MS-16
Q4

Tri State Inspection & Consultants

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June 30, 1987

License Number: 37-19640-01
Docket Number: 030-19014
Control Number: 106300

U.S. Nuclear Regulatory Commission
Region 1
631 Park Avenue
King of Prussia, PA 19406

ATTENTION: Mr. John E. Glenn, PH.D. Chief
Nuclear Materials Safety Section B
Division of Radiation Safety and Safeguards

SUBJECT: Tri State Inspection & Consultants
Radiation Materials License

Dear Mr. Glenn:

Enclosed you will find the additional information you requested in your letter of May 14, 1987.

Also enclosed are changes to the Radiation Safety Manual and Safety Training Procedures reflecting clarification of these matters.

Very truly yours,

TRI STATE INSPECTION & CONSULTANTS

A. J. Mueller
Radiation Safety Officer

AJM/gdw

Enclosures

RESPONSES to your letter of May 14, 1987:
(The responses correspond to your noted request for additional information)

ITEM 1

See attached revised page for Item 5 of our application concerning the missing model numbers for the sources mentioned in Parts K and L.

ITEM 2

We have labeled the questions and answers noting which test(s) are given to radiographers and radiographer's assistants. The radiographer's assistant tests are given in stages covering his training.

ITEM 3

Tri State Inspection & Consultants confirms that the training of our radiographers will include "Inspection and maintenance performed by the radiographer" as well as the ones that are already outlined in our training section.

ITEM 4

Tri State Inspection & Consultants' procedure for previously trained radiographers newly hired by Tri State Inspection & Consultants will be to train them according to our Operating and Emergency Procedures in the use of our equipment.

ITEM 5

After further evaluation, we would no longer like to do any radiography in the shop and/or adjacent areas of our facility.

ITEM 6

Tri State Inspection & Consultants confirms that a performance review will be conducted quarterly (every three months) on each radiographer and/or radiographer's assistant for compliance with the requirements contained in this manual.

RESPONSES to your letter of May 14, 1987:
(The responses correspond to your noted request for additional information)

ITEM 7

Tri State Inspection & Consultants confirms that if a person's dosimeter is discharged beyond its capacity of 200 mr, the individual shall immediately cease radiographic operations, contact the RSO, and their film badge shall be sent for processing immediately.

ITEM 8

Tri State Inspection & Consultants confirms that in the event of an accident or an emergency involving radioactive material, there will be constant surveillance of the restricted area until the situation is corrected.

In addition, due to my work load and my traveling requirements, I will be unable to continue as Radiation Safety Officer for Tri State Inspection & Consultants. At this time, Michael H. Stiger has assumed the position of RSO. All necessary information on training and experience was submitted to you with the original renewal (License number 37-19640-01) dated October 15, 1986.

Revised 6/30/87

ITEM 5 - RADIOACTIVE MATERIAL

	SEALED SOURCES TO BE USED IN RADIOGRAPHY			RADIOGRAPHIC EXPOSURE DEVICES			
	By Product Material	Mfg. Name	Source Model No.	Mfg. Name	Model No.	Model No. for Source Changers	Max. Activity (Curries) per Source
A.	Iridium 192	Tech-Ops Gamma Ind.	A-424-1 T-1-T,T-1-A, T-1-G	Tech-Ops Gamma Ind.	T/O 490,T/O 533	650 C-10	100
B.	Iridum 192	Tech-Ops Gamma Ind.	A-424-9 T-3-T	Tech-Ops Gamma Ind.	T/O 660	650 C-10	100
C.	Iridium 192	Gamma Ind. Tech-Ops Automation Ind.	A-2-TC,A-2-A,A-2-G 848 39998	Gamma Ind. Tech-Ops Automation Ind.	Century	C-10 650 500SU	100
D.	Iridium 192	Gamma Ind.	GP	Gamma Ind.	Pipeliner #1	None	100
E.	Cobalt 60	Gamma Ind.	A-7-A	Gamma Ind.	Gammatron #20A	C-8	20
F.	Iridium 192	Tech-Ops	90003	Tech-Ops	Tech-Ops 920	T/O 850	200
G.	Iridium 192	Tech-Ops Gamma Ind.	A-58101-8 TP	Tech-Ops Gamma Ind.	Tech-Ops 616	None None	200
H.	Cesium 137	Tech-Ops	77302	T/O Calibrator	Tech-Ops 773	None	.16
I.	Iridium 192	Gamma Ind.	PL-2	Gamma Ind.	Pipeliner #201	None	200
J.	Cobalt 60	Gamma Ind.	A-8-A	Gamma Ind.	Gammaton 100A	C-8	100
K.	Cesium 137	Gamma Ind.	VD-HP	J. L. Sheppard	Calibrator: Model 28-5	None	.12
L.	Cesium 137	Gamma Ind.	VD-HP	J. L. Sheppard	Calibrator: Model 28-6A	None	1.2

T/O = Tech-Ops

RADIOGRAPHER'S EXAM

NAME _____ BRANCH _____

DATE _____ GRADE _____

1) Gamma and X-radiation damage human body tissue by a process known as _____.

2) When a body tissue cell is damaged by radiation,

a) The cell may lose its ability to reproduce
b) The cell may die
c) Damage is caused by knocking an electron out of the orbit of its parent atom
d) All of the above

3) The basic difference between X-rays and gamma rays is

a) Their RBE
b) Their origin
c) Their ability to damage cells of human tissue
d) That gamma rays are electromagnetic radiation

4) Radiation hazard to humans exists from

a) Natural radiation
b) Primary and scattered radiation
c) Primary beams only
d) All types of radiation except electromagnetic radiation.

5) Materials exposed to gamma rays and X-rays become radioactive and dangerous to handle.

True ( ) False ( )

6) A person who becomes contaminated with radioactive material can spread contamination to other persons.

True ( ) False ( )

7) An X-ray machine presents an internal radiation hazard.

True ( ) False ( )

8) The most penetrating radiation from radioisotopes is

a) Beta particles
b) Alpha particles
c) Gamma rays
d) X-rays

9) Radioactive (or physical) half-life is

a) The time is takes one-half of the atoms of a radioisotope to disintegrate.
b) The time it takes one-half of a radioactive material to be passed from the body as waste material.
c) The time needed to rid the body of one-half of a radioactive material by a combination of biological elimination of biological elimination and radioactive decay.

10) Biological half-life is

a) The time it takes one-half of the atoms of a radioisotope to disintegrate.
b) The time it takes one-half of a radioactive material to be passed from the body as waste material.
c) The time needed to rid the body of one-half of a radioactive material by a combination of biological elimination and radioactive decay.

11) The basic unit of measure used to express gamma or X-radiation exposure is the

a) rem
b) rad
c) roentgen
d) RBE

12) The abbreviation "r" stands for _____.

13) The abbreviation "mr" stands for _____.

14) The term "rad" stands for _____ _____ _____.

15) The term "rem" stands for _____ _____ _____.

16) The roentgen is a measure of

a) Alpha radiation
b) X-rays and gamma rays
c) Radiation damage to human cells
d) All of the above

17) The unit which is a measure of absorbed dose in tissue is the

a) rem
b) rad
c) roentgen
d) RBE

18) An exposure of one roentgen of gamma radiation equals an absorbed dose of one rad.

True ( ) False ( )

19) An exposure of 5r of gamma or X-radiation equals _____ rem.

20) The time rate at which a radiation dose is received is called _____ _____.

21) The whole-body radiation dose must normally be limited to a dose of

a) 1 1/4 rems per calendar quarter
b) 18 3/4 rems per calendar quarter
c) 7 1/2 rems per calendar quarter
d) 5 rems per calendar quarter

22) A given radiation dose will cause less damage if it is received over a very short period of time than if it is received over a long period of time.

True ( ) False ( )

23) The most serious radiation exposure is to the

a) Whole Body
b) Feet and ankles
c) Skin
d) Hands and forearms

24) A person who is 10 years old would be subject to greater radiation damage from a given exposure than a person age 27.

True ( ) False ( )

25) A person must be _____ years old to be allowed to work in a radiation area.

26) Permissible accumulated dose is

a) The occupational dose received by a person in any calendar year
b) The occupational dose a person could have been permitted in relation to his current age
c) The radiation dose recorded on his records for any reporting period
d) The total radiation dose a person has received during his lifetime

27) The formula for finding permissible accumulated dose is

a) 12 (n-18)
b) 18 (5+N)
c) 5 (N-18)
d) 12 (N+18)

28) The permissible accumulated dose for a person who is 35 years old is _____.

29) If a person does not exceed his permissible accumulated dose, he is allowed to receive a whole-body dose of

a) 5 rems per year
b) 18 3/4 rems per year
c) 12 rems per year
d) Any balance that he has in his radiation bank account

30) For each year a person is past age 18, how many rems are deposited in his radiation bank account for whole-body exposure?

a) 18 3/4 rems
b) 12 rems
c) 1 1/4 rems
d) 5 rems

31) The earliest indications of radiation damage may be detected in the

a) Nerve cells
b) Skin cells
c) Bone cells
d) Blood cells

32) The radiation effects which can be passed on to the offspring or to a later generation of a person receiving radiation are called

a) Future effects
b) Genetic effects
c) Somatic effects
d) Radiosensitive effects

33) It is possible to receive a dose considerably above the regulatory limits without showing detectable radiation effects.

True ( ) False ( )

34) Portable instruments used to monitor radiation areas are called

a) Film badges
b) Survey meters
c) Personnel monitoring devices
d) Area meters

35) Devices attached to the clothing of people working in radiation areas for measurement of radiation are called

a) Survey instruments
b) G-M counters
c) Personnel monitoring devices
d) Portable rate meters

36) Radiation measuring devices operate on the principle of ionization.

True ( ) False ( )

37) Two types of personnel monitoring devices are _____ _____ and _____ _____.

38) Two types of survey meters are _____ _____ and _____ _____.

39) Personnel monitoring devices provide cumulative readings of radiation exposure.

True ( ) False ( )

40) Survey meters provide

a) Cumulative readings of radiation exposure
b) Radiation exposure rate readings
c) Readings which must be checked on a separate reading device
d) Only readings of gamma radiation

41) Pocket dosimeters depend upon a _____ for their indication.

a) G-M tube.
b) Battery to provide electrical power
c) Quartz fiber electroscope
d) Theory that like charges attract and unlike charges repel

42) The normal operating range of a pocket dosimeter is

a) 0 to 200 mr
b) 50 to 500 mr
c) 0 to 75 r/hr
d) 25 to 250 r

43) The film badge operates on the principle that _____ exposes film.

a) Light
b) Heat
c) Ionizing radiation
d) Alpha particles

44) Which statement about the film badge is true?

a) It has the advantage of providing an immediate indication of radiation exposure
b) It is easily exposed by alpha particles
c) It has the advantage of providing a permanent record
d) All of the above

45) The pocket dosimeter has the advantage of

a) Being more accurate than the film badge
b) Providing a permanent record of radiation exposure
c) Providing an immediate indication of radiation exposure
d) All of the above

46) When wearing a pocket dosimeter, there is no need to wear a film badge at the same time.

True ( ) False ( )

47) How many electrodes does the ionization chamber survey meter have?

a) 2
b) 3
c) 4
d) 6

48) The Geiger-Mueller counter uses the G-M tube to

a) Slow down the ion flow to make detection easier
b) Provide electrical power for operation of the meter
c) To amplify the effects of the radiation entering the tube
d) To read extremely high levels of radiation

49) When reading low levels of radiation, the _____ (G-M counter or ion chamber meter) is more effective.

50) The standard dose rate of a radioisotope is expressed in

a) Roentgens per hour per curie at any standardized distance not exceeding 75 feet
b) Roentgens per hour per curie per foot
c) Roentgens per hour per curie at a distance of one foot
d) None of the above

RADIOGRAPHER'S EXAM

ANSWER SHEET

		REF. NO.
1)	ionization	
2)	d	1.9
3)	b	1.9
4)	b	1.10
5)	False	1.16
6)	True	1.18
7)	False	1.18
8)	c	1.27
9)	a	1.30
10)	b	1.30
11)	c	2.1
12)	Roentgen	2.1
13)	Milliroentgen	2.4
14)	Radiation Absorb Dose	2.7
15)	Roentgen Equivalent Man	2.18
16)	b	2.3
17)	b	2.7
18)	True	2.11
19)	5	2.24
20)	Dose rate or Exposure rate	2.26
21)	a	3.4
22)	False	3.11
23)	a	3.6
24)	True	3.14
25)	18	3.16
26)	b	3.31
27)	c	3.32
28)	85	3.32
29)	c	3.41
30)	d	3.44
31)	d	4.3
32)	b	4.7
33)	True	4.6
34)	b	5.1
35)	c	5.1
36)	True	5.3
37)	Film badges, dosimeters	5.6
38)	Ionization chambers G-M counters	5.36
39)	True	5.6
40)	b	5.25
41)	c	5.7
42)	a	5.18
43)	c	5.22
44)	c	5.28
45)	c	5.29
46)	False	5.31
47)	a	5.38
48)	c	5.42
49)	G-M counter	5.42
50)	c	6.2

RADIOGRAPHER'S ASSISTANT

TEST I

Name:_____

Date:_____

Branch:_____

Grade: _____

1. Miners in Uranium mines have developed long cancer after inhaling gases with a high concentration of Radon. For this reason, breathing of air near an encapsulated source of C_o-60 should be avoided.

   a. True
   b. False

2. Give the complete name for the abrevations listed below

   a. r_____

   b. rem_____

   c. rad_____

   d. RBE_____

3. List three of the four common ways in which it is possible to get radioactive materials into the body.

   a._____

   b._____

   c._____

4. Define "Biological Half-life".

5. Select the radiation dose that corresponds with the classifications listed:

_____a.	Mild dose	1. 50-200 rem
_____b.	Moderate dose	2. 0-50 rem
_____c.	Median leathal dose	3. 600-800 rem
_____d.	Leathal dose	4. 200-600 rem

6. The average long term exposure limit for industrial radiographers should not exceed _____rem per quarter.

   a. .125 rem
   b. .5 rem
   c. 1.25 rem
   d. 5 rem

7. When a body tissue cell is damaged by radiation,

a) The cell may lose its ability to reproduce.

b) The cell may die

c) Damage is caused by knocking an electron out of the orbit of its parent atom.

d) All of the above.

8. There is always a small amount of contamination when working with radioisotope sources.

a. True
b. False

9. The annual whole body dose for the general population should not exceed:

a. .125 rem
b. .5 rem
c. 1.25 rem
d. 5 rem

10. Use the formula for determining the occupational exposure limit for yourself. You must show your work for credit, not just the answer.

ANSWERS: RADIOGRAPHER'S ASSISTANT - TEST I

1. b

2. a. Roentgen
   b. Roentgen equivalent man
   c. Radiation absorbed dose
   d. Relative biological effectiveness

3. a. breathing
   b. swallowing
   c. through breaks in the skin
   d. absorption through the skin

4. That period of time which it takes for one-half the element to be excreted from the body by natural processes.

5. a. 2
   b. 1
   c. 4
   d. 3

6. c

7. d

8. b

9. b

10. Exposure limit = 5(N-18) N = Age in years

RADIOGRAPHER'S ASSISTANT

TEST II

Name _____ Examiner _____

Date _____ Grade _____

1. There are three (3) fundamental principles involved when controlling exposure to radiation. List the three (3) and give brief descriptions of how they protect you from receiving radiation.

   (a)

   (b)

   (c)

2. Define the following terms:

   (a) "Half-life" -

   (b) Curie -

   (c) Roentgen -

   (d) Dose -

   (e) Dose Rate -

   (f) Restricted Area -

   (g) Inverse Square Law -

Page 2

3. Matching

_____1.	Half life period for ^{60}Co	A. 3 months
_____2.	The gamma dose rate of 100 Ci of ^{192}Ir at 2 feet is	B. greater than 2 mR/hr.
_____3.	half life period for ^{192}Ir	C. greater then 5 R/hr.
_____4.	A dosimeter pencil measures	D. 9 months
_____5.	An exposure device must be leak tested every	E. 14.5 R/hr.
_____6.	The range of your survey meter for industrial radiography	F. greater than 5 mR/hr.
_____7.	The gamma dose rate of 1 Ci of ^{60}Co at 1 foot is	G. Dose rate
_____8.	A survey meter must be calibrated every	H. 5.9 R/hr.
_____9.	Survey meter measures	I. 148 R/hr.
_____10.	If a survey meter has a check source it must be leak tested every	J. less than 2 mR/hr.
_____11.	A milliroentgen is how much of a roentgen?	K. 75 days
_____12.	Radiation Area	L. 30 days
_____13.	Restricted Area	M. greater than 100 mR/hr.
_____14.	Unrestricted Area	N. 1.25 years
_____15.	High Radiation Area	O. 1/10,000
		P. radiation received
		Q. 1 mR to 1 R
		R. 0.5 mR to 5 R
		S. 2.7 inches
		T. 5.25 years
		U. greater than 100 R/hr.
		V. 6 months
		W. 1/1,000

4. What is the purpose of a Strontium 90 source in a survey meter?

5. What would you do if during radiographic operations on a field project you discovered your survey meter was not working?

6. Describe exactly at what intervals you utilize your survey meter after arriving at a radiographic assignment.

7. When a survey meter is removed for radiographic operations, how do you know that the instrument has been calibrated within the required limits?

8. What are the required range limits per AEC Regulations that your survey meter must be able to detect radiation?

9. Describe in detail, exactly what steps must be taken after your exposure time has elapsed when using a remote exposure device.

10. Describe how you would make an exposure with a Gaama Century exposure device.

11. Why is it necessary to survey the front (source tube side of unit) after each exposure? Explain in detail.

12. How often must a radioisotope be leak tested and what are the required limits of contamination?

13. How do you secure an exposure device on a field radiographic project when going to lunch?

14. How do you know the activity of your radioisotope in your exposure device?

15. Vehicles hauling radioactive materials:

    (a) What type warning signs are required?

    (b) Where should they be placed?

    (c) What is the maximum allowable radiation outside your vehicles?

16. What would you do if you dropped your film badge near a source while your exposure was is the "ON" position and what must you do in the event that you do not discover it until the exposure has been completed?

17. What action would you take if you knew your source was loose in the source tube?

18. What would you do if your dosimeter pencil went off-scale during radiographic operations and you were 200 miles away from your home office?

19. What is the range of your dosimeter pencil and where must it be worn?

20. Do your procedures permit you to leave a restricted area unattended during an exposure?

ANSWERS

1. a. Distance - the further away the less radiation you will receive.

   b. Time - the less time you are near the source, the less radiation you will receive.

   c. Shielding - the more you are shielded from the source, the less radiation you will receive.

2. a. Half-Life - the period of time in which a given quantity of a specific radioactive isotope will decay to an activity equal to one-half (1/2) of the original acitivity.

   b. Curie - the unit of activity for measuring the quantity of a radioactive material.

   c. Roentgen - the unit of measure of radioactive material received.

   d. Dose - amount of radiation received.

   e. Dose Rate - amount of radiation received per hour.

   f. Restricted Area - any area greater than 2 MR/HR.

   g. Innerse Square Law - as the distance is doubled, the radiation is reduced to 1/4 the original level.

3. MATCHING:

1. T	6. Q	11. W
2. I	7. E	12. F
3. K	8. A	13. B
4. P	9. G	14. J
5. V	10. V	15. M

4. Strontium 90 is used as a check source to determine if meter is capable of detecting ionizing radiation.

5. Stop all operations.

   Check dosimeter pencil for radiation exposure.

   Notify RSO for replacement meter.

6. 2 MR area

   After each exposure.

   Assignment is completed, therefore survey vehicle.

7. The survey meter should have a sticker on it indicating last calibration date and the calibration due date.

8. 0 MR/HR to 1 R/HR

9. Turn crank counter-clockwise until the source is returned to the camera. Survey exposure device. Survey the entire tube. Lock camera.

10. Making an exposure with a Gamma Century exposure device:

    a. Remove safety plug from lock box.

    b. Pull out pigtail 1/2 inch and connect control cable to pigtail

    c. Thread control cable to lock box.

    d. Remove safety plug from source tube side of unit and thread on source tube.

    e. Unlock unit and crank clockwise to expose source.

    f. After exposure time has elapsed, crank source back in counter-clockwise and lock source in position.

    g. Survey unit and source tube.

11. The source may not be fully retracted into the unit.

12. Every six (6) months. 0.005 microcuries.

13. Lock the source in the camera and lock the camera inside the vehicle. Chain it to a steel beam and post warning signs around source.

14. Decay curve or 75 day half-life.

15. Vehicles hauling radioactive materials:

    a. Signs required: CAUTION --- Radioactive Material or Radioactive

    b. Placement: Outside the vehicle on both sides and rear

    c. Maximum allowable radiation outside vehicle: 2 MR/HR.

16. Stop operations immediately, contact RSO, and send film badge in for immediate processing. Get new badge and make a statement of facts.

17. Return to the control cable and turn the hand crank clockwise and counter-clockwise trying to bring the pigtail back into the unit. If this is not successful, then the area should be secured and posted as a Restricted Area, and the RSO should be called.

18. Notify RSO immediately.

19. 0 to 200 MR. It must be worn where it will pick up the maximum amount of radiation while you are working on job assignment.

20. No.

RADIOGRAPHER'S ASSISTANT

TEST III

Name: _____

Date: _____

Branch: _____

Grade: _____

1. The fundamental particles which are of primary concern in Atomic Theory are:

   A. _____

   B. _____

   C. _____

   D. _____

2. When referring to $_{92}U^{238}$, the subscript refers to

   a. Number of protons in the nucleus
   b. Atomic number of the element
   c. Nuclear charge of the nucleus
   d. All of the above

3. List the mass and weight of gamma radiation

   a. Mass = _____

   b. weight = _____

4. X-Rays and gamma rays are dis-similar in that X-rays are electromagnetic radiation and gamma rays are not.

   a. True
   b. False

5. The _____ is an electron accelerator which uses magnetic induction to accelerate electrons in a circular path. A varying magnetic field is used to provide the orbital acceleration.

   a. X-ray tube
   b. linear accelerator
   c. betatron
   d. Van de Graaff Generator

6. Of the first 92 elements, how many have had Radioisotopes obtained from them?

   _____

7. When a reactor is used as a power plant, it (the reactor) is considered primarily as a source of _____energy.

   a. heat
   b. electrical
   c. kinetic
   d. hydrostatic

8. The bombarding of atoms with neutrons so that their nucleus capture neutrons and become radioactive without changing to another material or element is a principal method of obtaining _____

   a. electrical energy
   b. radioisotopes
   c. steam
   d. natural radioactive salts

9. A curie is defined as the amount of any radioisotope that gives _____disintegrations per second.

   a. 3.7×10^{-7}
   b. $.37 \times 10^{10}$
   c. 37×10^{10}
   d. 3.7×10^{10}

10. The number of disintegrations which a given amount of a radioisotope has during a given length of time is called the _____of the isotope.

    a. activity
    b. daughter
    c. strength
    d. none of the above

11. A 100 Curie Source of IR^{192} was purchased on May 1, 1975. Plot a decay curve for that source and determine the source strength on September 20, 1975. Graph paper is supplied for this problem.

12. A free electron, not attached to any parent atom, is called a _____.

    a. ion pair
    b. positive ion
    c. ionizing particle
    d. negative ion

13. An alpha particle may strike an orbital electron in an atom and cause the electron to leave its orbit. This action is called _____.

    a. ionization
    b. secondary ionization
    c. impact
    d. any of the above are correct

14. Describe an ion pair.

15. What particles of radiation might be filtered out by the stainless steel source capsule?

16. List the three processes by which X and Gamma rays lose their energy.

    a.
    b.
    c.

17. Define the "Inverse Square Law".

18. A 60 Curie source of IR-192 is to be used at 10 feet from a group of workmen. (a) What dose rate will they receive? (b) What dose will they receive in 8 hours? (c) At what distance would the group of men receive only 2 MR/hr?

    Note that the dosage rate for IR-192 is 5.9 r/hr/c at 1 foot.

19. A radiographer plans to make a radiograph in a location where it is necessary for people to work periodically as close as 40 feet to a 20 curie source of IR-192. He plans to reduce the dose rate to less than 4 MR/hr by placing a portable lead shield between the radiographic set up and the work area. What thickness shield would be needed to attenuate the gamma radiation to the required level, calculated to the nearest half value layer?

    Note that the half value layer for lead, when used with IR-192, is 0.19 inches.

20. What is the radiation level in the work area in the problem above?

21. List and define the three principals for controlling body exposure to sources

    1.

    2.

    3.

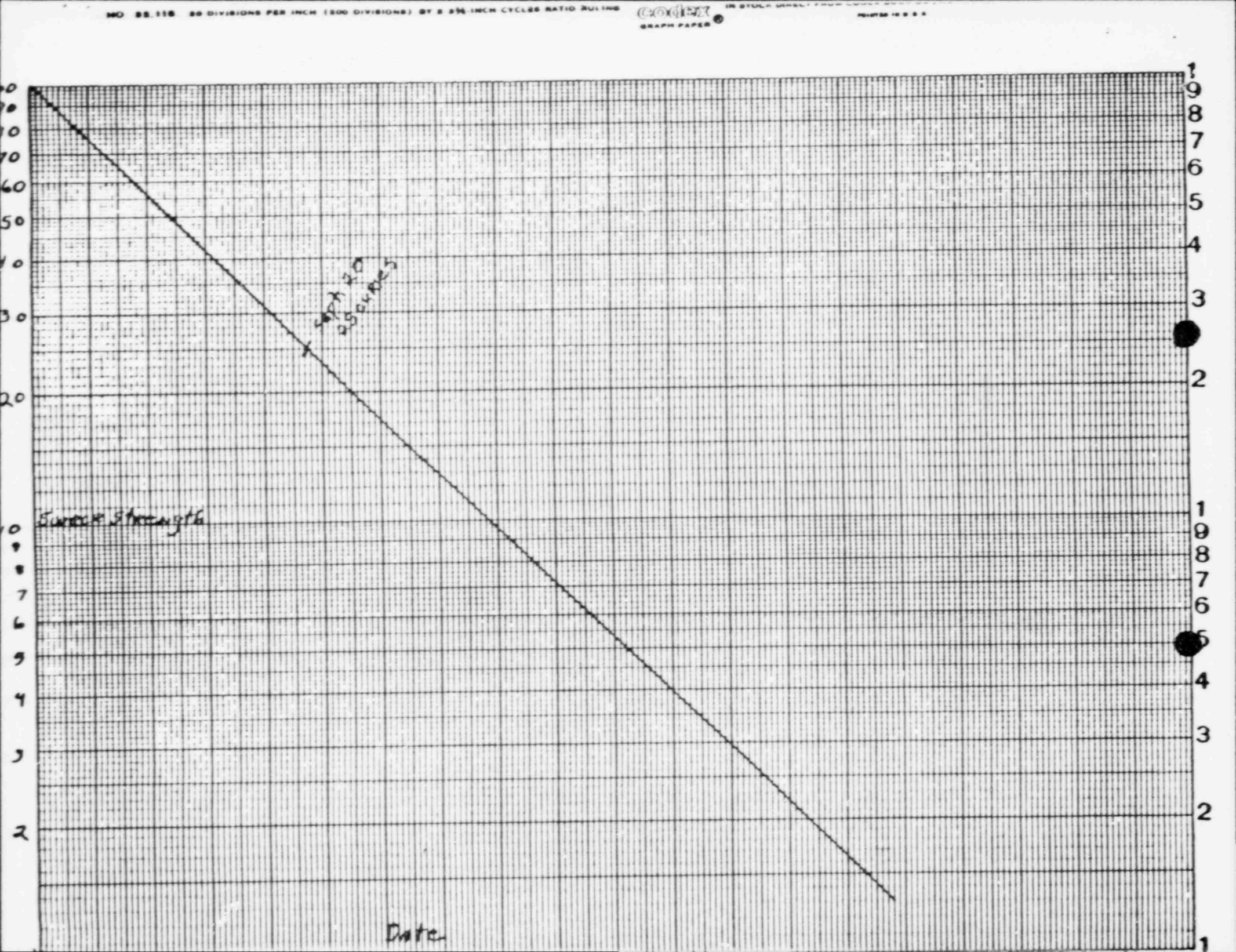
22. A small fabricating shop produces a welded product that requires 40 radiographs each week. A 75 curie IR-192 source is needed to make each exposure in 4 minutes. Only a small shop floor area is available. This requires that the radiographer work within 20 feet of the exposed source. Determine the lead shield thickness that must be provided to prevent the radiation workers from receiving more than 100 MR/week.

23. Briefly describe how an ionization chamber survey meter works.

24. How may a dosimeter pencil be used to determine approximate source strength?

25. Which type of instrument should be used to measure low intensity radiation levels?

    a. Ionization chamber instruments
    b. Dosimeter pencil
    c. Geiger counters
    d. Film badge


Surface Strength
Date

ANSWERS: RADIOGRAPHER ASSISTANT - TEST III

1. a. Proton
   b. Neutron
   c. Electron
   d. Positron

2. d

3. a - Zero, or none

   b - Zero, or none

4. b

5. c

6. 92, or all

7. a

8. b

9. d

10. a

11. See attached decay curve

12. d

13. a

14. When an electron is dislodged from an atom, it becomes a free electron, or negative ion. The original atom now has a positive charge and is a positive ion. The free electron and positive ion are an ion pair. Also, if the free electron combines with another atom, this becomes a negative ion and is an ion pair with the positive ion.

15. Alpha and beta particles

16. a. Compton effect
    b. photoelectric absorption
    c. pair production

17. The intensity of radiation is inversely proportional to the square of the distance from the source.

18. a. 3.54 r/hr or 3540 mr/hr

    b. 28.32 r/hr

    c. 420.7

ANSWERS: RADIOGRAPHER'S ASSISTANT - TEST III

19. Intensity is 118,000 mr/hr at 1 foot, 73.75 mr/hr at 40 feet. Five half value layers (.95 inches) reduces radiation levels to 2.3 mr/hr.

20. 2.3 mr/hr

21. 1. Time-less time spent near source - less radiation received.

    2. Distance - greater distance from source - less radiation received.

    3. Shielding - behind shielding from source, less radiation received.

22. 40 exposures at 4 min. each equals 2.67 hrs per week.

    100 mr/hr ÷ 2.67 equals 37.4 mr/hr maximum exposure.

    75 curies times 5900 mr/hr times $(1/20)^2$ equals 1106.25 mr/hr

    Five half value layers reduces 1106.25 mr/hr to 34.57 mr/hr.

    Ans. .95 inches of lead.

23. Ionization occurs in the chamber in the presence of an electrical field, the ions going to the electrode having the charge of the opposite sign, current flow through the batteries supplying the electrical field are measured and interpreted in terms of radiation intensity.

24. Exposure is made to a dosimeter pencil at a measured distance for a known period of time. The radiation received is computed to mr/hr. This value, the distance from the source, and the know dose rate for the isotope are used to determine source strength with the "Inverse Square Law".

25. c