recommendations which might be implemented in future development of proficiency testing in this discipline. In this connection, ETS staff working with an outside specialist in the use of audiovisual materials in allied health education conducted site visits, developed lists of alternative media and secured information about practicality and costs. A panel of specialists in radiology and diagnostic radiologic technology prepared draft recommendations linking specific knowledge and skills requirements, types of media, and number of media units, which were subsequently reviewed by the Advisory Committee.

It might be noted that the present proficiency tests incorporate line drawings and photographic reproductions, and that these two media are recommended as appropriate for a majority of the knowledge and skills categories specified in Part 7.

Part 2:

DEFINITIONS OF JOB LEVELS
IN
DIAGNOSTIC RADIOLOGIC TECHNOLOGY

The following job descriptions are hierarchial in nature: it is assumed that the knowledge and skills required at each level are cumulative; i.e., a person at Level II has the knowledge and skills required at Levels I and II.

Six levels have been described. No titles are attached in order to avoid the confusion arising from possible variation in these titles.

Not all levels are necessarily employed in all health service facilities. In such cases, duties are assigned to existing personnel at other levels.

LEVEL I

Provides nonspecialized assistance to radiologic personnel. Performs duties of hospital orderly in the absence of an orderly. Performs patient handling, housekeeping and messenger duties.

Supervisory responsibilities:	None
Direction received:	Direct supervision by Level III and above.
Need to know:	No specific radiologic knowledge required.

LEVEL II

Develops, reproduces, indexes, and files X-ray films. Prepares and replenishes chemical solutions needed for X-ray development. Maintains darkroom facilities.

Supervisory responsibilities:	None
Direction received:	Direct supervision by Level III and above.
Need to know:	Knowledge of film development and reproduction procedures, ability to use and maintain standard darkroom equipment. Ability to prepare chemical solutions necessary for X-ray development. Knowledge of standard filing techniques.
Note:	In small installations, this function is covered by Level III.

LEVEL III

Performs all routine radiographic procedures (i.e. spine, skull, thorax, abdomen) to include fluoroscopy, tomography, pelvimetry, and other similar procedures.

Supervisory responsibilities: Supervision of Levels I and II.

Direction received: Direction received primarily from established policy and technique documents, with general supervision by the supervisory technologist, radiologist, or other physicians.

Need to know: Be proficient in routine radiographic and fluoroscopic procedures and techniques.

1) What procedure is; when utilized
2) What technique of procedure is
3) Be proficient in how to do it
4) Be able to modify standard procedure in emergency or unusual situations
5) Knowledge of the equipment limitations
6) Knowledge of safety procedures, which include radiation and/or monitoring

LEVEL IV

Performs specialized radiographic procedures requiring knowledge and understanding of more complex and sophisticated team procedures, equipment and equipment components directed towards demonstrating specific anatomical areas such as cardiovascular, neuroradiologic, and polytomography procedures.

Supervisory responsibilities:	Supervisory to and including Level III; may present demonstrations in formal classroom instruction.
Direction received:	Receives supervision under written directions from higher level personnel and physicians.
Need to know:	Be proficient in specialized radiographic and fluoroscopic procedures and techniques 1) What procedure is; when utilized 2) What technique of procedure is 3) Be proficient in how to do it Must have detailed knowledge of capabilities and limitations of equipment and components.

LEVEL V

Within designated areas of responsibility, provides supervision and coordination of ancillary personnel.

Is responsible for formal classroom instruction and demonstrations, and for in-service training courses. Works with educational organizations in development of courses and curriculum.

Supe visory responsibilities:	Supervision of Level I, II, III, and IV.
Direction received:	Works under general supervision of radiologist or Level VI.
Need to know:	Administrative and personnel procedures. Knowledge and experience in training programs and educational methods. Knowledge of interpersonal relationships. Knowledge of government standards, which include radiation safety procedures.

LEVEL VI

Uses management skills to provide for the development, interpretation and application of departmental policies, budgets, and long range planning. Responsible for technical aspects of radiation safety and interpretation and adherence to government standards. May be delegated to represent and act as Department Head in interdepartmental hospital conferences, functions and management activities.

Supervisory responsibilities:	Supervision of Levels I through V.
Direction received:	Works under the direction of the Chief Radiologist with considerable latitude in making management level decisions.
Needs to know:	Administrative, personnel and fiscal practices and procedures, government rules and regulations, hospitalization insurance programs.

Part 3:

DELINEATION OF ROLES, FUNCTIONS AND RESPONSIBILITIES OF DIAGNOSTIC RADIOLOGIC TECHNOLOGY PERSONNEL

RADIATION PROTECTION AND SAFETY

Appropriate knowledge and skills needed by entry level (and above) staff technicians (technologists) for adequate radiation protection of patients and personnel.

A. Biologic Effects and Radiation Units	Level
Tasks	
Understands potential genetic and somatic effects from ionizing radiation in relation to patient and personnel protection	III
Understands special radiation sensitivity during pregnancy and the need for special precautions	III
Knows basic terminology regarding radiation units, e.g. roentgen, rad, rem	III

B. Radiation Protection of Personnel	
Tasks	
Issues and collects personnel monitoring devices and maintains records	III
Understands use of personnel monitoring devices and wears as appropriate	III
Reads and recharges pocket dosimeters to check high level radiation procedures	III
Understands basic principles of time, distance, and shielding	III
Understands use of lead aprons and gloves and utilizes as appropriate; e.g. fluoroscopy, mobile units	III
Understands maximum permissible dose concept	III
Understands need for and uses ancillary shielding devices in fluoroscopy	III

	Level
Recognizes and investigates unusual personnel monitor readings	V

C. Radiation Protection of Patients

Tasks

Understands effect of kVp and mAs selection on patient exposure	III
Understands effect of collimation on film quality and patient exposure	III
Knows how to properly operate variable aperture collimator	III
Knows how to check alignment of light field in variable aperture collimator	III
Understands proper selection of fixed cones in absence of variable collimators	III
Understands use and need for extension cylinders in conjunction with (or separate from) collimators	III
Understands effect of filtration on patient exposure and relationship between kVp and required (and/or recommended) total filtration	III
Understands need for and use of gonadal shielding as related to sex, age groups, and anatomic site	III
Understands relationship of film speed, screen type, and processing to patient exposure	III

D. Electrical and Mechanical Safety

Tasks

Understands necessity of maintaining integrity of cables and wiring to avoid electrical hazard	III

	Level
Understands need for grounding	III
Understands need for and uses explosion-proof equipment in rooms utilizing flammable gases	III
Tests equipment for safe grounding	V

TECHNIQUE AND QUALITY CONTROL

A. X-Ray Examinations	Level
Tasks	
Assist (indicates assisting physician with nonexposure aspects of procedure) in the following radiographic procedures:	
Bronchograms	III
Gynecograms	III
Hysterosalpinograms	III
Cholangiograms	III
Discograms	III
Intravenous pyelograms (IVP's)	III
Myelograms	III
Pneumocystograms	III
Urographic studies	III
Sialograms	III
Upper GI series	III
X-rays for contrast studies of large bowel	III
X-rays of small intestine	III
Fistula or sinus tract X-rays	III
Ventriculograms	III
Cardiac catheterization and angiocardiogram	IV
Take (indicates determination, selection of technical factors, and making exposure in the following radiographic procedures:	

Technique and Quality Control

	Level
Paranasal X-rays	III
X-rays of extremities	III
X-rays of ribs and sternum	III
Tomograms	III
Macroradiograms	III
Mammograms	III
Scanograms	III
Stereoscopic X-rays	III
X-rays for cholecystographic studies	III
X-rays for pelvimetric studies	III
Foreign body localization X-rays of extremities	III
Foreign body localization X-rays of eye	III
Foreign body localization X-rays of skull	III
Foreign body localization X-rays of thorax	III
Photofluorograms	III
Retrograde cystogram	III
Retrograde pyelogram	III
Abdominal X-rays	III
Pelvis X-rays	III
Cervical spine X-rays	III
Facial X-rays	III
Lumbar spine X-rays	III
Mastoid X-rays	III

Technique and Quality Control

	Level
Skull X-rays	III
Thoracic spine X-rays	III
X-rays of lower extremities	III
X-rays of upper extremities	III
X-rays of kidney/ureter/bladder	III
X-rays of mandible	III
X-rays of ribs and sternum	III
X-rays of sacrum and coccyx	III
X-rays of temporomandibular joints	III
Sialograms	III
Urethrograms	III
Bronchograms	III
Cystograms	III
Hysterosalpingograms	III
Intravenous cholangiograms	III
Intravenous pyelograms	III
Long bone X-ray series	III
Mammograms	III
X-rays for contrast studies of large bowl or colon	III
Phlebograms	III
Pneumocystograms	III
X-rays for bone age radiographs	III
X-rays for cholecystographic studies	III

Technique and Quality Control

	Level
X-rays for metastatic surveys	III
X-rays for Upper GI series	III
X-rays for small intestines	III
Fetograms	III
Placentograms	III
Renal loopogram	III
Hypertensive intravenous pyelograms	III
Abdominal X-rays	III
Spinal X-rays	III
Chest X-rays	III
Facial X-rays	III
Mastoid X-rays	III
Lymphangiograms	III
Operate cinefluorographic equipment	III
Operate image intensifier flouroscopic units	III
Operate mobile X-ray units	III
Angiocardiograms	IV
Cerebral angiograms	IV
Femoral arteriograms	IV
Abdominal arteriograms	IV
Renal arteriograms	IV
Pneumocardiograms	IV
Pneumoencephalograms	IV

	Level
B. Films and Screens	
Tasks	
Assemble, index, and file X-ray films	II
Store unexposed films	II
Load and unload film magazines	II
Cleaning screens and cassettes	II
Use polaroid units	III
Load cameras for cinefluorography	III
Mounting screens	IV

C. Technique - Quality Control, including:

1. kVp
2. mA
3. Distance - target-screen, etc.
4. Time
5. Grids
6. Collimation
7. Filters
8. Technique adjustments between single and 3-phase

Tasks	
Check dark room for light leaks	II
Inspect condition of film storage areas, i.e. for proper temperature/lighting/humidity	II
Perform safety check for exposure safelights	II
Makes postexposure radiograph identification	III
Review X-ray films for technical adequacy	III
Determine and select kilovoltage on X-ray unit	III

Technique and Quality Control

	Level
Determine and select milliamperage on X-ray unit	III
Determine and select time of X-ray exposure	III
Modify technical factors due to unusual patient requirements	III
Produce radiographs using screen technique	III
Produce radiographs using fixed grid technique	III
Produce radiographs using nonscreen technique	III
Produce radiographs using bucky technique	III
Test cassettes for screen film contact	III
Identify radiographic subject previous to examination	III
Utilize technique and tube loading charts	III
Inspect X-ray film quality to evaluate development techniques	III
Checks postexposure radiograph identification	IV
Test for X-ray beam alignment	IV
Determine exposure technique for rapid sequence filming	IV
Formulate technique charts	V

D. Film Processing - Automatic and Manual

Tasks

Develop medical X-ray films	II
Develop industrial X-ray films	II
Operate automatic processing machines	II

Technique and Quality Control

		Level
	Reproduce X-rays by direct duplication method	II
	Prepare processing solutions	II
	Replenish solutions	II
E.	Artifacts	III
F.	Image Quality - Factors Determining Variation	III
G.	Film Systems - Technique and Processing Optimized to a Film	III

E, F and G are also knowledge areas.

PATIENT CARE

A. Patient Handling	Level
1. Handling Patients	
2. Trauma Patients	
3. Infectious Disease	
Tasks	
Accompany patient to other departments/ clinics	I
Assist patients in/out of bed, exam or O.R. tables	I
Drape/gown patient for examination/treatment	I
Transfer patients from stretchers	I
Transport nonambulatory patient to other departments/clinics	I
Restrain/control patient physically, e.g. arm hold	I
Check with patient to ensure that he has collected specimen as instructed	I
Measure/weigh patient or personnel	I
Recognition of change in patient's condition, e.g. description of injury, symptoms, response	I
Pick up/deliver specimens	I
Assist patients to or from litters or wheel-chairs	I
Receive patients on arrival, i.e. introduce self, obtain patient's name	I
Check patient's temperature	I

Patient Care

	Level
Check radial (wrist) pulse	I
Check patient/check chart for contraindication re procedure	III
Ask/instruct patient to collect specimen	III
Ascertain if patient has been prepared for procedure	III
Immobilize children for examination	III
Explain/answer questions about doctor's instructions to patient/family	III
Explain X-ray procedures to patient	III
Reassure apprehensive parents of pediatric patient	III
Reassure/calm children for examination	III
Review printed patient instructions on procedures with patient/family	III
Review patient's clinical history	III
Obtain clarification of conflicting doctor's orders	III
Give technical direction to patients concerning procedures	III
Verify identification of patient, e.g. for medications, examination	III
Regulate I.V. flow within standard limits	III
Change dressings	III
Observe/record patient's physical/emotional response to procedures	III
Reassure/calm apprehensive (anxious) patient	III
Label specimens	III

Patient Care

	Level
Check blood pressure utilizing blood pressure cuff	III
Check femoral pulse	III
Check pedal pulse	III
Check carotid pulse	III

B. Aseptic Technical (Infection Control)

Tasks

Wash and sterilize treatment facilities	I
Proper use of sterile equipment	III
Clean radiographic equipment	III
Proper disposal of contaminated items	III

C. Emergency Procedures and First Aid

Tasks

Give standard first aid treatment	I
Give emergency treatment/first aid for respiratory impairment	III
Give emergency treatment/first aid for cardiac arrest	III
Give emergency treatment/first aid for external hemorrage	III
Give emergency treatment/first aid for severe drug reaction	III
Give emergency treatment/first aid for shock	III
Give emergency treatment/first aid for head injury	III

Patient Care

	Level
Give external cardiac massage	III
Give oxygen, i.e. cannula, catheter/mask	III
Move/position patient with suspected spinal fractures or cord injuries	III

D. Contrast Agents (media) -- Injectable, Oral

1. Basic contrast materials and their use in the radiographic department	III

Tasks

Recognize contrast material drug reactions	III
Recognize drug reactions, e.g. hives, etc.	III

E. Immobilization

Tasks

Apply/remove splint/bivalve cast	III
Select immobilization devices	III
Apply/remove sling, e.g. arm, leg	III

D is a knowledge area

POSITIONING

A. Anatomy	Level
1. Normal	III
2. Pathologic	III
Tasks	
Position patient for examination	III
Move/position patient with suspected trauma	III
Move/position patient with head injuries	III
Move/position patient with suspected internal injuries	III
X-ray positioner, head	III
Position patients for treatment	III
Place patient in radiographic position	III
Move/position comatose/anesthetized patient	III
Select immobilization devices	III
B. Projections	
1. Standard	III
2. Magnification	III
3. Special	III

A and B are also knowledge areas.

ETHICS

		Level
A.	Rights and Expectations of the Patient	
	Consideration of and sensitivity to the rights and expectations of the patient to courteous, compassionate, discreet, competent, and safe handling in the radiological setting	
B.	Legal Requirements	
	Compliance with legal requirements pertaining to proper, competent, and safe handling in the radiological setting	
	Tasks	
	Maintain confidentiality of patient's records	I
	Transfer patient's file	I
	File radiographic reports	II
	Review physicians' orders and instructions with physician	III
	Refer to M.D. all questions by patient or family re findings (or results) of procedures	III
	Verify procedures to be performed on patient	III
	Maintain operating file of regulations, instructions and/or policies	V
	Plan and direct the maintenance and distribution of patients' reports and records	VI
	Establish and direct administrative operating policies, procedures and regulations	VI
C.	Professional Standards	
	Conformance to generally accepted professional standards of attitude and behavior	

Ethics

Tasks	Level
Actively seek to promote highest quality work performance in self and peers	III
Attempt to be cognizant of major changes in knowledge and procedures in radiologic field	III
Seek clarification of conflicting or unclear orders from physician or supervisors	III

RADIOGRAPHIC EQUIPMENT

A. X-Ray Tubes	Level
General Knowledge	
1. Target material	III
2. Inherent filtration	III
3. Focal spot	III
4. Stationary and rotation anodes (speed)	III
5. Energy loading capabilities (single and three phase)	III
6. Tube and tube housing construction	III
7. Tube rating charts (target loading capacity, anode cooling, housing cooling charts)	III
8. Manipulation of tube for the direction of central rays	III
Tasks	
Use of appropriate focal spot	III
Recognition of abnormal operating conditions	III
Recognition of abnormal conditions	III
Selection and use of tube rating charts; determination of appropriate technique factors	III
Recognition of related target problems	V
B. Collimator	
General Knowledge	
1. Types of collimators	III
Tasks	
Selection and use of proper collimating devices	III

Radiographic Equipment

C. X-Ray Control Console	Level
General Knowledge	
1. Identification of console tables	III
2. Basic knowledge of X-ray circuits and rectification	III
Tasks	
Manipulation of control corresponding to technique factors desired	III
Recognition of abnormal conditions related to portable units	III
Recognition and verifications of abnormal conditions related to rectification, timing, power supply	V
D. Generators	
General Knowledge	
1. Single and three phase	III
Tasks	
Technique adjustments from single to three phase	III
E. Tilt table	
General Knowledge	
1. Identification of table controls	III
Tasks	
Manipulation of table controls corresponding to position, procedure and patient needs	III

Radiographic Equipment

		Level
F.	Radiographic Films, Screens, Grids (stationary and moving), Film Holders	
	General Knowledge	
	1. Types of films, screens, grids in common use	III
	Tasks	
	Selection and use of films, screens, film holders, grids	III
	Care of films, screens, film holders, grids	III
	Recognition of common radiographic artifacts	III
G.	Processors (automatic and manual)	
	General Knowledge	
	1. Principles and techniques of operation	II
	2. Chemistry	II
	Tasks	
	Routine maintenance	II
	Changing and preparation of chemicals	II
	Recognition of abnormal operating conditions	II
	Retrieve silver from used fixer	II
	Maintain darkroom accessories	II
	Dryer; use and care of	II
	Standardization of processing	II
	Recognition of common processing artifacts	II
H.	Ancillary Equipment	
	General Knowledge	
	1. General understanding of items listed below	III

Radiographic Equipment

Tasks		Level
Use and care of :	Cassette changer (Vertical)	III
	Polaroid unit	III
	Automatic film changers	IV
	Pneumoencephalographic chair	IV
	Automatic injector	IV

I. Fluoroscopes

General Knowledge

1. Principles of operation of components of fluoroscopic units	III

Tasks

Use and care of:	Fluoroscopic tower	III
	Video tape	III
	Closed circuit TV	III
	Photo spot apparatus	III
	Cine cameras	III
	Spot film changer	III
	Image intensifier	III
	Operate video tape equipment	III
	Load cameras for cinefluorography	III

SPECIAL TECHNIQUES

		Level
A.	Stereo	
	Tasks	
	Select stereo shift-distance ratio	III
B.	Tomography	
	Tasks	
	Tomography	III
	Special tomographic procedures	IV
C.	Pediatrics	
	Tasks	
	Pediatric immobilization techniques	III
	Gonadal shielding for pediatric patients	III
D.	Operating Procedures	
	Tasks	
	Use mobile unit in O.R.	III
	Operate fixed equipment in O.R.	IV
	Assist physician in special procedures	IV
	Take blood pressure using sphygmomanometer and stethoscope	IV
	Prepare trays for special examinations	IV
	Construct catheters for special procedures	IV

E. Subtraction Techniques	Level
Tasks	
Select factors for serial magnification radiography	IV
Perform subtraction techniques	IV

ADMINISTRATION RESPONSIBILITIES

Task	Level
A. Staff Organization	
Prepare and submit job descriptions	V
Interview and evaluate prospective employees	V
Maintain operating files of regulations, instructions, and/or policies	V
Maintain radiology work record for statistical purposes	V
Modify work methods or procedures	V
Contact other departments to obtain/coordinate patient or personnel appointments	V
Writ' technical reports	V
Coordinate radiology activities with hospital administration	VI
Develop organizational function charts	VI
Establish and direct administrative operating policies, procedures and regulations	VI
B. Training and Supervision of Personnel	
1. Keeping Abreast of Current Technical Literature 2. Participate in Teaching and/or In-Service Training Programs 3. Administrative Aspects of Training/Supervision	
Conduct formal classroom instruction	IV
Conduct on-the-job training	IV
Operate audio-visual aids	IV
Teach formal classes	IV
Demonstrate clinical procedures using patient/ subje t	IV

Administration Responsibilities

	Level
Coordinate work function of volunteers (hours, patient handling, etc.)	V
Develop technical procedures for special radiology examinations	V
Establish, direct, and maintain quality control functions	V
Modify work methods and procedures	V
Schedule work assignments	V
Direct personnel in compliance with radiation control regulations	V
Resolve staff complaints	V
Resolve technical problems	V
Supervise technical staff	V
Investigate reports of unusual incidents	V
Arrange for training aids, space and equipment	V
Prepare employee ratings and counsel individuals in progression and career development	V
Orient newly assigned personnel	V
Plan, schedule, and evaluate training programs	V
Prepare, administer and score tests	V
Evaluate instructors	V
Select and assign instructors	V
Supervise training programs	V
Recruit trainees (students)	V
Undertake placement activities	V
Originate correspondence	V
Maintain an on-call roster of technicians	V

Administration Responsibilities

	Level
Prepare vacation schedule	V
Schedule appointments for clinic/department, e.g. maintain appointment book	V
Coordinate with supervisors/instructors on student training	V
Supervise darkroom procedures	V
Check/correct calculations performed by other technicians	V
Plan emergency evacuation of patients, establish emergency priorities	VI
Serve on employee relations boards	VI

C. Procurement of Equipment and Supplies

Prepare and submit supply requests	III
Establish an inventory system for supplies, equipment and material	V

D. Adequate Records

Tasks

Loan x-ray films to doctors/other departments	II
Prepare x-rays for mailing	II
Prepare radiographs for viewing by doctor	II
Prepare and maintain x-ray file envelopes	II
Assemble patient records for review by doctor	II
Maintain x-ray film library/file	II
Label and transfer specimen	III
Record in the log the patient, examination, exposures and/or films	III

Administration Responsibilities

	Level
Maintain technique chart	III
Log number of examinations and exposures made for each patient	III
Record/maintain records of experimental findings on tests	IV
Maintain operating file of regulations, instructions and/or policies	V
Maintain publications reference files	V
Maintain radiology work records for statistical purposes	V
Maintain and review student training records	V
Maintain personnel files	V
Maintain publications reference files	V
Review, retire, or dispose of films and x-ray indexes	V
Maintain log of quality control procedures	V
Develop procedures for data processing	VI
Plan and direct the maintenance and distribution of patient reports, records, and departmental records and correspondence	VI
E. Facilities Maintenance	
Coordinate physical plant work orders or requests	V
Plan or modify radiology facilities physical	VI
Develop and schedule contract preventive maintenance programs	VI
F. Financial Management	
Work up budget estimates and justification	VI
Develop and prepare cost analysis data	VI

Administration Responsibilities

	Level
G. Patient Procedures	
Prepare patient examination schedule	V
Develop patient instruction forms for radiologic examination	V
Write exposure technique chart for x-ray	V

Part 4:

SECTION A:

PROFICIENCY EXAMINATION CONTENT SPECIFICATIONS FOR

LEVEL III DIAGNOSTIC RADIOLOGIC TECHNOLOGY PERSONNEL

I. Radiation Protection

Weight 12%

1-1.5% A. Monitoring

3.5% B. Shielding

1. Patients

2. Personnel

1-1.5% C. Units of measure and permissible levels

2.5% D. Radiation effects (e.g., pregnancy)

3.5% E. Technical considerations in reducing radiation exposure and frequency of retakes

1. Filtration

2. Film speeds

3. Types of intensifying screens

4. kVp

5. Collimation

II. Technique and Quality Control

Weight 30%

3.5% A. X-ray production

5% B. X-ray films and screens

7.5% C. Technique conversions

1. kV
2. mA
3. Distance
4. Grids
5. Time
6. Filters (copper, aluminum, etc.)
7. Technique adjustments between single and 3-phase

3.5% D. Film processing

2% E. Artifacts

5% F. Image quality

3.5% G. Control of secondary radiation

III. Patient Care

Weight 10%

3% A. Nursing procedures

1. Trauma patient
2. Infectious control
3. Handling of patients

2% B. Aseptic techniques

2% C. Emergency procedures

3% D. Contrast agents (media)

1. Effects and reactions

IV. Positioning

Weight 30%

15% A. Anatomy

1. Normal

2. Pathological

15% B. Standard projections

1. Magnification

V. Ethics

Weight 3%

.5-1% A. Maintenance of records

.5-1% B. Confidentiality of communications

.5-1% C. Professional attitudes

.5-1% D. Legal responsibilities

.5-1% E. Interprofessional relationships

VI. Radiographic Equipment and Operator Maintenance

Weight 10%

1% A. X-ray tubes

1. Tube rating charts

1% B. Grids

2% C. Standardization of equipment

1. Rectification

2. Spin tops

3. Step wedges

1% D. Generators (portable equipment)

1% E. Preventive maintenance

1% F. Basic electricity

1. Safety and hazards

3% G. Automatic processing and maintenance

VII. Special Techniques

Weight 5%

1% A. Stereo

1% B. Body section radiography

1% C. Pelvimetry

1% D. Image intensification of phototiming

1% E. Mobil units

SECTION B:

PROFICIENCY EXAMINATION ABILITIES SPECIFICATIONS FOR LEVEL III DIAGNOSTIC RADIOLOGIC TECHNOLOGY PERSONNEL

Part 1 - Description of Abilities

The Committee of Examiners for the Diagnostic Radiologic Technology Proficiency Examination decided to test five levels of mental ability*: knowledge, comprehension, application, analysis, and evaluation. This list of the abilities is in the order of increasing complexity of the mental processes involved. The first level in the classification, knowledge, is the one that involves the least complex mental ability. In general, successful mastery of the first level is required before a person can demonstrate competence at any of the higher levels. The following explanation with examples of questions at different ability levels was designed to assist item writers in preparing questions at these levels of mental ability.

I. KNOWLEDGE

The knowledge level emphasizes the processes of remembering. In answering a knowledge question, the test-taker does little more than recognize the appropriate response from among those offered. He may be required to alter to some small extent the material he knows in order that he may recognize the correct response, but this alteration is a relatively minor part of the task.

1. The plane that divides the body into right and left halves is called

   (A) sagittal
   (B) transverse
   (C) lateral
   (D) medial
   (E) coronal

   Answer: A

*This classification of abilities is based on one which was developed by a group of college and university examiners and published as the Taxonomy of Educational Objectives (Benjamin S. Bloom, Ed., David McKay Co. Inc., New York).

2. All of the following procedures help to reduce patient exposure to ionizing radiation EXCEPT

   (A) using cones

   (B) using filtration

   (C) using fast screens

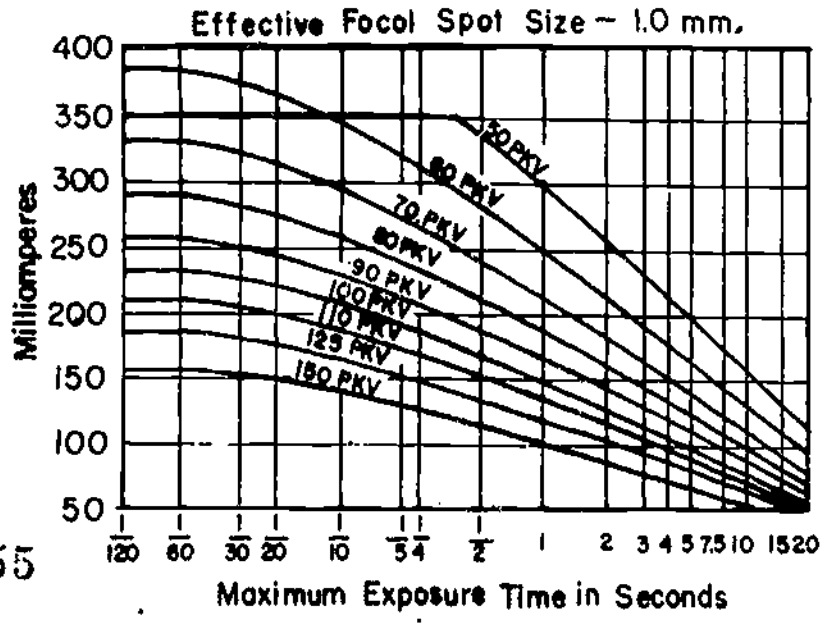
   (D) increasing mAs

   (E) choosing high-speed films Answer: D

II. COMPREHENSION

Questions testing the comprehension ability require the type of understanding that an individual needs in order to understand a communication and to make use of the material in the communication without necessarily seeing its full implications. Notice that for a question to fall into this category the question must present some kind of communication that is to be comprehended. The following, when associated with a given communication, may be comprehension questions:

I. What is the meaning of a given statement, diagram, or formula?
II. How can the meaning of a given formula, equation, or graph be expressed in different form without changing the meaning?
III. What extrapolation of given quantitative data is reasonable?
IV. Which of the following occurrences is an example of a theory or law that is explicitly stated in the question?



3. From the tube rating chart above, supplied by the manufacturer for a specific model x-ray tube used on full wave, single-phase operation, one finds that the maximum time for an exposure using 80 kilowatts peak and 200 milliamperes is

   (A) over 10 sec.

   (B) 1.5 sec.

   (C) 3/4 sec.

   (D) 1/5 sec.

   (E) less than 1/5 sec. Answer: C

III. APPLICATION

Application questions require that the test-taker rearrange material he has learned in order to select the answers. The rearrangement may seem slight to a person sophisticated in the field being tested, but a person who does not understand what he has "learned" has little chance of answering such questions correctly. Problems involving mathematical manipulations and substitution in formulas are of this type. If an application has been explicitly presented to a test-taker, a question based on that application becomes a knowledge question for that test-taker since he can answer the question by recalling the presentation. Questions similar to the following may be application questions for many test-takers:

I. What scientific principle is applicable in a given situation, which may or may not be familiar?
II. What applications illustrate a scientific principle that is not stated in the question though it may be named?
III. What effect would a specific change in a part of the system have on another part of the system or on the system as a whole? (System may have a biological or a physical connotation.)
IV. What experimental procedures might be useful in attacking a particular problem, a problem that the test-taker has not faced before?
V. In what ways does previously learned material (definitions, laws, concepts, formulas, etc.) apply to a situation that is not familiar?

4. A radiograph of a lateral lumbar spine appears almost black in the L-1 region, and very light in the lumbosacral area. To correct this problem, the radiologic technologist should

   (A) double the mA

   (B) increase the exposure time

   (C) use a higher ratio grid

   (D) increase the kVp and decrease the mAs

   (E) increase the mAs and decrease the kVp Answer: D

5. A good radiograph of the cervical spine is produced by using a 72-inch target-film distance, 20 milliampere seconds, and 70 kilovolts. Provided all other factors remained the same, how many milliampere seconds would be required if the distance is reduced to 36 inches?

   (A) 80 mAs

   (B) 40 mAs

   (C) 25 mAs

   (D) 10 mAs

   (E) 5 mAs

IV. ANALYSIS

The analysis objectives emphasize the breakdown of a communication into its constituent parts, the identification of the relationships of the parts, and detection of the way in which the parts are organized. The communication, which must be presented with the question or questions, may be the details of an experiment, an array of data, the steps in an argument, and so forth. Analysis questions may also be directed at the techniques and devices used to convey the meaning or to establish the conclusions of a communication. Possible enalysis questions are suggested by the following:

I. What part of the communication is the conclusion?
II. What part or parts support the stated conclusion and what parts contradict it?

III. What part of the communication is factual and what part is hypothetical?
IV. What is a hypothesis that can be tested by an experimental design presented in the communication?
V. Is a given hypothesis consistent with the information in the communication?
VI. What are the logical fallacies in the arguments presented?
VII. What are unstated assumptions associated with material in the communication?

Questions 6-7 are based on the following passage. (Though not from the field of radiologic technology, the passage and questions illustrate the nature of analysis questions.)

(1) Tomatoes grow well in air containing 0.03% carbon dioxide. (2) This is the amount usually found in the atmosphere. (3) A researcher found that he could increase the yield of tomatoes by increasing the CO_2 concentration to 1.0%. (4) Concentrations exceeding 1.0% did not yield a satisfactory growth response. (5) He also found that windy days and high light intensity increased the growth of tomatoes.

6. Which of the sentences in this report is NOT a conclusion based on horticultural research?

(A) 1 (B) 2 (C) 3 (D) 4 (E) 5 Answer: B

7. Which of the following would have supplied the strongest support for the report that "concentrations exceeding 1.0 percent did NOT yield a satisfactory growth response"?

(A) Tomatoes grown in 1 percent CO_2 have a somewhat different flavor from those grown in 0.03 percent CO_2.

(B) Tomatoes grown in 1 percent CO_2 have a somewhat different color from those grown in 0.03 percent CO_2.

(C) Tomato plants grown in 1 percent CO_2 are taller than those grown in 0.03 percent CO_2.

(D) Tomato plants grown in 1 percent CO_2 produce fewer tomatoes than those grown in 0.03 percent CO_2.

(E) Fewer of the leaves on tomato plants grown in 1 percent CO_2 have wormholes than do leaves of plants in 0.03 percent CO_2.

Answer: D

V. EVALUATION

For a question to be placed in this category, it must require the use of two or more criteria when the question is answered. In a sense the answering of any question requires the application of at least one criterion: To give the number of inches in a foot, for example, one uses the knowledge that there are 12 inches in a foot. The answering of an evaluation question requires not only the application of knowledge such as this but also the use of a second criterion such as, for example, which of the options acceptable as judged by the first criterion, if the safest. The options offered must necessitate the use of both criteria to determine the correct response. Possible evaluation questions include the following:

I. Which of several suggested procedures is not only acceptable for achieving a stated goal but also meets an added criterion such as fastest, cheapest, most accurate?

II. Which of the suggested options meets two simultaneous criteria for acceptability?

8. You have selected the 100-milliampere station on your x-ray generator. During the exposure, however, you notice a reading of 50 on the milliammeter. The most likely cause for this would be that

(A) the x-ray tube is gassy

(B) two of the four valve tubes are defective

(C) one valve tube is not operating

(D) the meter is defective

(E) there is a line voltage drop Answer: C

(Note: Several of the options can cause the effect described. Of these, the correct response is the one that is most likely to be the cause.)

Part 2 - Abilities Specifications

Examination Weight	Category
25%	Knowledge
15%	Comprehension
40%	Application
15%	Analysis
5%	Evaluation

Part 5:

A GUIDE FOR EDUCATIONAL CURRICULUM DESIGN IN DIAGNOSTIC RADIOLOGIC TECHNOLOGY: LEVEL III

I. Radiation Protection

A. Monitoring

1. Use of personnel monitoring devices
2. Pocket dosimeters

B. Shielding

1. Basic principles of time, distance, and shielding
2. Use of lead aprons and gloves
3. Ancillary shielding devices in fluoroscopy
4. Gonadal shielding

C. Units of measure and permissible levels

1. Basic terminology
2. Concept of maximum permissible dose

D. Radiation effects

1. Potential genetic and somatic effects of ionizing radiation
2. Special radiation sensitivity during pregnancy

E. Technical considerations in reducing radiation exposure and frequency of retakes

1. kVp and mAs selection
2. Collimation

3. Fixed cones and extension cylinders
4. Filtration
5. Film speeds
6. Types of intensifying screens

F. Electrical and mechanical safety

1. Maintaining integrity of cables and wiring
2. Grounding
3. Uses of explosion-proof equipment

II. Technique and Quality Control

A. X-ray examinations

1. Assisting physicians with non-exposure aspects of radiographic procedures -

Brochograms

Gynecograms

Hysterosalpingograms

Cholangiograms

Intravenous pyelograms

Pneumocystograms

Urographic studies

Sialograms

Upper GI series

X-rays for contrast studies of large bowel

X-rays of small intestine

Fistula or sinus tract X-rays

Ventriculograms

2. Determining, selection of technical factors, and making exposure in radiographic procedures -

Paranasal X-rays

X-rays of ribs and sternum

Tomograms

Macroradiograms

Mammograms

Scanograms

Steresoscopic X-rays

X-rays for pelvimetric studies

Foreign body localization X-rays of extremities

Foreign body localization X-rays of eye

Foreign body localization X-rays of skull

Foreign body localization X-rays of thorax

Photofluorograms

Retrograde cystogram

Retrograde pyelogram

Abdominal X-rays

Cervical spine X-rays

Facial X-rays

Lumbar spine X-rays

Mastoid X-rays

Skull X-rays

Thoracic spine X-rays

X-rays of lower extremities

X-rays of upper extremities

X-rays of kidney/ureter/bladder

X-rays of mandible

X-rays of sacrum and coccyx

X-rays of temporomandibular joints

Sialograms

II. A. 2. (con't)

Urethrograms

Bronchograms

Cystograms

Hysterosalpingograms

Intravenous cholangiograms

Intravenous pyelograms

Long bone X-ray series

X-rays for contrast studies of large bowel or colon

Phlebograms

Pneumocystograms

X-rays for bone age radiographs

X-rays for cholecystographic studies

X-rays for metastatic surveys

X-rays for Upper GI series

X-rays for small intestines

Fetograms

Placentograms

Renal loopogram

Hypertensive intravenous pyelograms

Spinal X-rays

Chest X-rays

Lymphangiograms

3. Operating special equipment

a) Cinefluorographic equipment

b) Image intensifier fluoroscopic units

c) Mobile X-ray units

II. B. X-ray production

1. Determining and selecting kilovoltage, milliamperage, and exposure time
2. Screen techniques
3. Fixed grid technique
4. Nonscreen technique
5. Bucky technique
6. Testing cassettes for screen fi m contact
7. Identifying radiographic subject
8. Formulating technique charts
9. Utilizing technique and tube loading charts

C. Films, screens, film holders and grids

1. Types commonly employed
2. Selection and use
3. Care and handling

   Storage, loading and unloading magazines, loading cameras for cinefluorography, cleaning screens and cassettes
4. Assembly, indexing, and filing of X-ray films
5. Polaroid units

D. Technique conversions

1. kVp
2. mA
3. Distance
4. Time
5. Grids
6. Collimation
7. Filters
8. Technique adjustments between single and 3-phase
9. Modification of technical factors due to unusual patient requirements

II. E. Film processing

1. Postexposure radiograph identification
2. Darkroom light leaks and safelight safety check
3. Physical environment of film storage areas
4. Preparation and replenishment of processing solutions
5. Film development
   a) Medical X-ray films
   b) Industrial X-ray films
   c) Automatic processing machines
6. Image reproduction
   a) Direct duplication method

F. Artifacts

1. Common radiographic artifacts
2. Common processing artifacts

G. Image quality

1. Factors determining variation
2. Reviewing films for technical adequacy
3. Evaluating development techniques

H. Film systems

1. Optimizing technique and processing to a film

I. Control of secondary radiation

1. Kilovoltage
2. Anatomical composition of patient

III. Patient Care

A. Nursing procedures

1. Trauma patients

III. A. (cont'd)

2. Control of infections
3. Handling of patients
   a) Transport and transfer
   b) Draping and gowning
   c) Physical restraint and control
4. Immobilization
   a) Selecting immobilization devices
   b) Applying and removing splints, bivalve casts, and slings
   c) Pediatric immobilization
5. Communicating with patients
   a) Receiving patients
   b) Specimens
   c) Technical direction and instruction to patients
   d) X-ray procedures
   e) Anxious patients
   f) Pediatric patients and their parents
6. Other nursing procedures
   a) Measuring and weighing patients
   b) Checking for contraindication
   c) Reviewing clinical history
   d) Verifying patient identification and ascertaining patient preparation for procedure
   e) Checking patient's temperature
   f) Checking blood pressure
   g) Checking radial, femoral, pedal, and carotid pulses
   h) Regulating I.V. flow
   i) Labeling specimens
   j) Recognizing changes in patient's condition
   k) Observing and recording physical and emotional responses to procedures

III. B. Aseptic techniques

1. Washing and sterilizing treatment facilities
2. Use of sterile equipment
3. Cleaning radiographic equipment
4. Disposal of contaminated items

C. Emergency procedures and first aid

1. Respiratory impairment
2. Cardiac arrest
3. External hemorrhage
4. Severe drug reaction
5. Shock
6. Head injury
7. External cardiac massage
8. Oxygen
9. Standard first aid treatment
10. Moving and positioning patients with suspected spinal fracture or cord injuries

D. Contrast agents (media)

1. Basic contrast materials and their use
2. Recognizing effects and reactions

IV. Positioning

A. Anatomy

1. Normal
   a) Positioning patients
   b) Placing patient in radiographic position
   c) Adjusting the X-ray positioner
2. Abnormal
   a) Positioning patients for treatment

IV. A. 2. (cont'd)

b) Moving and positioning abnormal patients

suspected trauma

head injuries

suspected internal injuries

comatose/anesthetized patient

B. Projections

1. Standard
2. Magnification
3. Special

V. Ethics

A. Maintenance of records

1. Filing radiographic reports
2. Transferring patients' files

B. Confidentiality of communications

C. Professional attitudes

1. Rights and expectations of patients
2. Promoting highest quality work performance
3. Keeping abreast of major changes in knowledge and procedures
4. Standards of attitudes and behavior

D. Legal responsibilities and interprofessional relationships

1. Reviewing orders and instructions with the physician
2. Clarifying orders from physicians or supervisors
3. Referral of questions to the physician
4. Verifying procedures to be performed

VI. Radiographic equipment and operator maintenance

A. X-ray tubes
   1. Target materials
   2. Inherent filtration
   3. Focal spot
   4. Stationary and rotation anodes (speed)
   5. Energy loading capabilities (single and three-phase)
   6. Tube and tube housing construction
   7. Tube rating charts
      a) Target loading capacity
      b) Anode cooling
      c) Housing cooling charts
      d) Selection and use
      e) Determination of appropriate technique factors

B. Grids

C. Standardization of equipment
   1. Rectification
   2. Spin tops
   3. Step wedges

D. Generators (portable equipment)
   1. Single and three-phase types
   2. Technique adjustments from single to three-phase

E. Preventive maintenance
   1. Use of appropriate focal spot
   2. Recognition of abnormal conditions

F. Basic Electricity
   1. Safety and hazards

G. Film processors and maintenance
   1. Principles and techniques of operation
   2. Chemistry

VI. G. (cont'd)

3. Routine maintenance
4. Darkroom accessory maintenance
5. Use and care of dryers
6. Standardization of processing
7. Recognition of abnormal operating conditions
8. Retrieving silver from used fixer

H. Collimators

1. Types
2. Selection and use

I. X-ray control consoles

1. Identification of console tables
2. Manipulation of control corresponding to technique factors desired

J. Tilt tables

1. Identification of controls
2. Manipulation of controls

K. Ancillary equipment

1. Cassette changer
2. Polaroid units

L. Fluoroscopes

1. Principles of operation of fluoroscopic unit component
2. Equipment use and care
   a) Fluoroscopic tower
   b) Video tape
   c) Closed circuit TV
   d) Photo spot apparatus
   e) Cine cameras
   f) Spot film changer
   g) Image intensifier

VII. Special Techniques

- A. Stereo
  - 1. Selecting stereo shift-distance ratio
  - 2. Operating video tape equipment
- B. Body section radiography
- C. Pelvimetry
- D. Image intensification and phototiming
- E. Mobile units
  - 1. Use in operating room

Part 6:

RECOMMENDED POLICIES AND PROCEDURES FOR CREDENTIALING LEVEL III DIAGNOSTIC RADIOLOGIC TECHNOLOGY PERSONNEL

A. Minimum proficiency test standards

1. Correctly answer 85% of all proficiency test questions designated by the Credentialing Subcommittee of the Advisory Committee as minimum competency questions.

and:

2. Correctly answer 75% of all such minimum competency questions in each of the following content categories (as defined in the Delineation of Roles, Function and Responsibilities of Radiologic Technology Personnel produced as part of this project): Radiation Protection and Safety, Technique and Quality Control, Positioning, and Radiographic Equipment.

B. Other qualifications standards

1. Secondary school diploma or equivalent

2. Either: Successful completion of an educational program in diagnostic radiologic technology accredited by an agency recognized by the U.S. Commissioner of Education,

or: Two years progressive work experience as a staff diagnostic radiologic technologist utilizing diagnostic radiographic equipment under direction of either a board-certified or board-eligible radiologist or registered radiologic technologist,

or: Three years experience in utilizing diagnostic radiographic equipment in a clinical setting.

C. Responsibility for credentialing

It is recommended that the American Registry of Radiologic Technologists govern the administration of the examinations and issue credentials.

D. Other recommended policies and procedures

1. Candidates should be screened on the qualification standards in B, above, prior to admission to the examination

2. Implementation of this credentialing system should be expedited by the U.S. Department of Health, Education, and welfare.

Part 7:

POTENTIAL USE OF AUDIOVISUAL INSTRUCTIONAL MATERIALS FOR PROFICIENCY TESTING IN DIAGNOSTIC RADIOLOGIC TECHNOLOGY

I. General Considerations

Selection of audiovisual media to be used will require careful analysis of technical adequacy, cost of production, equipment required for presenting the audiovisual display, and physical facility requirements.

Questions relating to these four broad areas are listed below:

A. Technical Adequacy

1. Does the medium provide adequate resolution of detail?

2. Are relevant stimulus characteristics presented with adequate realism?

B. Cost of production

1. What is the production cost per test?

2. How often must the materials be replaced and what is the ease and cost of replacement?

   a. replacement due to damage or loss

   b. replacement due to updating or revising needs

C. Equipment required

1. What is the cost per unit?

2. Is it practical for testing in large group settings?

3. Is equipment operating simple?

4. What are the maintenance costs?

5. Can equipment and materials be easily shipped or transported without breakage?

6. How dependable and expensive is shipping?

7. Can equipment be rented for testing purposes?

8. Is proper storage space available for both equipment and materials when not in use?

9. Are personnel available for maintenance of equipment?

10. How expensive are replacement parts?

D. Physical facility requirements

1. If equipment requires electrical outlets for each individual in the testing situation, are there enough outlets and is sufficient power available?

2. If equipment is battery operated, how bright an image is required for standardization?

3. Do overhead lights need to be dimmed for better individual viewing of visual test items?

4. How large an examinee work space is required for optimal testing?

II. Potentially Applicable Testing Materials

The essential materials adaptable for inclusion in proficiency tests in diagnostic radiologic technology consist of static, black and white visual images, including radiographs, photographs, line drawings and graphs. By and large, color, motion, and sound are not required. (Possible exceptions are noted in the succeeding sections.)

Media meeting the above criteria include images reproduced on paper, 35mm slides (or filmstrips), and radiographs. Microfiche and other film media of smaller dimension than 35mm are judged to provide less than minimally acceptable resolution of detail for many areas of application.

Of the three media recommended above, reproduction on paper is the least expensive and most practical to administer. Actual radiographs are expensive and somewhat cumbersome to use in standardized large group testing administrations. Projected slides fall in between the former media in costs, but probably invite the most administration problems in large scale testing.

Reproduction on paper is an adequate medium for line drawings, graphs, and photographs. Paper reproduction of radiographs is acceptable for use in identifying anatomical structures (although line drawings are often adequate in this application). Actual radiographs are definitely preferable for use in identifying technical deficiences. Slides are a second choice over paper reproductions and actual radiographs in testing a number of knowledge and skill areas.

III. Knowledge and Skills Requirements Recommended for Testing with the Assistance of Audiovisual Media

The left-hand column of Table 1 identified those knowledge with skills requirements of Level III personnel judged to be most efficiently and effectively examined through the use of audiovisual media. The use of audiovisual materials in the three areas linked to the motion picture medium (nursing procedures, contrast agents (media), and ethics) is considered

to be desirable, but of a lower order of priority as compared to the other knowledge and skills requirements.

IV. Audiovisual Materials Recommended for Inclusion in Proficiency Tests for Level III Personnel

The remaining columns of Table 1 describe the recommended medium and maximum number of media units (images or motion pictures) for inclusion in each form of a proficiency test for Level III personnel. Line drawings and photographs may be incorporated in the test book. Radiographs refer to reproductions of original radiographs on standard size (14" x 17") radiographic film plates. As indicated on the "Total" line at the bottom of Table 1, it is recommended that each form of the test include up to 67 line drawings, 3 motion pictures, 9 photographs, and 23 radiographs.[1] The response mode for all test questions associated with audiovisual materials will be written paper and pencil. It is proposed that one set of radiographs be made available for every 30 candidates tested in one room at one time, and that at least one set be available for each test administration room.

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1 This recommendation represents a maximum amount of audiovisual materials, assuming every knowledge and skill indicated for audiovisual materials will 1) require separate media units and 2) non-visual questions could not be substituted adequately for any of the indicated knowledges and skills. On the other hand, there is substantial likelihood that in some instances 1) two or more knowledge and skill requirements can be adequately tested with the same audiovisual materials and 2) non-visual questions can be generated which will function with equivalent validity. The degree of "shrinkage" possible in the total number of media units is dependent upon the specific audiovisual materials and questions available. The present maximum estimate is designed to be generous in order to provide for a wide range of potentially available materials and questions in future forms of the tests.

With respect to motion pictures, it should be noted that their inclusion in the testing program necessitates special equipment and facility requirements as reflected in the questions listed in Sections C and D of the General Considerations at the beginning of this report. In contrast, elimination of motion pictures eliminates these considerations. Further, the cost of producing and reproducing motion pictures is comparatively high. Consequently, the decision to include motion pictures in the testing program should receive careful review in terms of costs and practicality vs. unique contribution to measurement prior to actual commitment of funds.

V. Cost Estimates

Approximate development and reproduction costs for audio-visual materials described in Table 1 are presented in Table 2.

TABLE 1

Recommended Use of Audiovisual Materials in Proficiency Testing of Level III Diagnostic Radiologic Technology Personnel:

Knowledge and Skills Requirements, Media, and Suggested Number of Media Units

Knowledge and Skills Requirements	Medium[1]	Number of Media Units
Radiation Protection		
-Shielding	L	4
Technique and Quality Control		
-X-ray production	L	3
-Technique conversions		
kVp	R	3
mA	R	3
distance	L	3
grids	R	3
time	R	3
filters	L	3
technique adjustments	L	3
collimators	L	2
	R	3
-Artifacts	P	5[2]
-Image quality	R	4
Patient Care		
-Nursing procedures	M	1
-Contrast agents (media)	M	1
Positioning		
-Anatomy, normal	L	15
-Anatomy, abnormal	L	3
-Standard projections	L	10
magnification	L	3

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1. Legend: L = Line drawings M = Motion pictures P = Photographs R = Radiographs
2. Printed radiographic reproductions on paper

TABLE 1
(con't)

Knowledge and Skills Requirements	Medium[1]	Number of Media Units
Ethics	M	1
Radiographic Equipment and Operator Maintenance		
-X-ray tubes		
tube rating charts	L	3
-Grids	L	2
-Standardization of equipment		
spin tops	L	2
step wedges	R	2
-Preventive maintenance	L P	1 1
-Basic electricity		
safety and hazards	L P	1 1
-Automatic processing and maintenance	L P	2 2
Special Techniques		
-Body section radiography	L R	2 2
-Pelvimetry	L	2
-Image itensification and phototiming	L	3
TOTALS	L 3 M P R	67 3 9 23

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3. Averaging approximately 10 to 15 minutes in length for each.

TABLE 2

Cost Estimates for Development and Reproduction of Audiovisual Materials Recommended for Proficienty Testing of Level III Diagnostic Radiologic Technology Personnel, Per Test Form

	Materials			
	Line Drawings	Motion Pictures	Photo-graphs	Radio graphs
Number of media units	67	3	9	23
Original development costs	$3,350.00[1]	$37,500.00[2]	$315.00[3]	$575.00[4]
Reproduction costs:				
per testing room		125.00		92.00
per candidate	5.70	4.10[5]	.50	3.00[6]

Total development costs:	
with motion pictures	$41,740.00
without motion pictures	4,240.00
Total reproduction costs, per candidate:	
with motion pictures	13.30
without motion pictures	9.20

1. @ $50.00 per unit
2. @ $1,000.00 per minute
3. @ $35.00 per unit
4. @ $25.00 per unit
5. Assumes average of 30 candidates per testing room and one test administration per set of materials.