TRAINING AND QUALIFICATION OF RADIOGRAPHIC PERSONNEL

TABLE OF REVISIONS

Date	Section	Change Made	Rev. No.	Page No.	Revised By
		Original Issue	0		R. Pfannenstiel
1/10/81	II.A.1.	Added Code Rule 38	1	1	R. Pfannenstiel
"	App. C, IV	Added Code Rule 38	1	14	R. Pfannenstiel
2/6/84	Rev. Page	Added	2	1	R. Pfannenstiel
"	Contents	New Contents, New Section Ident.	2	i	R. Pfannenstiel
"	A.	New Section Ident.	2	2	R. Pfannenstiel
"	A.II.B.2.	Added Code Rule 38	2	2	R. Pfannenstiel
"	B.	New Section Ident. in New Order	2	5	R. Pfannenstiel
"	B.IV.D.	New Appendix	2	6	R. Pfannenstiel
"	C.	New Section Ident.	2	7	R. Pfannenstiel
"	App.B.3.	Changed (3) & (4)	2	15	R. Pfannenstiel
"	App. E	Added	2	24,25	R. Pfannenstiel
"	App. F	Added	2	26	R. Pfannenstiel
"	App. G	Added	2	27	R. Pfannenstiel
"	App. H	New Heading, Additional Material	2	Several	R. Pfannenstiel
8/15/84	Sec. B	Deleted	3	-	R. Pfannenstiel
"	Sec. C	Deleted	3	-	R. Pfannenstiel
"	App. A	Rewritten	3	10	R. Pfannenstiel
"	App. B	Rewritten	3	12	R. Pfannenstiel
"	App. C	Rewritten	3	14	R. Pfannenstiel
"	App. D	Rewritten	3	22	R. Pfannenstiel
"	App. H	Deleted	3	-	R. Pfannenstiel
"	Sec. A.1.	Revised	3	3	R. Pfannenstiel
"	Sec. A.2.	Revised	3	3	R. Pfannenstiel
"	Sec. A.3.	Revised	3	6	R. Pfannenstiel
"	Contents	Revised	3	2	R. Pfannenstiel
9/6/85	Sec.II A2,3	Revised	4	4,5	D. Kidney
"	Sec.II B 3,4, 5,6,7	Revised	4	6,7	D. Kidney
"	Sec.II B	Revised	4	8	D. Kidney

TRAINING AND QUALIFICATION OF RADIOGRAPHIC PERSONNEL

CONTENTS

A. TRAINING AND QUALIFICATION OF RADIOGRAPHIC PERSONNEL

I. General

Training and qualificaton of radiographic personnel at Trutom shall be accomplished in accordance with this Procedure. This Procedure is written in accordance with CFR Part 34, US NRC Regulatory Guide 10.6, Appendix C, and New York State "Industrial Code Rule 38".

The training and qualification procedures detailed herein are soley for the purpose of assuring that radiographic personnel employed by Trutom work in a safe manner, within the New York State and Federal regulations and Trutom's "Emergency and Operating Procedures T78-46", latest revision.

Technical competence as it relates to NDT and inspection shall require separate training and qualification.

Personnel shall be qualified in the following categories:

a. Radiographer's Assistant (Trainee)

b. Radiographer's Assistant

c. Radiographer

II. Training and Qualification of Personnel with No Previous Experience

A. Radiographer's Assistant

1. Personnel may not act as Radiographer's Assistants until they have completed the requirements of this section. Until that time they shall be considered trainees. They shall not perform any source manipulations, surveys, etc., unless under the direct supervision of a radiographer who is physically present and actually watching and instructing the individual. At no time will the radiographer allow the trainee to handle the source unless he is standing by his side and watching everything he does.

2. Prior to being allowed into radiation areas, the trainee shall undergo the following classroom training and examination. He shall be presented with and directed to read and study Trutom's "Operating & Emergency Procedures" and "Industrial Code Rule 38". The RSO or his appointee shall give direct classroom training using the following outline:

continued. . .

		Hours
a)	Wearing of Film Badges	¼
b)	Importance of Film Badges	¼
c)	Use of Dosimeters	½
d)	Use of Survey Meters	½
e)	What to do if Dosimeter is Reading Over Scale	¼
f)	Operation of Alarm System	¼
g)	Radiation Levels for Restricted Areas	1
h)	Limitations of Duties of Radiographer's Asst.	1
i)	Safety Inspection of Equipment	2
j)	Actions to be Taken in Emergency Sitations	1
k)	Safe Operation of Exposure Devices	3
l)	Operating and Emergency Procedure	5
	Total	15

At the conclusion of the classroom training, the RSO shall administer a written 25-question examination. The examination shall be closed-book and shall cover the subjects from the above course outline. A sample examination is found in Appendix A to this Procedure. The trainee must score 70% or better to be eligible for the next phase of training. A score of less than 70% shall necessitate six more hours of training given by the RSO. The additional training shall be from the above course outline with emphasis on the areas with which the trainee had the most problems. The exam shall be changed each time it is used.

3. After the classroom training has been successfully accomplished, then the trainee shall be assigned to a radiographer for field training. He shall observe operation of exposure devices and survey instruments while assisting the radiographer in all other aspects of his daily routine. The radiographer shall instruct the trainee in the proper techniques for using this equipment, but shall not allow the trainee to do any of the operations unless the radiographer is standing by his side and watching closely everything the trainee does. After a minimum of 40 hrs. of field training the radiographer shall give a written evaluation of the trainee's progress to the RSO.

4. If, in the opinion of the radiographer, the trainee has shown a responsible attitude and has learned equipment operation, survey techniques and safety procedures, he shall then be given a field examination by the RSO. If, in the opinion of the radiographer, the trainee has a poor attitude towards safety or has not shown the ability to

continued. . .

learn or comprehend fully the importance of the safety procedures, the trainee shall be re-assigned to nonradiographic responsibilities or terminated. The field examination shall consist of at least 10 checkpoints and shall cover emergency procedures, surveys, posting, equipment inspection and handling, etc. The trainee must receive a grade of 70% or better. Failure of the exam shall necessitate an additional 40hrsof field instruction by the radiographer prior to re-testing. A typical field examination for qualification to radiographer's assistant is included in Appendix B to this Procedure.

5. Upon successful completion of the above training, favorable evaluation and successful examinations, the trainee shall assume the duties and responsibilities of radiographer's assistant. The RSO shall maintain on file for a minimum of three years the following information on each radiographer's assistant:

   a) Outline of training course and course attendance record.

   b) Written examination and re-tests, as applicable.

   c) Written evaluation by radiographer.

   d) Dates and records of field training received.

   e) Record of field examination.

   f) Certifying statement signed by RSO that the trainee has met all the above requirements and is now a qualified radiographer's assistant in accordance with this Procedure, NRC regulations and New York State regulations.

B. Radiographer

1. Before an individual may become eligible for promotion to radiographer, he msut receive the following classroom and on-the-job training.

2. On-the-job training shall be that time which is spent performing the duties of radiographer's assistant. At no time shall on-the-job training time be credited if the individual has not completed the requirements for and been certified as a radiographer's assistant. The radiographer with which the assistant works shall administer on-the-job training. The emphasis of on-the-job training shall be to teach the assistant to be a self-sufficient radiographer. The assistant may perform all of the duties of radiographer. However, the radiographer must be physically present and must double-check all safety related tasks performed. During this time, the radiographer shall be totally responsible for all radiographic operations performed by the assistant.

continued. . .

3. After a minimum of 520 hours of on-the-job training, the radiographer who is responsible for the assistant shall give a written evaluation to the Radiation Safety Officer of the assista progreess and suitability for promotion to radiographer. This evaluation shall be based on attitude, knowledge of operating and emergency procedures, knowledge of equipment, and knowledge of pertinent government regulations. A favorable evaluation shall make the assistant elegible for promotion. An evaluation other han favorable shall necessitate more on-the-job training. It may also be possible that the assistant does not have the ability to promoted and may be kept as as assistant indefinitely.

4. Classroon training shall take place at any time during the on-the-job training. Thr Radiation Safety Officer shall administer the class oom training in accordance with the following course outline:

		Minimum Hours
I.	Fundamentals of Radiation Safety	12
	A. Characteristics of gamma radiation.	
	B. Units of radiation dose (mrem) and quantity of radioactivity (curie).	
	C. Hazards of exposure to radiation.	
	D. Levels of radiation from licensed material.	
	E. Methods of controlling radiation dose: 1. Working time. 2. Working distances. 3. Shielding.	
II.	Radiation Detection Instrumentation to be Used	6
	A. Use of radiation survey instruments: 1. Operation. 2. Calibration. 3. Limitations.	
	B. Survey Techniques	
	C. Use of personnel monitoring equipment: 1. Film badges and thermoluminescent dosimeters (TLD's). 2. Pocket dosimeters.	
II	Radiographic Equipment to be Used	6
	A. Remote handling equipment.	
	B. Radiographic exposure devices.	
	C. Storage containers.	
IV.	Inspection and Maintenance Performed by the Radiographers	8
V.	Case Histories of Radiography Accidents	8
VI.	Operating & Emergency Procedures	5
VII.	Requirements of Pertinent Federal and NYS Regulations Including 10 CFR, Parts 19, 20, 21, 34 and NYS Code Rule 38	5
	Total Hrs.	50

5. At the completion of this classroom training, the Radiation Safety Officer shall administer to the assistant a written examination like the one found in Appendix C to this Procedure. This examination shall have at least 50 questions, shall be closed-book, and shall cover all of the sections from the above class outline. This examination shall be changed each time it is used. The assistant must score a minimum of 70% on the exam. Additional classroom training of at least six hours shall be given if the test is failed. This training shall place its emphasis on the areas which were shown to be deficient by the exam. Each additional failure shall necessitate a one-week wait prior to re-testing, with six more hours of classroom, as above.

6. After a favorable evaluation and after the assistant has achieved a passing grade on the written exam, the Radiation Safety Officer sahll administer f field examination. The field examination shall cover a minimum of 15 checkpoints to test the assistant's knowledge of operating and emergency procedures, government regulations, equipment operation, inspection, maintenance, transportation, etc. A typical field examination checklist is included in Appendix D to this procedure. The assistant must receive a grade of 90% or better to be promoted. A grade of less than 90% shall necessitate additional on-the-job training and possibly classroom training. The minimum amount of additional on-the-job training shall be 160 hours. The emphasis of the additional training shall be based on the areas shown deficient by the examination.

7. After all of the requirements above have been met, the Radiation Safety Officer shall issue a written certification stating that the assistant has completed all the requirements of this Procedure, the NRC, New York State, and is a qualified radiographer.

The Radiation Safety Officer maintain the following documentation on file for a minimum of three years:

a) Outline of training course and course attendance record.

b) Written examination and re-tests, as applicable.

c) Written evaluation by radiographer.

d) Dates and records of field training received.

e) Record of field examination and re-examinations, as applicable.

f) Certifying statement signed by RSO.

III. Training and Qualification of Personnel with Previous Experience

A. Personnel hired as radiographer's assistants, regardless of their prior experience, shall be required to undergo the training and examinations specified in Section II A of this Procedure.

B. An individual hired as an experienced radiographer shall meet the following criteria before he may be certified as a radiographer by Trutom:

a) Proof of prior certification as a radiographer.

b) Held this certification within six months prior to being hired at Trutom.

c) Trutom shall be responsible for above requirement

1. If the preceding criteria are met, the individual may be certified to radiographer by Trutom in the manner described herein.

2. First, the individual shall read and understand the company's "Operating & Emergency Procedures", including New York State's "Industrial Code Rule 38". He shall pass the test normally given a radiographer's assistant.

3 After passing that test, the individual must work with a qualified radiographer for a minimum of two days in the capacity of radiographer's assistant. During this period of training, emphasis shall be on familiarizing the new employee with Trutom's equipment, procedures, etc.

4. At the conclusion of the training, the radiographer with whom the new employee has been working shall render his written judgement to the RSO as to the acceptability of the new person as a radiographer.

5. If a favorable recommendation is received, the RSO shall proceed to administer the examinations as specified in Section II B of this Procedure.

continued. . .

6. Unsatisfactory examination scores will necessitate the same additional training and re-examination procedures as specified in Section II B of this Procedure.

7. If the candidate passes the examinations, the RSO shall certify that individual in the same manner as in Section II B of this Procedure.

8. If the candidate has not been employed as a radiographer within the six month limitation, the on-the-job training shall be increased to one-week minimum.

IV. Periodic Training

A. Both radiographers and radiographer's assistants shall be given periodic training which shall include the following subjects as applicable:

1. Revisions to "Operating & Emergency Procedures".
2. New equipment acquired by the organization.
3. Revisions to applicable state and federal regulations.
4. Deficiencies and mistakes noted during periodic management inspections.
5. Other miscellaneous subjects as deemed necessary by management.

B. This periodic training shall occur whenever management has enough of the aforementioned material to make for a meaningful session.

C. Immediate sessions shall be called if major revisions occur to the "Operating & Emergency Procedures", or pertinent federal and/or state regulations.

D. As a minimum, these sessions shall occur annually.

E. The Radiation Safety Officer shall conduct the sessions and shall keep records of the topics discussed, persons in attendance, approximate time spent, etc.

V. Instructors

A. The Manager and the RSO shall meet or exceed the requirements for those positions as specified in Section C, "Organization of Trutom (U.S.) Limited". Persons meeting the standards for these positions are acceptable as instructors for the specific training sections as outlined previously. (The names of the individuals are specified in that section.)

APPENDIX A

SAMPLE RADIOGRAPHER'S ASSISTANT TEST

Name: _____ Date: _____

RSO: _____ Grade: _____

Value — 4 pts. ea.

F 1. A person who has suffered radiation damage as a result of exposure to a gamma ray source should be confined to an isolated room so that the contamination will not spread.

T 2. When the gamma source has been removed, it is safe to immediately touch the specimen being radiographed without fear of contamination.

T 3. Ionizing radiation can produce an electric charge.

F 4. The milliroentgen is a larger unit of measure than the roentgen.

T 5. A given amount of radiation dose will have less effect on the body if the exposure occurs gradually over a long period of time.

T 6. A young person is usually considered to be more vulnerable to radiation damage than an older person.

F 7. A new drug has been developed by the medical profession that will prevent radiation damage if taken prior to the exposure.

F 8. Federal regulations state that no person under the age of 21 can work in an area where radiographic inspections are being performed.

F 9. Survey meters and pocket dosimeters are both considered to be "personnel monitoring devices".

T 10. Film badges, survey meters and pocket dosimeters are all designed to measure radiation in roentgens or milliroentgens.

F 11. A properly calibrated survey meter is considered to be the most reliable personnel monitoring device and should be used in establishing an individual's permanent record.

F 12. Your film badge should be turned in after each shift so that your exposure can be evaluated by your supervisor.

T 13. The film badge and the pocket dosimeter both work on the principle of ionization.

T 14. The three basic means of providing radiation protection refer to "time", "distance" and "shielding".

T 15. The "Inverse Square Law" can be used to determine the radiation intensity at a given distance if you know the intensity at a different distance.

APPENDIX A, Continued

Value

4 pts. ea.

16. Why do you need a film badge?

ANS: Permanent record of exposure.

17. Why do you need a dosimeter?

ANS: Gives instant read-out of dose received.

18. As a radiographer's assistant, when are you permitted to do radiography in the field by yourself?

ANS: Never

19. a. What is a "radiation area"?

ANS: 2 MR to 100 MR

b. If you are asked to check the "radiation area" boundaries by the radiographer, what would you do?

ANS: Use a survey meter and walk along boundaries; report readings.

20. a. What is a "high radiation area"?

ANS: 100 MR or greater.

b. When do you survey "high radiation" areas?

ANS: Never

21. If the source cannot be retracted you should first:
a. call police
b. call fire dept.
c. restrict radiation area
d. call RSO
e. do as radiographer directs

22. If you cannot find your film badge and dosimeter, you can just use the readings of the radiographer. True or False?

ANS: False

23. a. When can you approach the source without a survey meter?

ANS: Never

b. When you pick up a survey meter, what is the first thing that you should do?

ANS: Check the batteries.

24. How can you tell that the source is exposed without using a survey meter?

ANS: You can't.

25. What is an emergency?

ANS: When source will not retract by normal means.

APPENDIX B

SAMPLE RADIOGRAPHER'S ASSISTANT TEST
FIELD EXAM

Name: _____ Date: _____

RSO: _____ Grade: _____

Value

6.6 pts. ea.

1. Demonstrate charging of a dosimeter.

   ANS: Demonstrate charging & reading

2. Perform check of survey meter.

   ANS: Check Battery
   Check Calibration

3. Remove camera from locked storage.

   ANS: Obtain key for storage from radiographer.
   Use meter for survey of storage container.
   Unlock storage box & remove.
   Report to radiographer for sign-out.

4. Demonstrate loading camera into truck for transportation.

   ANS: First check cables & tubes with radiographer.
   Place in truck storage area & secure.
   Survey outside of vehicle & driver compartment.
   Extra shielding, if required.
   Radiographer to verify and fill out transport paperwork.

5. Demonstrate camera hook-up.

   ANS: Survey meter at front of camera.
   Proper hook-up technique
   Perform check of pigtail hook-up
   Cable hook-up prior to plug removal
   Lock & remove key after hook-up.

6. Demonstrate moving camera to new location 10' away.

   ANS: Must disconnect & secure camera prior to moving.
   Emphasise surveys.

7. Demonstrate camera set-up at about 6' off of floor.

   ANS: Note that cable & hose not under strain. Camera secured in new location.

8. Does trainee understand difference between radiation signs and high-radiation signs?

   ANS: Should understand posting and survey requirements.

APPENDIX B, Continued

Value	
6.6 pts. ea.	9. Demonstrate posting of "high-radiation" area. ANS: Should consult with radiographer on location. Should use proper posting and roping technique. Should understand that high-radiation areas must be locked or physically guarded.

10. Demonstrate posting of "radiation area".

ANS: Should consult radiographer. Should use proper technique for posting and roping.

11. Demonstrate technique for verifying radiation boundaries on first exposure.

ANS: Should survey boundaries and make adjustments as required.

12. Ask trainee to move to different location for exposure.

ANS: Should understand that boundaries will change and should consult radiographer. Should survey new boundaries.

13. Ask trainee to demonstrate how he can reduce the restricted area.

ANS: Should understand how to use additional shielding. Different collimators and/or lead sheets, or other available shielding.

14. Ask trainee how he would react if someone at the site walked through the radiation boundaries:

ANS: Immediately secure source. Notify radiographer.

15. Demonstrate what you should do if you drop a dosimeter.

ANS: Read to see if discharged. If discharged, recharge and notify radiographer.

APPENDIX C

SAMPLE RADIOGRAPHER TEST

Name: _____ Date: _____

RSO: _____ Grade: _____

Value		
2	1.	An excellent radiograph is obtained under given conditions of exposure with the film located at a distance of 36 inches from the target of the x-ray tube. If the film is now placed only 18 inches from the target, and all exposure conditions except time are held constant, the new exposure time will be: a. unchanged b. longer by approximately 80 percent c. shorter by approximately 55 percent d. only about 25 percent as long as the original exposure time
2	2.	Lead is frequently employed in shielding against radiation from x-ray and gamma ray sources because of its: a. extremely low cost b. high absorption for a given thickness and weight c. ability to emit electrons when irradiated d. ability to diffract alpha particles
2	3.	Cobalt 60, used in nondestructive testing, emits: a. alpha particles b. neutrons c. gamma rays d. x-rays
2	4.	The time required for one half of the atoms in a particular sample of radioactive material to disintegrate is called: a. the inverse square law b. a curie c. a half life d. the exposure time
2	5.	What does the term (R/h) refer to when speaking of intensity? a. radiation limits for humans b. Roentgens per hour c. x-rays per hour d. radiation in hydrogen
2	6.	Small amounts of exposure to x-rays or gamma rays: a. will have a cumulative effect which must be considered when monitoring for maximum permissable dose. b. will be beneficial since they build up an immunity to radiation poisoning. c. will have no effect on human beings. d. will have only a short-term effect on human tissues.

Appendix C, Continued

Value

7. A dose of ___ would be dangerous, if not fatal, if applied to the entire body in a short period of time: 2
   a. 1.5 to 15 r
   b. 25 to 70 r
   c. 200 to 800 r
   d. all of the above doses would most likely be fatal

8. When doing gamma ray radiography with high-intensity emitters, the sources are best handled: 2
   a. directly by personnel equipped with special protective clothing.
   b. by remote handling equipment which permits the operator to remain several yards away at all times.
   c. directly by personnel with special clothing except when radiographs are being made.
   d. by the same methods used for low-intensity emitters.

9. A Cobalt 60 capsule will have a half-life of: 2
   a. 1.2 years
   b. 6 months
   c. 5.3 years
   d. 75 days

10. Overexposure to x-rays or gamma rays may cause damage to human ____: 2
   a. blood tissue
   b. skin
   c. internal organs
   d. all of the above

11. A general rule used to define the amount of radiation exposure that is excessive is: 2
   a. Although small amounts of radiation (0.4 r per week or less) are beneficial since they build up an immunity to these rays, anything above 0.4 r per week is excessive.
   b. Any dose over 5 r per week is excessive.
   c. Any dose which causes a mid-range reading on a Geiger Counter is excessive.
   d. Any unnecessary exposure to radiation is excessive.

12. X-ray exposure may be due to: 2
   a. the direct beam from the x-ray tube target.
   b. scatter radiation arising from objects in the direct beam.
   c. both a and b above.
   d. both a and b above, plus residual radiation that exists for the first few minutes after the x-ray machine has been returned to the "off" position.

13. A curie is the equivalent of: 2
   a. .001 millicuries
   b. 1,000 millicuries
   c. 1,000 megacuries
   d. 100 megacuries

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14. A primary disadvantage of the fountain pen-type of ionization chamber used to measure the amount of radiation received by personnel is: 2
    a. the delay necessary before the rsults of a measurement are known.
    b. the inaccuracy of such devices in measuring scatter radiation.
    c. the inability of such a device to provide a perranent record of exposure.
    d. the cost of recharging such devices.

15. The exposure of personnel to x- and gamma radiation can be determined by means of: 2
    a. film badges
    b. dosimeters
    c. radiation meters
    d. all of the above

16. Short wavelength electromagnetic radiation produced during the disintegration of nuclei of radioactive substances is called: 2
    a. x-radiation
    b. gamma radiation
    c. scatter radiation
    d. back scatter radiation

17. An unshielded isotope source gives a dosage rate of 900 mr. per hour at ten feet. What would the unshielded dosage rate be at 30 feet? 2
    a. 300 mr/hr.
    b. 600 mr/hr.
    c. 100 mr/hr.
    d. 2700 mr/hr.

18. In making an isotope exposure in an unshielded area, you find the dose rate six feet from the source is 1200 mr/hr. What would be the dose rate at 24 feet? 2
    a. 75 mr/hr
    b. 100 mr/hr.
    c. 200 mr/hr.
    d. 300 mr./hr.

19. The intensity of x-radiation is measured in: 2
    a. roentgens
    b. ergs
    c. roentgens per unit of time
    d. H & D units

20. An advantage of the fountain pen-type of ionization chamber used to monitor radiation received by personnel is: 2
    a. it provides a permanent record of accumulated dosage
    b. it provides an immediate indication of dosage
    c. it is the most sensitive detector available
    d. all of the above are advantages

alue

21. The absorption of gamma-rays from a given source when passing through matter depends on: 2

a. the atomic number, density, and thickness of the matter
b. the Young's modulus value of the matter
c. the Poisson's ratio value of the matter
d. the specific activity value of the source

22. The fact that gases, when bombarded by radiation, ionize and become electrical conductors made them useful in: 2

a. x-ray transformers
b. x-ray tubes
c. masks
d. radiation detection equipment

23. The gamma ray intensity at one foot from a one curie source of radioactive Cobalt 60 is nearest: 2

a. 15 roentgens per hour
b. 1,000 roentgens per hour
c. 1 roentgen per minute
d. 10 milliroentgens per day

24. The quantity of radiation which will produce, by means of ionization, one esu. of electricity in 0.001293 grams of dry air is known as: 2

a. a millicurie
b. a gamma
c. a roentgen
d. a curie

25. A good Cobalt 60 shot is made on a 3" steel casting using an exposure time of ten minutes and a source-to-film distance of 36 inches. If it is necessary to change the source-to-film distance to 24", what exposure time would produce a similar radiograph if all other conditions remain the same? 2

a. 1.6 min.
b. 4.4 min.
c. 6.4 min.
d. 8.8 min.

Answer questions 26 through 30 in the space provided. If more space is required, use the reverse side of the sheet.

Value

Explain or define in four or five lines the following:

26. Half-value layer

1 ANS: Amount of shielding required to reduce radiation intensity to one-half of its intensity at the front side of the shield.

27. Rem

1 ANS: Reontgen equivalent man. Absorbed dose in rads times the relative biological effectiveness of the radiation absorbed.

Appendix C, Continued

Value

1 28. Calibration of survey meter

ANS: Comparison of survey meter reading to known radiation intensity. Minimum interval is three months and must be accurate to ± 10%.

1 29. Scattered radiation

ANS: Low level radiation of random direction caused by primary radiation interacting with matter.

1 30. X-rays

ANS: High energy, short wave length portion of electromagnetic wave spectrum. Caused when electrons produced at Cathode of X-ray tube collide with atoms in anode.

4 31. The radiation intensity at a distance of 2 meters from a source is 90 mR per hour.

a) How far from the source would the intensity be 2.5 mR per hour? (Show all your calculations).

ANS: $\frac{I1}{I2} = \frac{(D2)^2}{(D1)^2}$

$\frac{90\ MR/HR}{2.5\ MR/HR} = \frac{(D2)^2}{(2M)^2} = \frac{(D2)^2}{4M^2}$

$\frac{4 \times 90}{2.5} = \frac{360}{2.5} = 144 = D2^2$

$D2 = 12M$

4 32. What thickness of concrete would be required to reduce the intensity to 2.5 mR per hour at a point 3 meters from the source in Question 31. (Assume for concrete, HVL = 5c. Show all your calculations.

ANS: Step #1 $\frac{I1}{I2} = \frac{(D2)^2}{(D1)^2} = \frac{X}{90} = \frac{(2)^2}{(3)^2} = \frac{4}{9}$

$X = \frac{90 \times 4}{9} = 40\ MR/HR$

Step #2 40 MR/HR at 3M unshielded
$\frac{40}{2.5}$ = 16 so intensity must be reduced 16 times.

$\frac{1}{16} = \frac{1}{24}$ or 4 HVL's 4 x 5cm = 20cm of concrete

4 33. What is the radiation intensity at 50 cm. from an unshielded 50 ci IR 192 source after 296 days? (Assume that the radiation intensity from a 1-curie source to be 0.5 R/H at one meter and the half-life to be 74 days).

ANS: 1) Intensity at start is 50 CI x .5 R/H=25 R/H at 1M

2) $\frac{296}{74}$ = 4 half-lives

continued

Appendix C, Continued

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33. Continued

3) After 296 days $\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} = \frac{1}{16}$ $\frac{1}{16}$ (.0625) x 25 = 1.56 R/hr at 1 met

4) $\frac{I1}{I2} = \frac{(D2)^2}{(D1)^2}$ $\frac{I1}{1.56R} = \frac{(1 \text{ meter})^2}{(.5 \text{ meter})^2}$

$I1 = \frac{1.56R \times 1 \text{ meter}}{.25 \text{ meter}}$ $I1 = 6.24$ R/hr

1 34. Name two commonly used methods of personnel monitoring; explain why and when they should be used.

ANS: 1) Film Badge
2) Pocket Dosimeter

Both film badge and dosimeter should be worn at all times when working with radiation-producing equipment. It provides a permanent record of accumulated dose. The film badge makes possible assessment of type and amount of accumulated dose. Dosimeter is used for immediate radiation dose information.

2 35. List the radiation safety precautions necessary when performing radiography at a busy construction site. (Consider before, during, and after each exposure).

ANS: 1) Calculate high radiation area (> 100 MR/HR) and restricted area (> 2 MR/Hr).

2) Post high-radiation area signs at access points to high-radiation area.

3) Rope off and post restricted area.

4) Notify all cognizant personnel of intentions and clear area much larger than restricted area of all personnel.

5) During exposure keep constant vigil of restricted area.

6) Once source is cranked out, survey restricted boundaries to be sure they are accurate and adjust as necessary.

7) At each set-up, survey area and equipment (before and after each exposure).

In the following five questions, circle the best answer (do not circle more than one in each question).

2 36. The best instrument for detecting a lost radiographic source is:

a. G.M. Survvey Meter
b. ion chamber survey meter
c. personnel dosimeter
d. betameter

Appendix C, Continued

lue

37. Water, sand, etc., are often used for shielding radiography sources in emergency situations. The protection afforded depends mainly upon: 2

a. density of the material
b. chemical properties of the material
c. isotope number
d. the number of ion pairs produced

38. According to current recommendations, emergency procedures involving industrial radiographic equipment should be planned: 2

a. to limit the personal exposure to 300 mR during the operation
b. to limit the radiation level to 10 mR per hour
c. using the 5 (N-18) formula for personal dose
d. to limit total exposure to 100 mR per week

39. IR 192 is potentially less hazardous than Co 60 because: 2

a. it has shorter half-life
b. it is less damaging to tissue
c. smaller sources are used
d. it has a lower specific activity

40. Blood counts taken for persons who have been occupationally exposed to radiation are of value in: 2

a. assessing the chronic low level absorbed radiation doses.
b. fulfilling federal regulations on radiation monitoring.
c. assessing an acute exposure (greater than 25 rads) if taken periodically following the exposure.
d. all of the above.

41. If you were standing in an x-ray area for six hours that showed a survey meter reading of 150 MR/HR, what would be your dose in Rems? 2

ANS: 150 MR/HR x 6 HRS = 900 milliroentgens = .9 Rem

42. If a person started to work in a radiation area on his 21st birthday, what would be his "radiation bank account" balance? 2

ANS: 5(N-18) $\quad \begin{array}{r} 21 \\ -18 \\ \hline 3 \end{array} \quad 3 \times 5 = 15$

43. If a radiographic inspection is to be performed in an open area using a 100 curie IR-192 source, what would be the radiation intensity at 30 feet from the source? (IR 192 - 5.9 R/HR/Curie at 1 ft.) 3

ANS: $\begin{array}{r} 5.9 \\ \times\ 100 \\ \hline 590\ \text{R/HR} \end{array} \quad \frac{590}{X} = \frac{30^2}{1^2} \quad X = .65\ \text{R/HR}$

Appendix C, Continued

Value

3 44. If your survey meter showed an intensity of 90 MR/HR at 30 feet, how far would you have to move back to be in an area with less than 10 MR/HR?

ANS: $\frac{90}{10} = \frac{X}{30^2}$ $X = 8100$ $\sqrt{8100}$ 90

3 45. If an IR 192 source had an intensity of 850 MR/HR through a concrete wall, how much lead (0.19 HVL) would need to be added to reduce the intensity to below 15 MR/HR?

ANS: $\frac{850}{15} = 56.6 \times 6$ HVL $.19 \times 6 = 1.14"$

3 46. The intensity of a Co 60 source is 75 R/HR at a distance of 4 feet. At what distance would the intensity be reduced to below 80 MR/HR?

ANS: $\frac{75}{.08} = \frac{X}{42}$ $X = 15{,}000$ $\sqrt{15{,}000}$ 122

1 47. One half-value layer of a material will effectively reduce the radiation to one-half the original intensity. True/False?

1 48. Two half-value layers of a material will effectively stop all radiation from passing through the material. True/False?

1 49. The standard dose rate of a radioisotope is expressed in roentgens per hour per curie at one foot. True/False.

1 50. A person will receive a .16 Rems if he stands in a 40 MR/HR area for a period of four hours. True/False

APPENDIX D

SAMPLE RADIOGRAPHER TEST
ORAL & PRACTICAL FIELD EXAM

Name: _____ Date: _____

RSO: _____ Grade: _____

Value

1. What documents must the radiographer have with him at all times when performing radiography?

6.6 ANS: Code Rule 38
Operating & Emergency Procedures
10 CFR Part 34, 21, 20, 19
His Certifications
Leak Test Cert.

2. Demonstrate initial survey and inspection of RT equipment.

6.6 ANS: Follow exact procedure and inspection checklist in ~~T75-46~~ T78-45, Appendix H.

3. Demonstrate job set-up under field conditions.

.6 ANS: Calculate high radiation and radiation areas.
Post boundaries.
Notify personnel & evacuate.
Double check that area has been evacuated.
Be sure high-radiation areas are locked or physically guarded.
Should choose best possible set-up in relation to distance and shielding.

4. Demonstrate first exposure boundary survey.

.6 ANS: Boundaries to be verified and adjusted.

5. Check dosimeter of examinee.

6.6 ANS: Should be calibrated.
Should be within 10% of zero.

6. Observe set-up and ask examinee to describe what he would do if source became stuck in hose.

6.6 ANS: Crank source back to colimator. Send assistant to call RSO. Calculate unshielded boundaries. Post new boundaries and notify cognizant personnel. If RSO or other emergency technician not available, call Tech-Ops Retrieval Crew. Do not attempt to retrieve source without their help.

7. Does examinee have required safety equipment on site with him?

.6 ANS: Tongs
Safety container
Lead sheet
Lead tunnel
Rope & Signs

Appendix D, Continued

Value

6.6 8. Check the transport vehicle to verify:

a. Radiation levels
b. Transportation paperwork
c. Location and security of source
d. Placarding, if applicable
e. Source vehicle card

ANS: Should be in accordance with T78-45, Appendix G.

9. Check survey meters of examinee for calibration and function.

6.6 ANS: Calibration within three months.
Proper function.

10. Ask examinee what he would do if someone crossed his boundaries.

.6 ANS: If source is out, retract immediately.
Identify individual and report him to his supervisor.
Keep name of individual.
Try to calculate the exposure he received.

11. Observe examinee's procedure for final source disconnection, securing and survey.

.6 ANS: Most important step is final survey. Note way equipment is put away for transport. Is care taken to prevent damage and to prevent dirt from getting into tubes? Did he remove key?

12. Review examinee Utilization Log for the day.

6.6 ANS: Check for completeness and accuracy. Sketches for each location with actual boundary readings. Calculations for restricted and high-radiation areas. Dosimeter readings logged. Inspection of equipment signed off.

13. Does examinee leave camera unattended while developing film?

6.6 ANS: Should lock securely to prevent movement. Should maintain boundaries. Should keep key in his possession.

14. At end of day, does examinee:

6.6 a. Log dosimeter reading?
b. Survey locked storage compartment?
c. Sign camera back in?

ANS: Yes, to all questions.

15. Does examinee know how to complete paperwork for source location change from office to office? Have him describe procedure step by step.

.6 ANS: Should be in accordance with T78-46, Appendix G.3. and Appendix O.

TRUTOM NONDESTRUCTIVE TESTING SERVICES

APPENDIX E

CERTIFICATION

We hereby certify that _____, by virtue of his/her training, experience, and examination records, as specified by T78-46, Rev. (latest), Section A., II, A., and as specified by New York State's "Industrial Code Rule 38", is qualified to perform the duties of Radiographer's Assistant.

Issued: _____

_____
David F. Kidney
Radiation Safety Officer
Trutom (U.S.) Limited

TRUTOM NONDESTRUCTIVE TESTING SERVICES

APPENDIX E

CERTIFICATION

We hereby certify that _____, by virtue of his/her training, experience, and examination records, as specified by T78-46, Revision (latest), Section A.II.B., and as specified by New York State's "Industrial Code Rule 38", is qualified to perform the duties of a Radiographer.

Issued: _____

_____
David F. Kidney
Radiation Safety Officer
Trutom (U.S.) Limited

NAME OF INDIVIDUAL _____ APPENDIX F LEVEL _____

RECORD OF TRAINING

DATE	TIME	SUBJECTS COVERED	REFERENCE	INSTRUCTOR SIGNATURE	INDIVIDUAL SIGNATURE

I certify that the individual named above has performed the above training as specified.

RSO/ MANAGER _____ Date _____

APPENDIX G

PERIODIC TRAINING LOG

PERSONS INVOLVED	DATE	TIME	SUBJECTS	REMARKS