NRC Form 313 I (12-81) 10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

1. APPLICATION FOR: *(Check and/or complete as appropriate)*

- a. NEW LICENSE
- b. AMENDMENT TO: LICENSE NUMBER
- X c. RENEWAL OF: LICENSE NUMBER

2. **APPLICANT'S NAME** *(Institution, firm, person, etc.)*
Independent Testing Laboratories
Subsidiary of Veritas, USA, Inc.

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
268-7191 501 16

3. **NAME AND TITLE OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION**
Homer L. Wilson

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
268-7191 501 16

4. **APPLICANT'S MAILING ADDRESS** *(Include Zip Code)*
(Address to which NRC correspondence, notices, bulletins, etc., should be sent.)
P.O. Box 657
Searcy, AR 72143

5. **STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED** *(Include Zip Code)*
All NRC Controlled States

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. **INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL**
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	William E. Swain	Company President
b.	John R. Sanderson	Manager of Manlift Services
c.	David Stracener	Supervisor of Manlift Services

7. **RADIATION PROTECTION OFFICER**
Homer L. Wilson

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.
Radiation Safety Officer

8. **LICENSED MATERIAL**

LINE NO.	A ELEMENT AND MASS NUMBER	B CHEMICAL AND/OR PHYSICAL FORM	C NAME OF MANUFACTURER AND MODEL NUMBER *(If Sealed Source)*	D MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME
(1)	Iridium 192	Physical	Gamma Industries A1A	100C - 8 each
(2)	Iridium 192	Physical	Gamma Industries A2A	100C - 8 each
(3)	Iridium 192	Physical	Gamma Industries Model G.P.	100C - 6 each
(4)	Iridium 192	Physical	Gulf Nuclear RC16	100C - 4 each

	E DESCRIBE USE OF LICENSED MATERIAL
	See Attached Sheet
(1)	All sources are used in nondestructice evaluation.
(2)	" " " " " " "
(3)	" " " " " " "
(4)	" " " " " " "

NRC F

9. STORAGE OF SEALED SOURCES

LINE NO.	A. CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED.	B. NAME OF MANUFACTURER	C. MODEL NUMBER
(1)	Camera	Gamma Industries	Century 100
(2)	Camera	Gamma Industries	Century ~~1600~~ 100
(3)	Camera	Gamma Industries	G.P. 1
(4)	Camera	Cumberland Research Corp.	120

See Attached Sheet

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	A. TYPE OF INSTRUMENT	B. MANUFACTURER'S NAME	C. MODEL NUMBER	D. NUMBER AVAILABLE	E. RADIATION DETECTED (alpha, beta, gamma, neutron)	F. SENSITIVITY RANGE (milliroentgens/hour or counts/minute)
(1)	Geiger Counter	Ludlum	4	1	Gamma	1MR to 1R/hr.
(2)	G.M.	G.E. Smith	1000A	10	Gamma	1MR to 1R/hr.
(3)	G.M.	Victoreen	3009	2	Gamma	1MR to 1R/hr
(4)	G.M.	Gamma	250B	1	Gamma	1MR to 1R/hr

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☒ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

Any compnay that is liscensed by an agreement state or the NRC for calibration service used only when outside of the state of Arkansas and the instrument needs calibration.

☒ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

12. PERSONNEL MONITORING DEVICES

A. TYPE (Check and/or complete as appropriate.)	B. SUPPLIER (Service Company)	C. EXCHANGE FREQUENCY
☒ (1) FILM BADGE	Atomic Energy Industries Labs. of the Southwest. Inc. 6421 S. Main Str. Houston. TX 77030	☒ MONTHLY
☐ (2) THERMOLUMINESCENCE DOSIMETER (TLD)		☐ QUARTERLY
☐ (3) OTHER (Specify): _____		☐ OTHER (Specify): _____

13. FACILITIES AND EQUIPMENT (Check were appropriate and attacn annotated sketch(es) and description(s).

☒ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS (Include filtration, if any), ETC.

☒ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING (fixed and/or temporary), ETC.

☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.

☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC. See Section II

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

Application is for seal sources - These are returned to manufacturing.

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

Returned to manufacturing.

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

    c. Mathematics and calculations basic to the use and measurement of radioactivity.

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.–18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)*	b. CERTIFYING OFFICIAL *(Signature)* Homer L. Wilson
	c. NAME *(Type or print)* Homer Wilson
(1) LICENSE FEE CATEGORY: 170.31 - 3.0	d. TITLE Radiation Safety Officer
(2) LICENSE FEE ENCLOSED: $ 700.00	e. DATE 09-04-84

SECTION II

1. PERMANENT STORAGE:

Permanent office and source storage facilities for the Testing and Inspection Department of Independent Testing Laboratories, are located at #1. Research Drive, Searcy, Arkansas 72143.

This facility is a Star Metal Building, owned by ITL. Two radiographic shot rooms and a rapid process darkroom are located in the bay area. (see drawing).

Inside the shop area, a Mosler lead-lined safe contains the exposure devices in four compartments. This safe is approximately 24" wide X 33" deep X 54" high. It is equipped with a separate lock and key.

Radiation levels with radioactive material inside the safe are less than 2mR/hr outside the storage area in the high bay area and also outside the building. "Caution - Radiation Area" signs are posted on the safe.

A sketch of the property, building, and storage area are attached. Dimensions are included on the sketch.

2. USE:

Locations of use under this license shall include temporary sites in which work will be performed from mobile laboratories.

3. Temporary Storage:

When radioactive material covered by this license is utilized at job sites remote from the Searcy office, the devices being utilized will be stored in a locked box in the darkroom section of a company truck under lock and key. Separate locks are on the box and the darkroom.

The storage box is posted "Caution - Radioactive Materials" and "Radioactive" signs are posted on the four sides of the vehicles, in accordance with DOT regulations. The latter signs are removed when there are no radioactive materials in the truck. The former sign is also posted on the darkroom door if the truck is used for temporary storage.

For leased service station (24 hour attendants) parking, place the truck in the designated, well lighted area. Perform step 10 above. Check with the attendant before leaving to assure that he will keep personnel away from the truck and that he knows how you can be reached if necessary.

NOTE: If leased parking is utilized Independent Testing Laboratories will in no manner create Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour or Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 millirems in any seven consecutive days.

CALCULATIONS FOR RADIATION EXPOSURE BAYS:

A. 1.9 inches of concrete equals one half-value-layer for Iridium 192.

B. One curie of Iridium 192 emits : 5900 mR/hr at one foot.

C. Radiation decreases in intensity by the square of the distance.

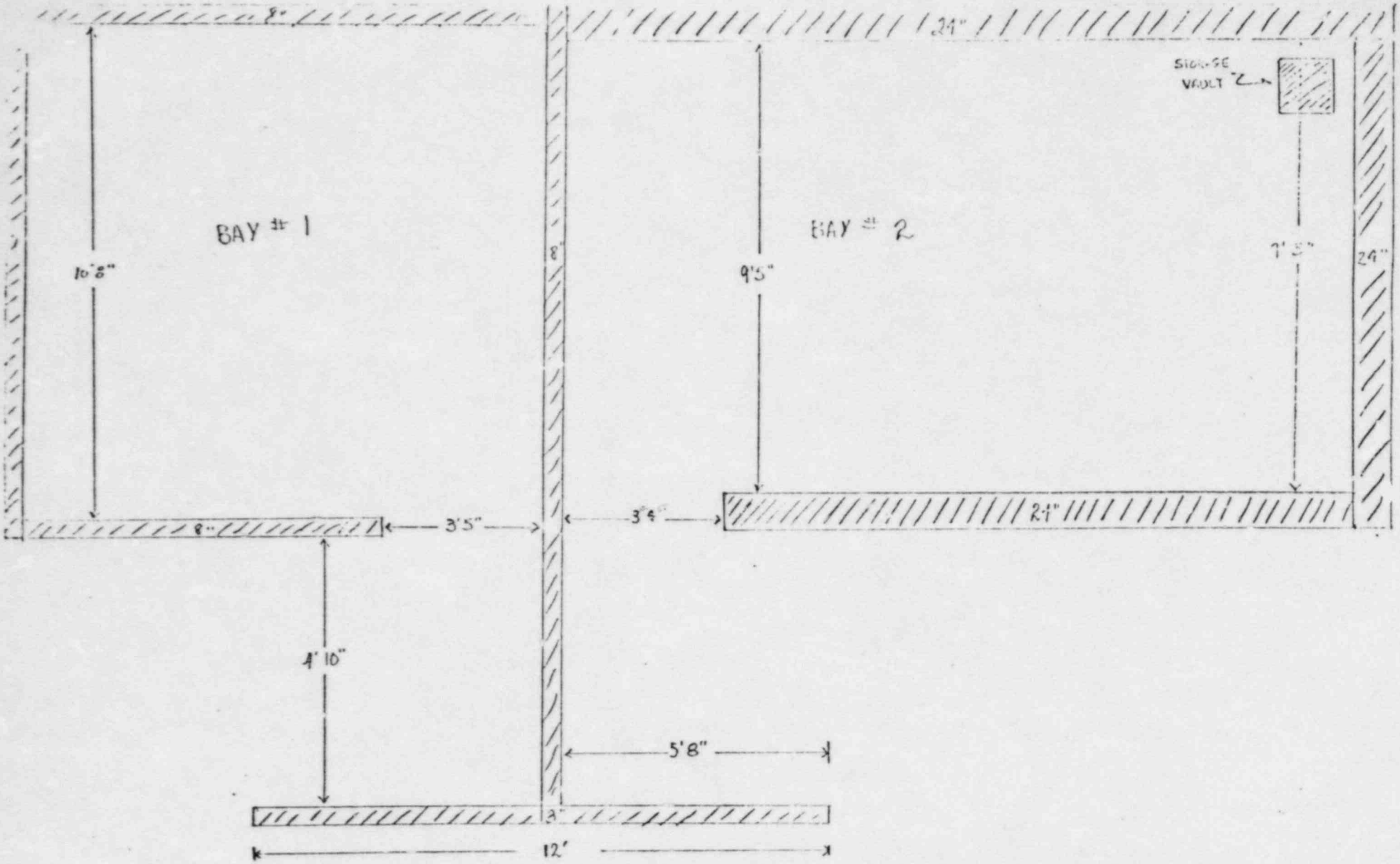
D. The center or exposure area of the bay is a minimum of 4 feet to the surface of the inside wall.

E. The walls are 24" of solid concrete.

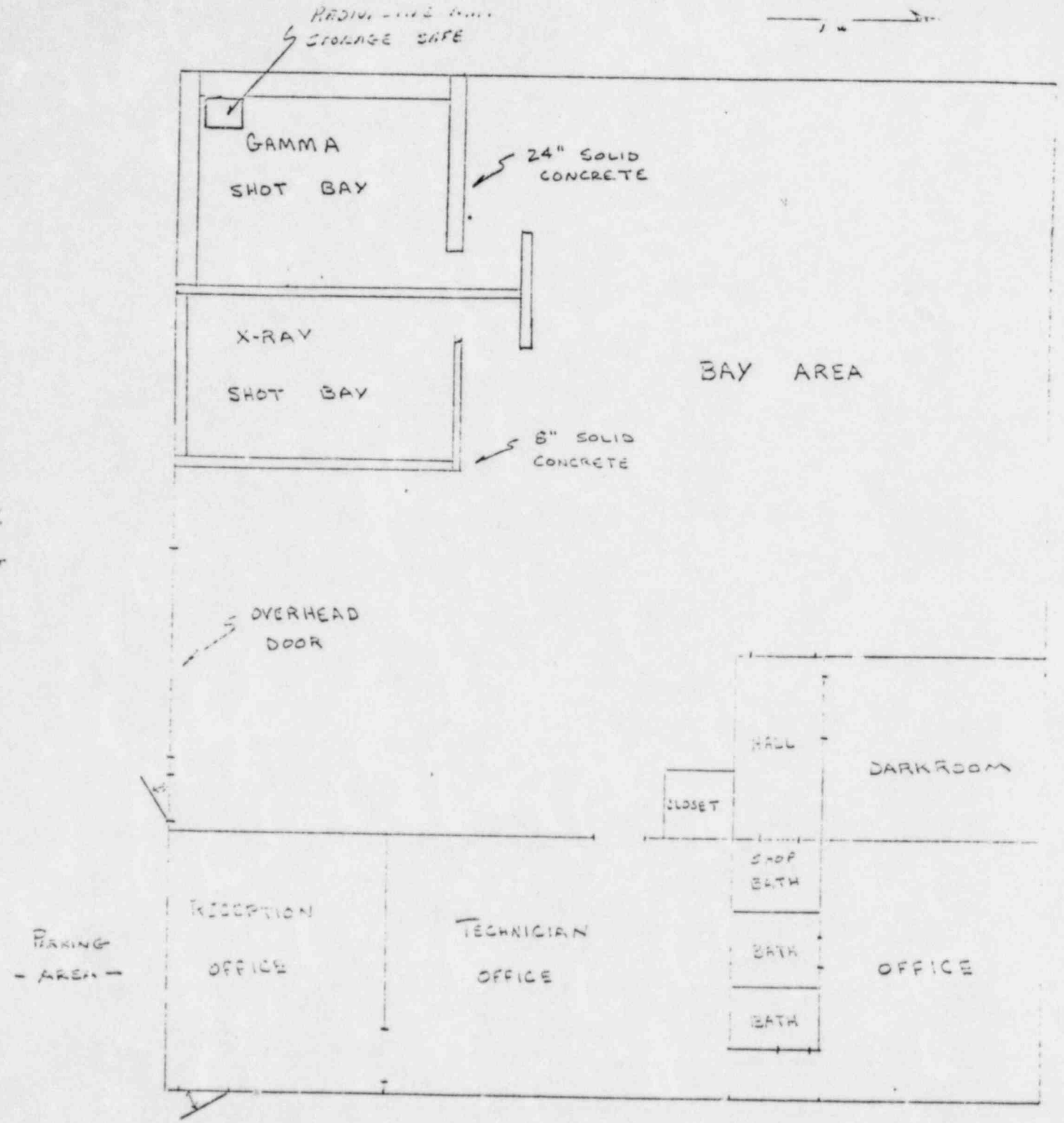
F. The X-ray bay has no leakage at surface with the 200B X-Ray machine.

Therefore: 70 Curies = 413,000 mR/hr @ 1'
= 103,250 mR/hr @ 2'
= 25,812 mR/hr @ 4'

24 inches of concrete = 12.63 half - value - layers or
2 mR/hr at outside surface


10'9"
11'6"
8"
24"
SIGN-SE
VAULT "2"
BAY # 1
BAY # 2
10'8"
8"
9'5"
7'5"
24"
8"
3'5"
3'4"
24"
4'10"
5'8"
3"
12'

WES 11-2-76


RADIOACTIVE MATERIALS STORAGE SAFE
GAMMA
SHOT BAY
24" SOLID CONCRETE
X-RAY
SHOT BAY
BAY AREA
8" SOLID CONCRETE
OVERHEAD DOOR
HALL
DARKROOM
CLOSET
SHOP
BATH
RECEPTION
OFFICE
TECHNICIAN
OFFICE
BATH
OFFICE
BATH
PARKING
AREA
PARKING AREA
- LAWN -

SECTION III

A. Radiation Detection Instruments

At the present time, a total of seventeen portable survey instruments are available for use. These instruments are G.M. types of G.E. Smith and Associates, Model GS-1000A. Dose rates from 0 to 1000 mR/hr. (gamma) can be measured utilizing the three ranges provided by selection switch position. These ranges are: 0-100, and 0-1000 mR/hr. We also have a Victoreen Model 3009 and Gamma 250B. These are ionization chamber-type instruments. We also have a Ludlum geiger counter type instrument. The three ranges are identical to those noted above. The instruments will be used to perform all required surveys as detailed in the Emergency and Operating Procedures.

During work in the field, at least two survey meter, properly operating and calibrated, will be utilized with all exposure devices.

B. Calibration Procedures

Survey instrument calibration services are provided by Independent Testing Laboratories or an approved agent. Calibrations are performed on a quarterly basis and also following any required repairs.

C. Personnel Monitoring

Film badges to be used by work crews under this license will be supplied by Atomic Energy Industrial Laboratories of the Southwest, Houston, Texas. Services will be provided on a monthly basis. Pocket dosimeters utilized by production personnel are Victoreen, Model 54/A or B, or equivalent, with a range from 0-200 mR. On all field work, a dosimeter charger, such as Bendix, Model 906-1, Victoreen, Model 2000A, or equivalent is provided to the work crew.

In certain cases, personnel monitoring equipment, in addition to the above, may also be provided to the work crew. Such equipment includes pocket dosimeters similiar to these noted above, but having a higher range i.e., Landsverk #L51, 0-5R. Also, personnel radiation audial warning devices, such as Victoreen "Tattlers" or Tech'ops "Rad-Tads", are sometimes utilized. The devices noted in this paragraph, however, are not required for the conduct of radiographic operations. They are for back-up purposes only.

D. Leak Testing of Sealed Sources

Leak test services are provided by Atomic Energy Industrial Laboratories of the Southwest, or an approved company. The vendor shall supply the kits, performs the analysis, and reports the test results.

E. Source Exchange

Source exchange will normally be performed at the facilities of the source suppliers or at the company's facilities. Source exchange procedures, however, are included in the Operating and Emergency Procedures should it become necessary for a radiographer to make an exchange in the field.

SECTION IV

Training Program

Responsibility for proper training of radiographers and assistant radiographers is assigned to the Radiation Safety Officer. As indicated in his resume, Section V of this Section, he has previously presented training programs to all ITL employees as assistant Radiation Safety Officer under the direction of William E. Swain.

A. Initial Training and Qualification

1. New Radiography Assistants will complete the Radiographer's Assistant Training Course outline shown on the attached pages. Qualification as Radiographer's Assistant will consist of 520 hours of on the job training and passing a written examination with a score of 70% or more plus satisfactory demonstration, under the personal supervision of a qualified radiographer, that he is competent to use the sources of radiation, related handling tools, and radiation survey instruments which will be employed in his assignment. This demonstration will be observed personally by the RSO who will judge the individuals competence under actual field conditions. Personnel failing the test and/or field demonstration will receive additional training and/or practice. They will then be re-examined.

   After six months (1040 hours) on-the-job work and training under a qualified radiographer, a Radiographer's Assistant will be considered eligible for promotion to full Radiographer.

2. During the latter portion of a Radiographer's Assistant on-the-job period of six months, he will complete the remaining training required by the NRC regulations for a full Radiographer. This training is outlined on the following pages. He will then be given a writen examination which must be passed by a score of 75% or more. After the full six months as Radiographer's Assistant, the individual must demonstrate to the RSO, under field conditions and without supervision competence to use the company's sources of radiation, related handling tools, and radiation survey instruments which will be employed in his assignment as radiographer. After satisfactory completion of the examination and equipment demonstration, the individual is considered eligible for promotion to full radiographer.

3. Personnel with previous training and experience as radiographer will have such training, qualification, and experience verified by the previous employer(s). He will complete a minimum of ten hours training in the company's NRC license, operating and emergency procedures, and use of the company's sources of radiation, related handling tools, and radiation survey instruments, plus a practical examination which is included in the training outline. He will also receive training in any of the other NRC required subjects which can not be verified as having been satisfactorily completed previously.

   To qualify as a full Radiographer for this company, the individual must pass the same type written and practical examination as specified above with a score of 75% or more, and satisfactorily demonstrate to the RSO competence in unsupervised use of the company's sources of radiation, related handling tools, and radiation survey instruments. He must also complete a minimum of two weeks on-the-job training as a Radiographer's Assistant under a qualified Radiographer prior to assignment as a full Radiographer for this company.

B. ON-THE-JOB TRAINING In and for the various groups of employees have been specified in 1., 2., 3. above.

C. PERIODIC TRAINING is provided to all radiography personnel through two means when ever practical. Monthly safety meetings are held by Mr. Wilson. He also conducts field job checks of crews. Through this means personnel received instructions in regulatory, license and procedure changes. Oral questioning is a part of both periodic training methods. Handling techniques and adherence to procedures are checked during the quarterly visits to job sites. All Technicians will participate in a refresher course every six months supervised by the Radiation Safety Officer.

D. COURSE OUTLINES & EXAMINATIONS

TRAINING PROGRAM OUTLINE

FOR RADIOGRAPHY ASSISTANTS

(See Section IV A.1.)

I. Introduction to Radioactive Materials and Radiation (1 hr.)

II. Radiation Detection Instrumentation to be used (1 hr.)

A. Use of Radiation Survey Instruments

1. Operation
2. Calibration
3. Limitations

B. Survey Techniques (1 hr.)

C. Use of Personnel Monitoring Equipment (1 hr.)

1. Film Badges
2. Pocket Dosimeters and Chargers

D. Demonstration and Practice with Above (2 hr.)

III. Radiographic Equipment to be used (5 hr.)

A. Remote Handling Equipment
B. Exposure Devices and Sealed Sources
C. Storage Containers (Source Exchangers)
D. Leak Testing of Sealed Sources
E. Demonstration and Practice with Above

IV. Company's Operating and Emergency Procedures (3 hr.)

V. Study and Review (1 hr.)

VI. Test (Practical) (1 hr.)

Minimum Total - (16 hr.)

TRAINING PROGRAM OUTLINE

FOR NEW RADIOGRAPHERS

(See Section IV A.2.)

I. Review of Radiographers Assistant Training (10 hr.)

II. Fundamentals of Radiation Safety (10 hr.)

A. Characteristics of Gamma Radiation

B. Units of Radiation Dose (mR) and Quantity of Radioactivity (curie)

C. Hazards of Excessive Exposure to Radiation

D. Levels of Radiation from Licensed Material

E. Methods of Controlling Radiation Dose

1. Working Time
2. Working Distance
3. Shielding

III. Requirements of NRC Regulations (5 hr.)

A. Part 19

B. Part 20

C. Part 34

IV. Independent Testing Laboratories (2 hr.)

A. Inclusions

B. Exclusions and Limitations

V. Study and Review (4 hr.)

VI. Test (Written) (1 hr.)

TRAINING PROGRAM OUTLINE

PREVIOUSLY QUALIFIED RADIOGRAPHERS

(See Section IV A.3.)

I. Review* of Sections I. II, and III of the Radiographer Assistants and the same Sections of the New Radiographers Training Programs. (4 hr.)

II. Company's Operating and Emergency Procedures (3 hr.)

III. Independent Testing Laboratories (1 hr.)

A. Inclusions

B. Exclusions and Limitations

IV. Study and Review (1 hr.)

V. Test (Written) (1 hr.)

* If previous training in these subjects can be verified by previous employer(s). If such training cannot be verified, the individual will receive full training in the subjects which are not verified.

WRITTEN TEST

On the attached pages are several sets of test questions. The written test for full radiographer qualification will consist of a minimum of 50 questions selected from the complete group of test questions. The written test for qualification as radiographer assistant will consist of a minimum of 25 questions.

As previously indicated, radiographers must score a minimum of 75% on these written test and radiographer assistants must score at least 70%.

INDEPENDENT TESTING LABORATORIES
SEARCY, ARKANSAS

RADIATION SAFETY EXAMINATION - RADIOGRAPHER TRAINING COURSE

Name_____ Date_____

The following statements are true or false. Indicate with a check, the best answer.

1. Since gamma radiation is very penetrating, more of its energy will be absorbed in body tissue than would be the case with other forms of radiation. T_____ F_____

2. The attenuation of alpha radiation requires careful consideration of problems of shielding. T_____ F_____

3. Alpha emitters offer serious problems of internal radiation. T_____ F_____

4. Gamma radiation will penetrate anything to some extent. T_____ F_____

5. Bremsstrahlung is the kind of radiation which is similiar to X-ray. T_____ F_____

6. Bremsstrahlung frequently results from the shielding of beta radiation. T_____ F_____

7. All alpha radiation from a given source will have the same energy and the same range in matter. T_____ F_____

8. Tissue damage is directly related to penetrability, energy, and specific ionization of radiation. T_____ F_____

9. The roentgen is the radioactivity which equals 3.7 x 10 disintegrations per second. T_____ F_____

10. The roentgen is the unit of external radiation exposure. T_____ F_____

11. The roentgen is a measure of the ionizing ability of the radiation. T_____ F_____

12. The curie is a unit of radioactivity which equals 3.7 x 10 disintegrations per second. T_____ F_____

13. The roentgen equivalent man (rem) is a unit based on the roentgen which takes into account the relative biological effectiveness of various types of radiation. T_____ F_____

14. The roentgen and the roentgen equivalent man are equivalent. T_____ F_____

15. The relative biological effectiveness of a given type of radiation is the ratio of the damage done in tissue by the radiation in question to the damage done by an equal amount of radium. T_____ F_____

16. Counts per minute and disintegrations per minute are the same. T_____ F_____

17. All radiation survey instruments give the same background reading. T_____ F_____

18. Radiation injury occurs in cells by causing changes in the atoms and molecules. T_____ F_____

19. Blood and blood-forming organs are the most radiosensitive. T_____ F_____

20. Skin and the GI tract are the least radiosensitive organs. T_____ F_____

21. Immature cells, cells in the early stage of division, and cells with high metabolic rates are the most sensitive to radiation. T_____ F_____

22. The safety of the individual workman is the primary criteria for the setting of acceptable levels of exposure to radiation. T_____ F_____

23. Acute symptoms or injury can be expected if the hazards due to handling of radioactive material presently used for radiography in Midland are not controlled. T_____ F_____

24. Life-span shortening has been demonstrated by experiments with human beings with radioactive materials and radiation. T_____ F_____

25. Experiments with animals have proven a potential hazard due to genetic effects but have not given us reliable quantitative information yet. T_____ F_____

26. Lack of knowledge is sufficient reason to be conservative in our control of radiation exposures. T_____ F_____

27. Present control levels are well below the bodily injury range and constitute little or no hazard to future generations. T_____ F_____

28. Present standards which limit exposure to radiation are based upon well established experience with human beings. T_____ F_____

29. All exposures must be kept below 2.5 mR/hr. T_____ F_____

30. Maximum Permissible Concentrations take into account biological half-life, radiation half-life, and organ sensitivity. T_____ F_____

31. The half-life of a material is the length of time it takes any given sample to decay. T_____ F_____

32. It is possible to predict whenever any particular radioactive atom will decay. T_____ F_____

33. Although radioactive materials can go through decay schemes which involve several other radioactive materials, they eventually all decay to a stable product. T_____ F_____

34. Materials can be made radioactive by exposing them to external radiation from radiographic sources. T_____ F_____

35. The biological half-life of material refers to the time it takes the human body to rid itself of one-third of the original dose of the material. T_____ F_____

36. The effective half-life refers to the time it takes for a dose to the human body to be reduced by one-half. T_____ F_____

37. Effective half-life is a function both of the physical half-life and of the biological half-life of the material. T_____ F_____

38. The NRC limit on the level of radiation for a radiographic exposure device measuring a minimum of four inches from the source storage position to any exterior surface of the device, is 200 mR/hr and 10 mR/hr at one meter from any exterior surface. (The radiation levels specified are with the sealed source in the shielded position.) T_____ F_____

39. Having locked storage containers for the Co-60 source is sufficient protection to prevent tampering or removal be unauthorized personnel. T_____ F_____

40. The main reason for having a radiation survey instrument at the site during radiographic work is to measure levels of radiation in case of a mishap. T_____ F_____

41. The Co-60 source should be tested for leakage at intervals not exceeding six months. T_____ F_____

42. A written record available for inspection by the NRC is needed indicating the plant sites and dates of use for the Co-60 sources. T_____ F_____

43. Since x-ray units are not governed by NRC regulations, there are no set regulations or records required to be kept. T_____ F_____

44. Portable x-ray units should not be operated if any unauthorized individual in the immediate area would be exposed to levels of radiation greater than 5 mR/hr. T_____ F_____

45. A film badge is not needed to be worn by an individual operating radiographic equipment unless he is likely to be exposed to levels of radiation greater than 5 mR/hr. T_____ F_____

46. Reading an individual's pocket dosimeter once each week is sufficient to account for the recommended weekly ~~dose~~ limit of 100 mr. T_____ F_____

47. An individual's film badge should be immediately processed of the pocket dosimeter worn in conjunction with the film badge reveals a radiation exposure greater than the range of the dosimeter. T_____ F_____

48. In the event of an accident involving an excessive exposure to radiation, a member of the Environmental Research Laboratory should be notified second only to your Radiation Safety Officer. T_____ F_____

49. The NRC must be notified within 24 hours of any radiation exposure to an individual in excess of the 1.25 rem/calendar quarter for the whole body. T_____ F_____

50. The levels for radiation for radiographic work using the Co-60 sources are such that a sign or signs bearing the words, "Caution: High Radiation Area", are needed to be posted in the area at all times. T_____ F_____

51. The levels of radiation for radiographic work using the portable x-ray units are that a sign bearing the words, "Caution: Radiation Area", are needed to be posted in the area at all times. T_____ F_____

52. A pocket chamber or dosimeter is a more reliable way of determining an individual's accumulated exposure to radiation than the film badge. T_____ F_____

53. The use of a radiation survey instrument is not needed for determining levels of radiation during radiographic operations as long as all persons involved wear film badges and pocket dosimeters. T_____ F_____

54. A physical radiation survey and a written record thereof is required by the NRC to determine that the Co-60 sources are returned to their shielded condition prior to securing. T_____ F_____

55. The radiation survey instrument must be calibrated at least quarterly. T_____ F_____

The following questions/statements are multiple choice, circle the best answer.

1. An excellent radiograph is obtained under given conditions of exposure with the film located at a distance of 36" from the target of the x-ray tube. If the tube is now placed only 18" from the target and all exposure condition, except time, are held constant, the new exposure time will be:

    a. unchanged
    b. longer by approximately 8%.
    c. shorter by approximately 55%.
    d. only about 25% as long as the original exposure time.

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 given thickness and weight.
    c. ability to emit electron when irradiated.
    d. ability to defract alpha particles.

3. The penetrability of an x-ray beam is governed by:

    a. kilovoltage or wavelength.
    b. time.
    c. milliamperage.
    d. source to film distance.

4. Co-60 used in nondestructive testing emits:

    a. alpha particles.
    b. neutrons.
    c. gamma rays.
    d. x-rays.

5. The time required for one-half 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.

6. 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 and hydrogen.

7. Upon completing an x-ray exposure and turning the equipment off:

   a. personnel should wait for a few minutes before entering the exposure area.
   b. personnel should wear a lead-lined apron before entering the exposure area.
   c. personnel may enter the exposure area without fear of radiation exposure.
   d. personnel should take a reading with Geiger counter before entering the radiation area.

8. The most widely used unit of measurement for measuring the rate at which the output of a gamma ray source decreases is the:

   a. curie.
   b. roentgen.
   c. half-life.
   d. MEV.

9. All 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 buildup an immunity to radiation poisoning.
   c. will have no effect on human beings.
   d. will have only a short effect on human tissues.

10. A dose of _____ would be dangerous, if not fatal, if applied to the entire body in a short period of time.

   a. 1.5-15R
   b. 25-70R
   c. 200-800R
   d. All of the above doses would most likely be fatal.

11. When doing ray radiography with high intensity emitters the sources are best handled:

    a. directly by personnel equipped with special protective clothing.
    b. by remote handling equipment which permits the operators to remain several yards away at all times.
    c. directly by personnel with special protective clothing except when radiographs are being made.
    d. by the same methods used for low intensity emitters.

12. The Co-60 capsule will have a half-life of:

    a. 1.2 years
    b. 6 months
    c. 5.3 years
    d. 75 days

13. As the Kilovoltage applied to the x-ray tube is raised:

    a. x-rays of longer wavelength and more penetrating power are produced.
    b. x-rays of shorter wavelength and more penetrating power are produced.
    c. x-rays of shorter wavelength and less penetrating power are produced.
    d. x-rays of longer wavelength and less penetrating power are produced.

14. Overexposure to x-rays or gamma rays may cause damage to human:

    a. blood tissues.
    b. skin.
    c. internal organs.
    d. all of the above.

15. A general rule used to define the amount of radiation exposure that is excessive is:

    a. although small amounts of radiation, 0.4 r/week or less, are beneficial, since they build up an immunity to these rays, anything above 0.4 r/week is excessive.
    b. any dose over 5 r/week is excessive.
    c. any dose which causes a mid-range reading on a Geiger counter is excessive.
    d. any necessary exposure to radiation is excessive.

16. X-ray exposure may be due to the:

    a. direct beam from the x-ray tube target.
    b. scatter radiation from arising from objects in the direct beam.
    c. both a and b.
    d. both a and b above, plus residual radiation that exists for the first few minutes after the x-ray machine has been turned to the off position.

17. Material which are exposed to gamma radiation below a few million volts:

    a. should not be handled for at least 3 minutes after exposure has ceased.
    b. should be stored in a lead-lined room.
    c. will not be dangerous to handle after exposure to radiation has ceased.
    d. should be monitored by means of a Geiger counter.

18. A primary disadvantage of the fountain pen type of ionization chamber used to measure the amount of radiation received by personnel is:

    a. the delay necessary before the results of the measurement are known.
    b. the inaccuracy of such devices in measuring the scatter radiation.
    c. the inability of such a device to provide a permanent record of exposure.
    d. the cost of recharging such devices.

19. Very short wavelength electromagnetic radiation produced when electrons traveling at high speeds collide with matter is called:

    a. x-radiation.
    b. beta radiation.
    c. gamma radiation.
    d. none of the above.

20. The exposure of personnel to x- and gamma radiation can be determined by means of:

    a. film badges.
    b. dosimeters.
    c. radiation meters.
    d. all of the above.

21. An advantage of the fountain pen type of ionization chamber used to monitor radiation received by personnel is:

    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.

22. In making an isotope measurement in an unshielded area, you find the dose rate 6 feet from the source at 1200 mR/hr, what would the dose rate at 24 feet be?

    a. 75 mR/hr
    b. 100 mR/hr
    c. 200 mR/hr
    d. 300 mR/hr

23. An unshielded isotope source gives a dosage rate of 900 mR/hr at 10 feet, what would the unshielded dosage rate be at 30 feet?

    a. 300 mR/hr
    b. 600 mR/hr
    c. 100 mR/hr
    d. 2700 mR/hr

24. The best method of controlling radiation dose while doing radiographic work is:

    a. decreasing time, decreasing distance, decreasing shielding.
    b. decreasing time, increasing distance, increasing shielding.
    c. decreasing time, decreasing distance, increasing shielding.
    d. by telephone.

KEY FOR RADIATION SAFETY EXAM

1. TRUE
2. FALSE
3. TRUE
4. TRUE
5. TRUE
6. FALSE
7. TRUE
8. TRUE
9. FALSE
10. TRUE
11. TRUE
12. TRUE
13. TRUE
14. FALSE
15. FALSE
16. TRUE
17. FALSE
18. TRUE
19. TRUE
20. FALSE
21. TRUE
22. FALSE
23. TRUE
24. FALSE
25. TRUE
26. TRUE
27. TRUE
28. FALSE
29. FALSE
30. TRUE
31. FALSE
32. FALSE
33. TRUE
34. FALSE
35. FALSE
36. TRUE
37. TRUE
38. FALSE
39. FALSE
40. FALSE
41. TRUE
42. TRUE
43. FALSE
44. TRUE
45. FALSE
46. FALSE
47. TRUE
48. TRUE
49. FALSE
50. FALSE
51. TRUE
52. FALSE
53. FALSE
54. TRUE
55. FALSE

MULTIPLE CHOICE

1. D
2. B
3. A
4. C
5. C
6. B
7. D
8. A
9. A
10. C
11. B
12. C
13. B
14. D
15. D
16. C
17. C
18. C
19. C
20. D
21. B
22. A
23. C
24. B

GENERAL EXAMINATION

FOR LEVEL I RADIOGRAPHERS

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" 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%.
    c. shorter by aproximately 55%.
    d. only about 25% as long as the original exposure time.

2. An excellent radiograph is obtained under given exposure conditions with a tube current of five milliamperes and exposure time of twelve minutes. If other conditions are not changed, what exposure time would be required if the x-ray tube current could be raised to ten milliamperes?

    a. 24 minutes
    b. 12 minutes
    c. 6 minutes
    d. 3 minutes

3. In film radiography, penetrameter are usually placed:

    a. between the intensifying screen and the film.
    b. on the source side of the test object.
    c. one the film side of the test object.
    d. between the operator and the radiation.

4. 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.

5. The penetrating ability of an x-ray beam is governed by:

    a. kilovoltage or wavelength.
    b. time.
    c. milliamperage.
    d. source-to-film distance.

6. Lead foil screens are used in radiography:

   a. to improve the quality of the radiograph by preferentially reducing the effect of scatter radiation.
   b. to reduce the exposure time.
   c. both a and b are reasons for using lead foil screens.
   d. neither a or b are reasons for using lead foil screens.

7. A densitometer is:

   a. a meter used to measure x-ray intensity.
   b. an instrument for measuring film density.
   c. a meter used to measure the density of a material.
   d. a meter used to measure tube current.

8. Three liquids which are essential to process an exposed film properly are:

   a. stop bath, acetic acid, and water
   b. developer, stop bath, and H_2O_2.
   c. developer, fixer, and water.
   d. acetic acid, fixer, and stop bath.

9. The two most common causes for excessively high density radiographs are:

   a. insufficient washing and overdevelopment.
   b. contaminated fixer and insufficient washing.
   c. overexposure and contaminated fixer.
   d. overexposure and overdevelopment.

10. To prevent back scatter from reaching an x-ray film it is customary to:

   a. back the exposure holder with a thick sheet of lead.
   b. place a mask between the specimen and the front surface of the film.
   c. back the exposure holder with a thick layer of cardboard.
   d. place a filter near the x-ray tube.

11. The purpose of agitating an x-ray film during development is to:

   a. protect the film excessive pressure.
   b. renew the developer at the surface of the film.
   c. disperse unexposed silver grains on the film surface.
   d. prevent reticulation.

12. The ability to detect a small discontinuity or flaw is called:

   a. radiographic contrast.
   b. radiographic sensitivity.
   c. radiographic density
   d. radiographic resolution.

13. Movement, geometry, and screen contact are three factors that affect radiographic:

    a. contrast.
    b. unsharpness.
    c. reticulation.
    d. density.

14. The difference between the densities of two areas of a radiograph is called:

    a. radiographic contrast.
    b. subject contrast.
    c. film contrast.
    d. definition.

15. Upon completing an x-ray exposure and turning the equipment off:

    a. personnel should wait for a few minues before entering the exposure area.
    b. personnel should wear a lead-lined apron before entering the exposure area.
    c. personnel may enter the exposure area without fear of radiation exposure.
    d. personnel should take a reading with a Geiger counter before entering the exposure area.

16. Small amounts of exposure to x-rays or gamma rays:

    a. will have a cumulative effect which must be considered when monitoring for maximum permissible 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 tissue.

17. The activity of the developer solution is maintained stable by:

    a. constant agitation.
    b. maintaining processing solution within the recommended temperature range.
    c. avoiding contamination from the wash bath.
    d. addition of replenisher.

18. For best results when manually processing film, solutions should be maintained within a temperature range of:

    a. 65 degrees fahrenheit and 75 degrees fahrenheit
    b. 65 degrees celsius and 75 degrees celsius
    c. 75 degrees fahrenheit and 85 degrees fahrenheit
    d. 75 degrees celsius and 85 degrees celsius

19. If a film is placed in a developer solution and allowed to develop without any agitation:

    a. the radiograph will not show proper contrast.
    b. it will be impossible to fix the radiograph permanently.
    c. there will be a general "fogging" condition over the entire radiograph.
    d. there will be a tendency for each area of the film to affect the development of the areas immediately below it.

20. The selection of the proper type of film to be used for the x-ray examination of a particular part depends on:

    a. the thickness of the part.
    b. the material of the specimen.
    c. the voltage range of the available x-ray machine.
    d. all three of the above factors.

21. When radiographing a part which contains a large crack, the crack will appear on the screen as a:

    a. dark, intermittent or continuous line.
    b. light irregular line.
    c. either a dark or light line.
    d. fogged area on the radiograph.

22. X-ray tube current is controlled by:

    a. the current passing through the filament.
    b. the distance from the cathode to the anode.
    c. the type of material used in the target.
    d. the voltage and waveform applied to the x-ray.

23. The voltage and waveform applied to the x-ray tube by a high voltage transformer determines the:

    a. quantity of radiation.
    b. duration of exposure.
    c. quality of radiation.
    d. x-ray beam divergence.

24. Lead foil in direct contact with x-ray film:

    a. intensifies the scatter radiation more than the primary radiation.
    b. decreases the contrast of the radiographic image.
    c. intensifies the primary radiation more than the scatter radiation.
    d. should not be used when gamma rays are emitted by the source of radiation.

25. Radiographic sensitivity, in the context of defining the minimum flaw, depends on:

    a. graininess of the film.
    b. the unsharpness of the flaw image in the film.
    c. the contrast of the flaw image on the film.
    d. all three of the above.

26. In order to decrease geometric unsharpness:

    a. x-rays should proceed from as small a focal spot as other considerations will allow.
    b. x-rays should proceed from as large a focal spot as other considerations will allow.
    c. the film should be as far as possible from the object being radiographed.
    d. the distance from the anode to the material examined should be as small as is practical.

27. As the kilovoltage applied to the x-ray tube is raised:

    a. x-rays of longer wavelength and more penetrating power are produced.
    b. x-rays of shorter wavelength and more penetrating power are produced.
    c. x-rays of shorter wavelength and less penetrating power are produced.
    d. x-rays of longer wavelength and less penetrating power are produced.

28. In order to increase the intensity of x-radiation:

    a. the tube current should be increased.
    b. the tube current should be decreased.
    c. the test specimen should be moved further from the film.
    d. a lower kilovoltage should be applied to the tube.

29. Primary radiation which strikes a film holder or cassette through a thin portion of the specimen will cause scattering into the shadows of the adjacent thicker portions producing:

    a. radiation imaging
    b. spotting
    c. undercut
    d. unsharpness

30. Scattered radiation caused by any material, such as a wall or floor, on the film side of the specimen is referred to as:

    a. primary scattering.
    b. undercut.
    c. reflected scattering.
    d. back-scattered radiation.

31. Which of the following materials is suitable for use in vessels or pails used to mix processing solutions?

    a. stainless steel
    b. aluminum
    c. galvanized iron
    d. tin

32. Overexposure to x-rays or gamma rays may cause damage to human:

    a. blood tissue
    b. skin
    c. internal organs
    d. all of the above

33. X-ray exposure may be due to:

    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.

34. A general rule often employed for determining the kilovoltage to be used when x-raying a part is:

    a. the kilovoltage should be as high as other factors will permit.
    b. the kilovoltage should be as low as other factors will permit.
    c. the kilovoltage is always a fixed value and cannot be changed.
    d. the kilovoltage is not an important variable and can be changed over a wide range without affecting the radiograph.

35. Excessive exposure of film to light prior to development of the film will most likely result in:

    a. a foggy film
    b. poor definition
    c. streaks
    d. yellow stain

36. White crescent-shaped marks on an exposed x-ray are most likely caused by:

    a. crimping film after exposure.
    b. crimping film before exposure.
    c. sudden extreme temperature change while processing.
    d. warm or exhausted fixer.

37. Frilling or loosening of the emulsion from the base of the film is most likely caused by:

    a. water or developer on unprocessed film.
    b. low temperature of processing solutions.
    c. developer solution contamination.
    d. warm or exhausted fixer solution.

38. One of the general rules concerning the application of geometric principles of shadow formation to radiography is:

    a. the x-rays should proceed from as large a focal spot as other considerations will allow.
    b. the film should be as far as possible from the object being radiographed.
    c. the distance between the anode and the material examined should always be as great as possible.
    d. all three of the above are correct.

39. As a check on the adequacy of the radiographic technique, it is customary to place a standard test piece on the source side of the specimen. This standard test piece is called a:

    a. reference plate
    b. lead screen
    c. penetrameter
    d. illuminator

40. A fluorescent intensifying screen will:

    a. transform x-ray energy into visible or ultraviolet light to which a photographic emulsion is sensitive.
    b. result in reticulation.
    c. decrease the graininess of the image when using gamma rays.
    d. increase the definition in a radiograph.

KEY TO GENERAL EXAMINATION LEVEL I RADIOGRAPHERS

1. D
2. D
3. C
4. B
5. A
6. A
7. B
8. C
9. D
10. A
11. B
12. B
13. B
14. A
15. D
16. A
17. D
18. A
19. D
20. D
21. A
22. A
23. C
24. C
25. D
26. A
27. B
28. A
29. C
30. D
31. C
32. D
33. C
34. B
35. A
36. B
37. D
38. C
39. C
40. A

RECOMMENDED SPECIFIC EXAMINATION QUESTIONS

FOR LEVEL I RADIOGRAPHER

1. Very short wavelength electronmagnetic radiation produced when electrons traveling at high speeds collide with matter is called:

    a. x-radiation
    b. beta radiation
    c. gamma radiation
    d. none of the above

2. The exposure of personnel to x- and gamma radiation can be determined by means of:

    a. film badges
    b. dosimeters
    c. radiation meters
    d. all of the above

3. A graph showing the relation between material thickness, kilovoltage, and exposure is called:

    a. a bar chart
    b. an exposure chart
    c. a characteristic curve
    d. an H and D curve

4. When referring to a "2T, 3T, or 4T" hole in the ASME Boiler Code, ASTM, or armed forces penetrameters, the T refers to:

    a. the part thickness
    b. the penetrameter
    c. the time of exposure
    d. the time for developing

5. Two x-ray machines operating at the same nominal kilovoltage and milliamperage settings:

    a. will produce the same intensities and qualities of radiation.
    b. will produce the same intensities but may produce different qualities of radiation.
    c. will produce the same qualities but may produce different intensities of radiation.
    d. may give not only different intensities but also different qualities of radiation.

6. The density difference between two selected portions of a radiograph is known as:

   a. unsharpness
   b. radiographic contrast
   c. specific activity
   d. subject density

7. In making an isotope exposure in an unshielded area, you find the dose rate 6 feet from the source is 1200 mr/hr. What would be the dose rate at 24 feet?

   a. 75 mR/hr.
   b. 100 mR/hr.
   c. 200 mR/hr.
   d. 300 mR/hr.

8. The intensity of x-radiation is measured in:

   a. roentgens
   b. ergs
   c. roentgens per unit of time
   d. H & D units

9. Lead screens in contact with the film during exposure:

   a. increase the photographic action of the film largely by reason of the electron emission and partly by the secondary x-rays generated in the lead.
   b. absorb the shorter wavelength scattered radiation more than the long wavelength primary radiation.
   c. intensifying the photographic effect of the scatter radiation more than that of the primary radiation.
   d. none of the above.

10. An unshielded isotope source gives a dosage of 900 mr. per hr. at 10 ft. What would the unshielded dosage rate be at 30 feet.

    a. 300 mR/hr.
    b. 600 mR/hr.
    c. 100 mR/hr.
    d. 2700 mR/hr.

11. 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

12. The most widely used unit of measurement for measuring the rate at which the output of a gamma ray source decreases is the:

    a. curie
    b. roentgen
    c. half-life
    d. MEV

13. A dose of _____would be dangerous, if not fatal, if applied to the entire body in a short period of time:

    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.

14. When doing gamma ray radiography with high-intensity emitters, the sources are best handled:

    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 protective clothing except when radiographs are being made.
    d. by the same methods used for low-intensity emitters.

15. A cobalt-60 capsule will have a half-life of:

    a. 1.2 years
    b. 6 months
    c. 5.3 years
    d. 75 days

16. Overexposure to x-rays or gamma rays cause damage to human:

    a. blood tissue
    b. skin
    c. internal organs
    d. all of the above

17. A general rule used to define the amount of radiation exposure that is excessive is:

    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 necessary exposure to radiation is excessive.

18. A curie is the equivalent of:

    a. .001 millicuries
    b. 1,000 millicuries
    c. 1,000 megacuries
    d. 100 megacuries

19. In making an isotope exposure in an unshielded area, you find the dose rate 6 feet from the source is 1200 mr/hr. What would be the dose rate at 24 feet?

    a. 75 mR/hr
    b. 100 mR/hr
    c. 200 mR/hr
    d. 300 mR/hr

20. An excellent radiograph is obtained under given exposure conditions with a tube current of five milliamperes and an exposure time of twelve minutes. If other conditions are not changed, what exposure time would be required if the x-ray tube current could be raised to ten milliamperes?

    a. 24 minutes
    b. 12 minutes
    c. 6 minutes
    c. 3 minutes

KEY TO SPECIFIC EXAM LEVEL I RADIOGRAPHER

1. C
2. D
3. B
4. B
5. D
6. B
7. A
8. C
9. A
10. C
11. B
12. A
13. C
14. B
15. C
16. D
17. D
18. B
19. A
20. D

RECOMMENDED GENERAL EXAMINATION QUESTIONS

NDT LEVEL II - RADIOGRAPHIC TESTING

1. The uneven distribution of developed grains within the emulsion of a processed x-ray film causes the subjective impression of:

    a. graininess
    b. streaks
    c. spots
    d. white scum

2. A source of iridium-192, whose half-life is 75 days, provides an optimum exposure of a given test object today in a period of twenty minutes. Five months from now, what exposure time would be required for the same radiographic density, under similiar exposure conditions?

    a. 10 minutes
    b. 20 minutes
    c. 1 hour and 20 minutes
    d. 6 hours

3. Of the following, the source providing the most penetrating radiation is:

    a. cobalt-60
    b. 220 kvp x-ray tube
    c. 15 megavolt betatron
    d. electrons from iridium-192

4. An x-ray film having wide latitude also has, by definition:

    a. poor definition
    b. low contrast
    c. high speed
    d. none of the above

5. One method of reducing radiographic contrast is to:

    a. increase the distance between the radiation source and the object.
    b. decrease the distance between the object and the film.
    c. decrease the wavelength of the radiation used.
    d. increase developement time within manufacturer's recommendations.

6. Thin sheets of lead foil in intimate contact with x-ray film during exposure increase film density because:

    a. they fluoresce and emit visible light which helps expose the film.
    b. they absorb the scattered radiation.
    c. they prevent back-scattered radiation from fogging the film.
    d. they emit electrons when exposed to x- and gamma radiation which help darken the film.

7. When radiographing to the 2-2T quality level, an ASTM penetrameter for 2.5 inch steel has a thickness of:

    a. one-half inch
    b. 2.5 mils
    c. 5 mils
    d. 50 mils

8. A good cobalt-60 shot is made on a 3" steel casting using an exposure time of 10 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 similiar radiograph if all other conditions remain the same?

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

9. When sharp, black, bird-foot shaped marks which are known not to correspond with any discontinuities appear at random on radiographs, they are probably caused by:

    a. prolonged development in old developer.
    b. exposure of the film by natural cosmic ray showers during storage.
    c. static charges caused by friction.
    d. inadequate rinsing after fixing.

10. In comparision with lower-voltage radiographs, high energy radiographs show:

    a. greater contrast
    b. greater latitude
    c. greater amounts of scatter radiation relative to primary beam intensity.
    d. none of the above.

11. An ASTM penetrameter for use when inspecting a one-half inch thick steel plate to the 2-2T quality level using a 15-inch source-to-film distance would be made of:

    a. 5 mil thick aluminum.
    b. 500 mil thick aluminum or steel.
    c. 10 mil thick steel.
    d. 2 mil strip of any metallic material.

12. Besides serving as a filter, screens of high atomic number, such as lead and lead antimony, also:

    a. decrease the source-to-film distance needed for a proper radiograph.
    b. provide some image intensifying action.
    c. permit the use of higher speed film.
    d. decrease the graininess in a radiograph.

13. The amount of unsharpness or blurring of a radiograph is:

    a. directly proportional to the object-to-film distance and inversely proportional to the size of the focal spot.
    b. directly proportional to the size of the focal spot and inversely proportional to the source-to-object distance.
    c. inversely proportional to the object-to-film distance and directly proportional to the source-to-object distance.
    d. inversely proportional to the size of the focal spot and the object-to-film distance.

14. Images of discontinuities close to the source side of the specimen becomes less clearly defined as:

    a. source-to-object distance increases.
    b. the thickness of the specimen increases.
    c. the size of the focal spot decreases.
    d. the thickness of the specimen decreases.

15. X-ray with large grain size:

    a. will produce radiographs with better definition than film with small grain size.
    b. have slower speeds than those with a relatively small grain size.
    c. have higher speeds than those with a relatively small grain size.
    d. will take longer to expose properly than film with relatively small grain size.

16. The formula $\frac{\text{milliamperes x time}}{\text{distance } 2}$ is:

    a. used to calculate film gradient.
    b. the reciprocity law.
    c. used to determine radiographic contrast.
    d. the exposure factor.

17. X-ray exposure holders and cassettes often incorporate a sheet of lead foil in the back which is not in intimate contact with the film. The purpose of this sheet of lead foil is:

    a. to act as an intensifying screen.
    b. to protect the film from back scatter.
    c. both a and b above.
    d. neither a or b above.

18. In certain cases, it may be advantageous to pack barium clay around a specimen. The purpose for doing this is:

    a. to prevent movement of the specimen.
    b. to increase the subject contrast.
    c. to generate smaller wavelength x-radiation.
    d. to decrease the effect of scattered radiation undercutting the specimen.

19. When radiographing steel with a thickness less than one inch:

    a. cobalt-60 would give greater radiographic sensitivity than a 250 kv. x-ray machine.
    b. a 250 kv. x-ray machine would give greater radiographic sensitivity than cobalt-60.
    c. the use of fluorescent screens would result in a radiograph of better quality than would lead foil screens.
    d. the use of lead foil screens would require a shorter exposure time than will fluorescent screens.

20. The interval between the time a film is placed in a fixer solution and the time when the original diffuse, yellow milkiness disappears is known as:

    a. clearing time
    b. fixing time
    c. hardening time
    d. oxidation time

21. Excessive subject contrast caused when the thickness range in the test specimen is too great for the radiation quality used may be corrected by:

    a. increasing the kilovoltage.
    b. using a filter at the x-ray tube and increasing the exposure time.
    c. both a and b are methods for correcting excessive subject contrast.
    d. decrease the exposure time.

22. Improper geometric factors, poor contrast between film and leak-screens, and graininess of film are possible causes of:

    a. high film density
    b. poor definition
    c. fogged film
    d. low film density

23. A radiograph is taken at a voltage of 500 kv. If the voltage is increased with a resultant increase in the energy of radiation while all other conditions remain the same:

    a. the graininess of the film will increase significantly if a high speed film is used.
    b. the graininess of the film will decrease significantly if a low speed film is used.
    c. the graininess of the film will increase significantly if a Class I film is used.
    d. there will be little change in the graininess of the film.

24. The reason the exposure time must be increased by a factor of four when the source-to-film distance is doubled as:

    a. the intensity of radiation decreases at an expotential rate when the source-to-film distance is increased.
    b. the quality of radiation is inversely proportional to the square root of the distance from the source to the film.
    c. the intensity of radiation is inversely proportional to the square of the distance from the source to the film.
    d. the scattered radiation effect is greater as the source-to-film distance increases.

25. The approximate radiographic equivalence factors for steel and copper at 220 kv are 1.0 and 1.4 respectively. If it is desirable to radiograph an 0.5 inch plate of copper, what thickness of steel would require about the same exposure characteristics?

    a. 0.7 in. of steel
    b. 0.35 in. of steel
    c. 1.4 in. of steel
    d. 1.0 in. of steel

26. Which of following technique variables is most commonly used to adjust subject contrast?

    a. source-film distance
    b. milliamperage
    c. kilovoltage
    d. focal point size

27. Subject contrast is affected by:

    a. thickness differences in specimen
    b. radiation quality
    c. scattered radiation
    d. all of the above

28. The Code of Federal Regulations requires that all shipping containers for radio-isotopes:

    a. contain provisions for sealing the lid of the container.
    b. be fire resistant.
    c. be shock-proof.
    d. be twice as thick as normal storage containers.

29. Which of following instruments would most likely be used to detect small leaks in a radiation barrier?

    a. a film badge
    b. a fountain pen type of ionization chamber.
    c. a Geiger counter.
    d. a dosimeter.

30. At voltages above 400 kv, the use of lead to provide protection may present serious structural problems. If this should be a serious problem, which of the following materials would most likely be used as a substitute?

    a. aluminum
    b. concrete
    c. steel
    d. boron

31. When using x-ray film for monitoring of radiation:

    a. faster film is normally used for personnel dosimetry and slower film is usually used for area monitoring.
    b. slower film is normally used for personnel dosimetry and faster film is usually used for area monitoring.
    c. fast film is normally used for all kinds of monitoring.
    d. slow film is normally used for all kinds of monitoring.

32. In processing radiographs, the hourly flow of water in the wash tank should be:

    a. two to three times the volume of the tank.
    b. four to eight times the volume of the tank.
    c. at least 40 gallons per hour.
    d. varied continuously in proportion to the number of radiographs being developed.

33. Which of the following is the primary function of a film interpreter?

a. find perfect parts which contain no discontinuities.
b. reject parts.
c. judge the effect discontinuities and manufacturing deviations will have on the serviceability of a part.
d. determine if the proper technique has been used during an exposure.

34. When viewing a radiograph, an image of the back of the cassette superimposed on the image of the specimen is noted. This is most likely due to:

a. undercut
b. overexposure
c. x-ray intensity too high
d. back scatter

35. The half-value layer of steel for cobalt-60 is approximately 1 inch. If the radiation level in the source side of a 3 in. steel plate is 64 R/hr., the radiation level on the opposite side is:

a. 8 R/hr.
b. 21-1/3 R/hr.
c. 10-2/3 R/hr.
d. 32 R/hr.

36. Which of the following is <u>not</u> a factor in determining subject contrast?

a. nature of the specimen.
b. the radiation quality used.
c. type of film used.
d. intensity and distribution of the scattered radiation.

37. In an exposure time of 60 seconds and a source-to-film distance of 4 ft. is necessary for a particular exposure, what exposure time would be needed for an equivalent exposure if the source-to-film distance is changed to 5 ft.?

a. 75 sec.
b. 94 sec.
c. 48 sec.
d. 38 sec.

38. In order to increase latitude so that thick and thin portions may be radiographed at reasonable viewing densities simultaneously:

a. a fluorescent screen should be employed.
b. the film cassette may be loaded with two separate films with one film placed on top of the other.
c. the film cassette may be loaded with two films of different speeds.
d. none of the above practical means of increasing latitude.

39. Developer solution should be discarded when the quantity of replenisher added equals:

    a. the original quantity of developer.
    b. two or three times the original quantity of developer.
    c. five to six times the original quantity of developer.
    d. ten times the original quantity of developer.

40. A 250 KVP x-ray machine used in conjunction with a lead foil screen has an approximate practical thickness limit of:

    a. 1 1/2 inches of steel or its equivalent.
    b. 3 inches of steel or its equivalent.
    c. 6 inches of steel or its equivalent.
    d. 7 1/2 inches of steel or its equivalent.

KEY TO GENERAL RADIOGRAPHER LEVEL II

1. A
2. C
3. C
4. B
5. C
6. D
7. D
8. B
9. C
10. B
11. C
12. B
13. B
14. B
15. C
16. D
17. B
18. D
19. B
20. A
21. C
22. B
23. D
24. C
25. A
26. C
27. D
28. B
29. C
30. B
31. A
32. B
33. E
34. D
35. A
36. C
37. B
38. C
39. B
40. B

RECOMMENDED GENERAL EXAMINATION QUESTIONS

FOR LEVEL II RADIOGRAPHER

1. The general method of producing x-rays involves the sudden deceleration of high velocity electrons in a solid body called a:

    a. focus cup
    b. filament
    c. target
    d. cathode

2. If it was necessary to radiograph a 7" thick steel product, which of the following gamma-ray sources would most likely be used?

    a. cobalt-60
    b. thulium-170
    c. iridium-192
    d. cesium-137

3. The velocity of electrons striking the target in an x-ray tube is a function of:

    a. the atomic number of the cathode material.
    b. the atomic mumber of the filament material.
    c. the voltage difference between the cathode and anode.
    d. the current flow in the rectifier circuit.

4. The uneven distribution of developed grains within the emulsion of a processed x-ray film causes the subjective impression of:

    a. graininess
    b. streaks
    c. spots
    d. white scum

5. The focal spot in an x-ray tube:

    a. is inclined at an angle of 30 degrees from normal to the tube axis.
    b. is maintained at a high negative voltage during operations.
    c. should be as large as possible without unduly shortening the life of the tube.

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

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

7. The specific activity of an isotope source is usually measured in:

   a. Mev (million-electron-volts)
   b. c/gr (curies per gram)
   c. R/hr (roentgens per hour)
   d. c/min (counts per minute)

8. An x-ray film having wide latitude also has, by definition:

   a. poor definition
   b. low contrast
   c. high speed
   d. none of the above

9. An x-ray tube with a small focal-spot is considered better than one with a large focal-spot when it is desired to obtain:

   a. greater penetrating power
   b. better definition
   c. less contrast
   d. greater film density

10. Thin sheets of lead foil in intimate contact with x-ray film during exposure increase film density because:

   a. they fluoresce and emit visible light which helps expose the film.
   b. they absorb the scattered radiation.
   c. they prevent back-scattered radiation from fogging the film.
   d. they emit electrons when exposed to x- and gamma radiation which help darken the film.

11. An x-ray is rated for a maximum of 250 kv. This tube may be operated at a maximum of:

   a. 250,000 volts peak voltage
   b. 250 kv effective voltage
   c. 250,000,000 RMS voltage
   d. 250 kv average voltage

12. The adjustment of tube current in conventional x-ray tube circuits is made by:

   a. adjusting the filament heating current.
   b. adjusting the target-to-cathode distance.
   c. inserting resistance in the anode lead.
   d. opening the shutter on the x-ray tube port.

13. Filters used at the port of the x-ray tube:

    a. intensify the x-ray beam be contributing secondary radiation.
    b. filter short wavelength x-ray beams to provide "softer" radiation.
    c. proved the most readily adjusted means of modifying x-ray intensity.
    d. filter out "soft" radiation to provide a more homogeneous x-ray beam.

14. The kilovoltage applied to an x-ray tube affects:

    a. the quality of the beam.
    b. the intensity of the beam.
    c. both a and b above.
    d. neither a or b above.

15. Besides serving as a filter, screens of high atomic number, such as lead and lead antimony, also:

    a. decrease the source-to-film distance needed for a proper radiography.
    b. provide some image intensifying action.
    c. permit the use of higher speed film.
    d. decrease the graininess in a radiograph.

16. Almost all gamma radiography is performed with:

    a. natural isotopes
    b. artificially produced isotopes
    c. radium
    d. thulium-170

17. The amount of unsharpness or blurring of a radiograph is:

    a. directly proportional to the object-to-film distance and inversely proportional to the size of the focal spot.
    b. directly proportional to the size of the focal spot and inversely proportional to the source-to-object distance.
    c. inversely proportional to the object-to-film distance and directly proportional to the source-to-object distance.
    d. inversely proportional to the size of the focal spot and the object-to-film distance.

18. X-ray films with large grain size:

    a. will produce radiographs with better definition than film with small grain size.
    b. have slower speeds than those with a relatively small grain size.
    c. have higher speeds than those with a relatively small grain size.
    d. will take longer to expose properly than film with relatively small grain size.

19. The most commonly used target material in an x-ray tube is:

    a. copper
    b. carbon
    c. carbide
    d. tungsten

20. The formula $\frac{\text{milliamperes x time}}{\text{distance } 2}$ is:

    a. used to calculate film gradient.
    b. the reciprocity law.
    c. used to determine radiographic contrast.
    d. the exposure factor.

21. X-ray exposure holders and cassettes often incorporate a sheet of lead foil in the back which is not in intimate contact with film. The purpose of this sheet of lead foil is:

    a. to act as an intensifying screen.
    b. to protect the film from back scatter.
    c. both a and b above.
    d. neither a or b above.

22. The interval between the time a film is placed in a fixer solution and the time when the original diffuse, yellow milkiness disappears is known as:

    a. clearing time
    b. fixing time
    c. hardening time
    d. oxidation time

23. Improper geometric factors, poor contact between film and lead-screen screens, and graininess of film are possible causes of:

    a. high film density
    b. poor definition
    c. fogged film
    d. low film density

24. The quantity of radiation striking a unit area of film:

    a. is the product of radiation intensity and time.
    b. is the intensity per unit of time.
    c. is directly proportional to intensity and inversely proportional to time.
    d. varies exponentially with time and directly with intensity.

25. Which of the following factors will <u>not</u> materially influence the image density of a radiograph?

    a. the type of film used.
    b. the size of the film.
    c. the total amount of radiation emitted by the x-ray or gamma ray source.
    d. the intensifying action of the screen.

26. Films that are left between lead screens too long in a high temperature and high humidity atmosphere may:

    a. show increased speed but decreased quality characteristics.
    b. become fogged.
    c. become mottled.
    d. show tree-shaped light areas in the finished radiograph.

27. The quantitative measure of film blacking is referred to as:

    a. definition
    b. photographic density.
    c. film contrast.
    d. radiographic contrast.

28. Which of the following instruments would most likely be used to detect small leaks in a radiation barrier?

    a. a film badge.
    b. a fountain pen type of ionization chamber.
    c. a Geiger counter.
    d. a dosimeter.

29. A qualitative term often used to indicate the size of the smallest detail which can be seen in a radiograph is:

    a. radiographic sensitivity
    b. radiographic definition
    c. radiographic contrast
    d. subject contrast

30. The activity of the fixer diminishes after being used for a period of time because:

    a. the active ingredients evaporate.
    b. the active ingredients are absorbed by the radiograph.
    c. the fixer solution accumulates soluble silber salts.
    d. the active ingredients settle to the bottom of the tank.

31. Lead screens are used for almost all exposures when using:

    a. the fluoroscopic technique
    b. low-voltage radiography
    c. high-voltage radiography
    d. zeroradiography

32. Which of the following is the primary function of a film interpreter?

    a. find perfect parts which contain no discontinuities.
    b. reject parts.
    c. judge the effect discontinuities and manufacturing deviations will have on the serviceability of a part.
    d. determine if the proper technique has been used during an exposure.

33. When viewing a radiograph, an image of the back of the cassette superimposed on the image of the specimen is noted. This is most likely due to:

    a. undercut
    b. overexposure
    c. x-ray intensity too high
    d. back scatter

34. If an exposure time of 60 seconds and a source-to-film distance of 4 ft. is necessary for a particular exposure, what exposure time would be needed for an equivalent exposure if the source-to-film distance is changed to 5 ft.?

    a. 75 sec.
    b. 94 sec.
    c. 48 sec.
    d. 38 sec.

35. In order to increase latitude so that thick and thin portions may be radiographed at reasonable viewing densities simultaneously:

    a. a fluorescent screen should be employed.
    b. the film cassette may be loaded with two seperate films with one film placed on top of the other.
    c. the film cassette may be loaded with two films of different speeds.
    d. none of the above are practical means of increasing latitude.

36. The degree of concentration of the radioactive material in a gamma-ray source is referred to as:

    a. the specific activity of the source.
    b. the quality of the source.
    c. the atomic weight of the source.
    d. the half-life of the source.

37. Developer solution should be discarded when the quantity of replenisher added equals:

    a. the original quantity of developer.
    b. two or three times the original quantity of developer.
    c. five to six times the original quantity of developer.
    d. ten times the original quantity of developer.

38. When using x-ray film for monitoring of radiation:

    a. faster film is normally used for personnel dosimetry and slower film is usually used for area monitoring.
    b. slower film is normally used for personnel dosimetry and faster film is usually used for area monitoring.
    c. fast film is normally used for all kinds of monitoring.
    d. slow film is normally used for all kinds of monitoring.

39. Agitation of the x-ray film during the development process by means of mechanical stirrers or circulating pumps may:

    a. speed the developing cycle.
    b. help replenish the developer.
    c. cause undesirable preferential flow of developer along certain paths.
    d. cause reticulation.

40. The most important factor for determining the amount of x-ray absorption of a specimen is the:

    a. thickness of the specimen.
    b. density of the specimen.
    c. atomic number of the material.
    d. Young's Modulus of the material.

KEY TO GENERAL EXAM LEVEL II RADIOGRAPHY

1. B
2. A
3. C
4. A
5. D
6. C
7. B
8. B
9. B
10. D
11. A
12. A
13. D
14. C
15. B
16. B
17. B
18. C
19. D
20. D
21. B
22. A
23. B
24. A
25. B
26. B
27. B
28. C
29. A
30. C
31. C
32. C
33. D
34. B
35. C
36. A
37. B
38. A
39. C
40. B

SUBJECT: PROCEDURE FOR PRACTICAL EXAMINATION	Effective Date 8-01-85	Number
	Page 1 of 3	Revision 0

1.0 SCOPE

1.1 This procedure shall establish guidelines and step by step instructions for the radiography safety examination to insure that radiation safety is understood in theory and is applied in radiography safety practical examination.

2.0 GENERAL

2.1 If any of the steps listed herein are not followed in the judgement of the examiner. The rejector failure criteria dictates automatic failure of the test, and must be instructed in the failure area before another radiation practical examination is given.

3.0 RADIATION MONITORING DEVICES

3.1 A dosimeter shall be zeroed and worn on the trunk portion of the body of each radiographer or assistant before removing any source from the vault and during the exposure, whether x-ray or source is being used.

3.2 A current film badge shall be worn at all times on the trunk portion of the body whether checking the source or making an exposure with either x-ray or a source.

3.3 A radiation survey instrument shall be used by each radiographer and assistant working with radiation exposure.

3.4 Each survey instrument shall be checked for a current calibration certificate attached to it.

3.5 Each survey instrument shall be checked to verify battery condition.

4.0 PROJECTOR INSPECTION

4.1 Inspect cable for cuts, breaks and broken fittings.

4.2 Inspect source tube for cuts, crushing and broken fittings.

4.3 Survey projector for excessive radiation levels.

4.4 Inspect shield for damage to fittings, lock fasteners and labels.

4.5 Inspect crank for damage and loose hardware.

4.6 Check operation of cable connection.

4.7 Check operation of control for freedom of source movement.

5.0 CURIE STRENGTH

5.1 Each radiographer and or assistant shall know the curie strength of source before any exposure is made.

6.0 RADIATION POSTING

6.1 Before any exposure is made other than in the radiation bay at Searcy, Arkansas, proper radiation warning signs shall be posted and area shall be roped off.

7.0 POSTING AND RESTRICTING OF RADIATION AREAS

A. Restricted Areas - are those in which radiation levels are such that if an individual were continuously present in the area, he could receive an exposure of 2 m/r any one hour, or a dose in excess of 100 m/r in any seven consecutive days. Entry into such areas shall be controlled by the radiographer.

B. Radiation Area - are those in which radiation levels are such if an individual were continuously present, he could receive an exposure in excess of 5 m/r in any one hour. Such areas shall be roped off and posted with "Caution - Radiation Area" signs.

C. High Radiation Area - are those in which radiation levels are such that if an individual were continuously present in the area, he could receive an exposure in excess m/r in any one hour. The perimeter of this area shall be posted with "Caution - High Radiation Area" signs.

8.0 After exposure return source to vault and fill out survey logs and remove signs and rope from area.

SECTION V

A. ORGANIZATION

Independent Testing Laboratories Inc., Radiography Operations will be under the direction of Mr. Homer L. Wilson and the Assistant Radiation Safety Officers. A detailed organization chart is shown on the attached page.

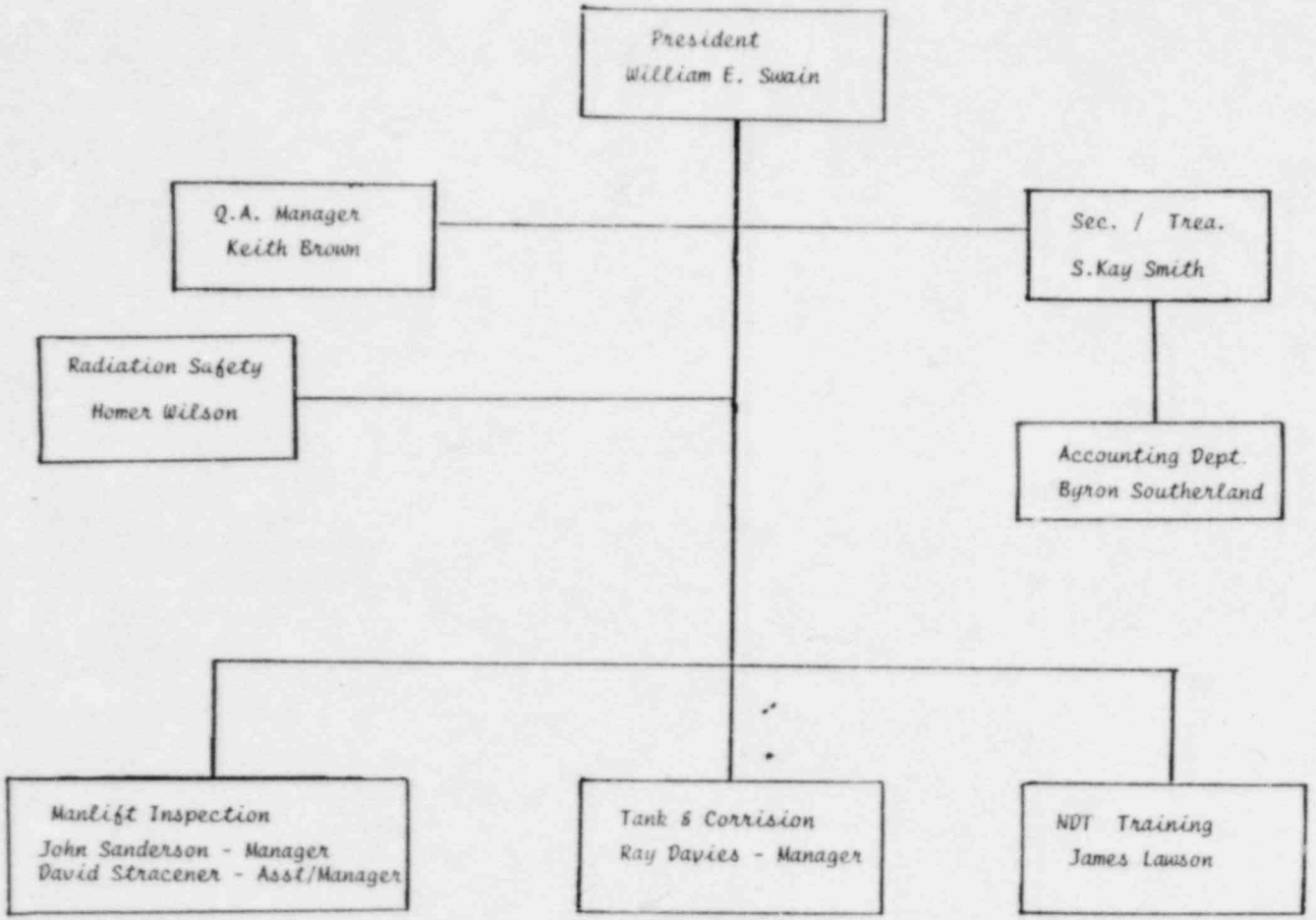
B. INTERNAL INSPECTION PROGRAM

Mr. Wilson reviews all weekly reports from the field, and the regular film badge reports. He also routinely reviews the Radiological Safety Records maintained by the Radiation Records Clerk.

In addition, he conducts field audits on a three (3) month interval of all assistant radiographers and radiographers who are actively performing radiography and should be conducted on the above individuals who do not perform radiography in a period that exceeds three (3) months the first time that individual conducts radiography. During the field visits, he also performs audits on the equipment inspections and maintenance as detailed in Section IV.

C. RESUMES

(See following pages)


President
William E. Swain
Q.A. Manager
Keith Brown
Sec. / Trea.
S.Kay Smith
Radiation Safety
Homer Wilson
Accounting Dept.
Byron Southerland
Manlift Inspection
John Sanderson - Manager
David Stracener - Asst/Manager
Tank & Corrision
Ray Davies - Manager
NDT Training
James Lawson

RESUME

David Stracener

Education:

School: Graduated Searcy High School in 1972.
College: Five year major in Political Science and Business
Florida College at Tampa, Florida
Arkansas State University at Beebe, Arkansas
Harding University at Searcy, Arkansas

Work Experience

Independent Testing Laboratories
Assistant Radiography Technician - 1977
Radiography Technician - 1978
Supervisor of Manlift Inspection - 1983
Assistant Manager of Manlift Inspection - 1984

Training

Yearly training in Radiation Safety, Methods and Techniques.

Radiation Safety Training included:

I. Atoms, The Building Blocks of Matter
II. Radiation and Radioactivity
III. Control of Radiation Exposure
IV. Measurement of Radiation
V. Effects of Radiation on the Human Body
VI. Federal Standards of Radiation Protection
VII. Radiograph Equipment
VIII. Emergency Procedures for Tech/Ops Isotope Units

Experience with Radiography Equipment

Gamma
Gamma Century 600 IR 92 100 Curies
Gamma Century 00 IR 92 100 Curies
CRC 20 IR 92 100 Curies
Tech/Ops Cal. Source

X-Ray
Balto
Fredrex
Andrex

RESUME

William E. Swain - President and General Manager
Radiation Safety Office

Mr. William E. Swain has nineteen years experience in industrial radiography and pieline technology. This includes laboratory and pipeline radiography, technique set-ups, code interpretation, and all phases of radiation safety. Mr. Swain is a member and past director of the American Society for Nondestructive Testing and a member of the American Welding Society, American National Standards Institute, a member of the American Society of Mechanical Engineers, and a member of the National Association Corrosion Engineers. He has attended Arkansas State Teachers College and Arkansas State University.

Mr. Swain's experience includes the following:

1964 -1965: Assistant technician at Consolidated X-Ray Company. Completed basic radiation safety operation training and was instructed in the safe operation of the following equipment:

(1) Gas-filled x-ray machines ranging from 00 KV to 250 KV

(2) IR- 92 Cameras

(a) Gamma Century, 0 - 100 curies
(b) Gamma, Model "35", 0 - 35 curies
(c) Radionics, 0 - 100 curies

1965 - 1967: Technician (SNT-TC-1A Level 1 & 11)
Consolidated X-Ray Company
Completed Level 1 & 11 radiation safety courses instructed by Mr. John Wright and used in both laboratory and field radiography the following equipment.

(1) Gas-filled x-ray machines, 00 KV to 250 KV

(2) IR- 92 Cameras

(a) Gamma Century, 0 - 100 curies
(b) Gamma, Model "35", 0 - 35 curies
(c) Radionics, 0 - 100 curies

(3) Co - 60 Camera, Radionics, 0 - 25 curies

1967 - 1969: Supervisor and District Director
North American X-Ray Company
Completed advanced courses in radiation safety and health physics which included the following:

(1) Body Damage (ionization)
(2) Radiation Levels
(3) Instruments and their use
(4) Instrument calibration
(5) Area survey
(6) Distance and intensity
(7) Monitoring
    (a) personnel
    (b) controlled areas
(8) Shielding
(9) Emergency procedures
(10) Shipping and storage of sources
(11) Record Keeping
(12) IR- 92 cameras and their use
(13) Co-06 cameras and their use
(14) Disposal of sourses

Mr. Swain was directly responsible for field radiography and assistant radiation safety officer under Mr. Ralph Van Syoc and Mr. Tom Owens. He was involved in source recovery and reporting of incidents concerning radiation sources and exposures.

During this period of time, he used and supervised the use of the following equipment.

(1) Tech-op calibration unit, 5 millicuries
(2) Oil-filled x-ray machines, 00 KV to 350 KV
(3) IR- 92 Cameras and source changers
    (a) Gamma Century, 0 - 00 curies
    (b) Gamma, Model "35", 0 - 35 curies
    (c) Radionics, 0 - 00 curies
    (d) VXR, 0 - 35 curies
    (e) Gamma Pipeliner, 0 - 00 curies
    (f) CRC " 00" curies
    (g) Model 135 changer
    (h) Gamma C- 0 changer
(4) Co-60 Cameras
    (a) Radionics, 0 - 25 curies
    (b) Gammatron, 0 - 25 curies

1969 - 1970 President, Technical Advisors, Inc.
Did not utilize radiograph equipment

1 970 - 1 975 NDT Project Manager, Dow Industrial Service, Division of Dow Chemical Company U.S.A. Responsible for directing the radiograph operations being conducted under a state of Texas license. Arkansas license and AEC license.

1 976 - 1 984 President and General Manager, Independent Laboratories. He is a graduate of the U.S. Army Welding School at Aberdeen, Maryland. He has satisfactorily completed the radiation instruction course as provided by the Hastings Radiochemical Works, Inc., Houston, Texas, which covered both the technical and practical use of radio isotopes and an indepth study of the effects of radiation on the human body. Further, he has been an instructor at the Atomic Energy Commission Welding and Radiographic School at White Plains, New York, where he taught the use of radiographic (IR- 92) exposure devices and interpretation of welding defects.

Training and experience has included the principles and practices of radiation protection, radioactivity measurement standardization and monitoring techniques and instruments, the mathematics and calculations basic to the use and measurement of radioactivity, and the biological effects of radiation. The experiences of using and directing the use of these materials has been gained through formal instruction at the various schools he has attended and further through the various positions he has held with the organizations which employed him. In all instances, the use of these materials was for industrial radiography and nondestructive inspection.

Recertified by Examination Level III in November 16, 1983

Certified by Electric Power Research Institute September 22, 1983.

RESUME

Homer L. Wilson - Radiation Safety Officer

Homer L. Wilson was certified per ASNT TC 1A Level II radiographer in July 1981 . I have trained under William E. Swain, Radiation Safety Officer since 1970.

I was the Safety Director for Searcy Flooring and Lumber Company where I was qualified to teach basis first aid, as well as a teacher's instructor. I am a graduate of Arkansas State University.

My work record is as follows:

1961 - 1962	Instructor of General Science and Chemistry at Bradford High School.
1962 - 1980	Purchasing Agent and Safety Director for Searcy Flooring and Lumber Company.
1980 - 1981	Training and Safety Instructor at Independent Testing Laboratories and in training to become Radiation Safety Officer.
1982 - present	Radiation Safety Officer, working as Level II ASNT TC 1A Radiographer.

I have satisfactorily completed the course in Radiation Safety Aspects of Isotope Radiography conducted by Technical Operation, Incorporated of Burlington, Massachusetts, which covered both the technical and practical use of the radio isotopes and an in depth study of the effects of radiation on the human body. I have also satisfactorily completed the course of instructions in fundamentals of radiography testing, in accordance with the requirements for NDT Level II.

For the past 4 years I have had practical experience with:

1. Tech-Ops Calibration Unit - 5 millicuries
2. Oil-filled x-ray machine - 00 kv. to 250 kv.
3. Iridium - 192 exposure devices.
    A. Gamma Industries Model Century 0 - 100 curies
    B. Cumberland Research Model 120, 0 - 100 curies

4. Source Changes

   A. Gamma Industries Model C - 10
   B. Gulf Nuclear Model U - 100A

5. Shielding

6. Personnel Monitoring

7. Security

During this time I have been working as a Level II and with a Level III technician. In all instances the use of these materials was for Industrial Radiography and Non-Destructive Inspections. At the present time I am enrolled in a home-study course on the Principles of Metals.

THE MAJOR TOPICS OF STUDY WERE:

I. ATOMS, THE BUILDING BLOCKS OF MATTER

- A. Matter
- B. Development of Atomic Theory
- C. Structure of the Atom
- D. Isotopes

II. RADIATION AND RADIOACTIVITY

- A. Discovery of Ionizing Radiation
- B. Electromagnetic Waves
- C. Interaction of Electromagnetic Radiation with Matter
- D. Principles of Radioactive Decay
- E. Modes of Radioactive Decay

III. CONTROL OF RADIATION EXPOSURE

- A. Time
- B. Distance
- C. Shielding

IV. MEASUREMENT OF RADIATION

- A. Units of Radiation and Exposure
- B. Personnel Monitoring Equipment
  - 1. Film Badge
  - 2. Pocket Dosimeter
  - 3. Thermoluminescent Dosimeter
- C. Survey Instruments
  - 1. Ionization Chamber Type
  - 2. Geiger Counter
  - 3. Calibration
- D. Survey Techniques

V. EFFECTS OF RADIATION ON THE HUMAN BODY

- A. Interaction of Radiation with Human Cells
- B. Somatic Effects of Radiation
- C. General Effects of Radiation

VI. FEDERAL STANDARDS OF RADIATION PROTECTION

- A. 10CFR20 Standards for Protection Against Radiation
- B. 10CFR30 Rules of General Applicability to Licensing of Byproduct Material
- C. 10CFR34 Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations
- D. 10CFR19 Notices, Instructions and Reports to Worker, Inspections

VII. RADIOGRAPHIC EQUIPMENT

- A. Gamma Ray Projectors
  - 1. Description
  - 2. Operating Procedures
  - 3. Leak Testing

Resume

John R. Sanderson

Mr. Sanderson has eight years experience in industrial radiography. This consists of field experience with on the job training. This experience included technique set ups and all phases of radiation safety.

Employment and Experience:

Dec. 1963-July 1975 - Sperry Remington - Final Inspector; this job consisted of inspecting and making final adjustments on Remington's products.

Sept. 1975-March 1976 - Dow Industrial Service, Division of Dow Chemical Company, U.S.A. - Assistant Technician; duties were to assist technician in the field operations using the following devices:

(1) Oil filled x-ray machines ranging up to 250 KV.
(2) IR-192 cameras
    (a) CRC "100", 0-100 curies
    (b) Gamma C-10 changer
(3) D.C. Dielectric Tester
    (a) 100 KV - Associated Research

March 1976-1979 - Mr. Sanderson became a technician inspecting aerial manlift equipment using magnetic particle, dye penetrant, ultrasonic, dielectric oil filled x-ray machines ranging up to 200 KV, IR-192 cameras using CRC "100" and gamma century. During this time, Mr. Sanderson worked with technicians on Melograf jobs for the U.S. Navy in the states of Washington, California, and Hawaii. These jobs required Mr. Sanderson to have a secret clearance.

Nov. 1979-1980 - Mr. Sanderson was promoted to Supervisor of NDT for Independent Testing Laboratories. The job includes supervising NDT jobs, training new employees, checking the quality of ITL employees work, and sales of NDT, mainly to the Rural Electric Cooperatives.

Mr. Sanderson attended Sperry Schools for Nondestructive Testing for magnetic particle and dye penetrant inspections in Columbus, Ohio; he also took "Fundamentals of Nondestructive Testing" course by Metals Engineering Institute, which included theory, uses, application, and safety of various test methods. Mr. Sanderson completed advanced courses in radiography which included the following:

(1) Body Damage
(2) Radiation Levels
(3) Instruments and their use
(4) Area Survey

(5) Monitoring personnel and controlled areas
(6) Shielding
(7) IR-192 cameras and their use

1980 to present - Mr. Sanderson was promoted to Manager of Manlift Inspections for Independent Testing Laboratories. This is managing the manlift inspection department of ITL. This department performs nondestructive inspections for electric utilities across the nation using acoustic emission, x-ray, gamma ray, magnetic particle, dye penetrant, ultrasonic, visual and dielectric test methods.

Mr. Sanderson has successfully attended and completed Westinghouse Electric Corp.'s Nondestructive Examination Technical Institute courses in:

(1) Radiographic Film Interpretation - 40 hrs.
(2) Liquid Penetrant, Level II - 40 hrs.
(3) Magnetic Particle, Level II - 40 hrs.
(4) Ultrasonic, Level II - 80 hrs.

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VI

EQUIPMENT INSPECTION AND MAINTENANCE PROGRAM

There will be a daily inspection made by each responsible radiographer of his radiographic devices, plus the associated crank-outs and guide tubes. A procedure for performing the daily checks is included in the Operating and Emergency Procedures. Records will be maintained by the radiographers of the inspections.

The Radiation Safety Officer will perform equipment inspections and he will also review the required preventive maintenance during his visits to the field locations for crew inspection purposes. During equipment maintenance, he may be assisted by a radiographer working directly with him.

The equipment inspection and maintenance procedures employed by the Radiation Safety Officer will be based upon the equipment manufacturer's recommended procedures (see following pages) coupled with his own previous training and experiences.

SECTION VII

NOTE: All records indicated below as well as those records required under Inspection and Maintenance Program, are maintained by Mr. Homer Wilson or the secretary under his direction unless other individuals are assigned responsibilities below.

A. Instrument Calibration
   1. Instrument calibration certificates are maintained in the Searcy Office.
   2. Calibration due dates are noted on the labels placed on the side of each instrument by the calibrator and/or vendor.

B. Source Leak Tests
   1. Intial and subsequent leak test reports for each source are maintained at the Searcy Office.
   2. Leak test due dates are listed in the Source Log Book in which is recorded information regarding each source installed in all cameras.

C. Utilization Records
   1. Camera utilization log sheets (posted on the entrance of the Searcy facility storage area) are filled out by the radiographer to indicate the make and serial number of each camera, date and time (out and in), the location to which it was taken, and the radiographer.
   2. A source log book, listed by camera, lists the camera manufacturer, model and serial numbers. For each camera a running inventory is maintained which shows each source installed in the camera, the date installed, source number, isotope and initial strength, leak test due dates, and the source disposal date.
   3. Each radiographer and assistant will list daily the following information on his own weekly Survey Log Sheet: Days off, days worked but no radiography performed, or the following if radiography was performed:
      a. Camera make, model, and serial number.
      b. Job site time - start to finish.
      c. Customer and location.
      d. Source serial number and current strength.
      e. Survey meter (s), serial numbers, and calibration due dates.
      f. Dosimeter types and serial numbers.

4. Survey Log sheets shall be turned in or mailed to the Searcy Office immediately following the last day included on the sheet.

D. Quarterly Inventory

1. Enter in the Source Log Book, for each camera, the following information on a quarterly basis:
   a. Camera make, model, and serial number.
   b. Serial number, isotope and strength of each installed source.
   c. Location of the camera and source, plus the name of the
   d. Date of inventory.
   e. Signature or initials of the individual performing the inventory.

E. Surveys

1. Radiation levels at work sites during radiography particularly at the perimeter of the restricted area will be recorded on Survey Log Sheet of each involved individual. Copies of these sheets shall be kept by each individual in the field. Originals will be returned to Searcy on a weekly basis.
2. Each individual will record on his Survey Log Sheet the radiation level at the surface of the source storage box in the vehicle darkroom. This reading shall be recorded at the start and completion of each day's work.
3. A notation shall be made on the Survey Log Sheet by each individual staying overnight in the field to indicate the outer surfaces of the vehicle were surveyed and the maximum radiation level noted during the survey.
4. Survey of the permanent storage area at the Searcy facility will be recorded.

F. Personnel Monitoring

1. Daily dosimeter readings will be recorded on each individual's Survey Log sheet for each day sources are handled. Total mR's for the day, as well as the actual starting and ending dosimeter readings, will be listed.
2. Film badge reports, plus occupational radiation exposure histories and current radiation exposures (on the appropriate NRC forms, or equivalent forms containing all of the information required on the NRC forms,) shall be maintained in the Searcy Office for all radiography personnel.

G. Inspection and Maintenance Program

See previous section.

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DEFINITIONS

ACTIVATION - The process by which neutrons bombard stable atoms to make them radioactive.

AGREEMENT STATE - A state which has accepted regulatory authority over by-product material from USNRC.

ALPHA PARTICLE - A positively charged particle emitted by certain radioactive materials. It is made up of two (2) neutrons and two (2) protons, hence it is identical to the nucleus of a helium atom.

ATOM - A particle of matter indivisible by chemical means. It is the fundamental building block of chemical elements.

ATOMIC NUMBER - Denotes the number of protons in the nucleus, the number of positive charges in the nucleus, and the number of orbiting electrons.

AUTHORIZED PERSONNEL - As used in this part - means personnel qualified as Radiographers and Radiographer's Assistants in accordance with USNRC - 10-CFR - Part 34 or applicable Licensed State Regulations.

BACKSCATTER - Radiation scattered from the floor, walls, equipment, and other items in the area of a radiation source.

BETA PARTICLE (Beta Ray) - An elementary particle emitted from a nucleus during radioactive decay. It has a single electrical charge and a mass equal to 1/1840 that of a proton.

	Beta particles are easily stopped by a thin sheet of metal. A negatively charged beta particle is physically indentical to the electron. If the beta particle is positively charged, it is called a positron. Beta radiation may cause skin burns, and beta emitters are harmful if inhaled or ingested.
BY-PRODUCT MATERIAL -	In atomic energy law, any radioactive material (except source or fissionable material) obtained in the process of producing or using source or fissionable material. Includes fission products and many other radioisotopes produced in nuclear reactors.
CALIBRATION -	As used in this part - means to check the accuracy of radiation measuring instruments against a known standard and correct as required.
CESIUM-137 -	A radioisotope of the element Cesium.
COBALT-60 -	A radioisotope of the element Cobalt.
COLLIMATOR -	A beam shaping device which utilizes shielding material to restrict the direction in which radiation is emitted.
COMPTON SCATTERING -	A process in which a photon transfers a portion of its energy to an orbital electron in matter and a lower energy photon is scattered at an angle to the original photon path.

CONTAMINATION -	The presence of unwanted radioactive matter, or the "soiling" of objects or materials with "radioactive dirt".
CURIE -	The basic unit used to describe the intensity of radioactivity in a sample of material. One (1) curie equals 37 billion disintegrations per second, or approximately the radioactivity of one (1) gram of Radium.
DECAY -	The spontaneous radioactive transformation of one (1) nuclide into a different energy state of the same nuclide. Every decay process has a definite half-life. (see also half-life).
DECONTAMINATION -	The removal of radioactive contaminants from surface, as by cleaning and washing with chemicals.
DISTRICT RADIATION SAFETY OFFICER -	As used in this part, the District Operations Manager is appointed by the President of Industrial Inspection Industries, Inc. and is responsible for Radiation Safety within his respective District.
DOSE -	The amount of ionizing radiation energy absorbed per unit mass of irradiated material as a specific location, such as, a part of the human body. Measured in rems and rads.
DOSE RATE -	The radiation dose delivered per unit time and measured for instance, in rems per hour. (see also dose).

DOSIMETER -	A device that measures radiation dose. It contains an ionization chamber.
DOSIMETER CHARGER -	A device used to charge a dosimeter.
ELECTROMAGNETIC RADIATION -	Radiation consisting of electric and magnetic waves that travel at the "speed of light". Examples: Light, Radio waves, Gamma rays, X-rays. All can be transmitted through a vaccum.
GEIGER COUNTER -	A radiation detection and measuring instrument. It contains a gas-filled tube which discharges electrically ionizing radiation passing through it. Discharges are counted to measure the radiations intensity.
GENETIC EFFECTS OF RADIATION	Effects that produce changes in those cells of organisms which give rise to egg or sperm cells and therefore affect offspring of the exposed individuals.
GOVERNMENT AGENCY -	Means any Executive Department, Commission, Independent Establishment, Corporation, Wholly or Partly Owned by the United States of America, which is an instrumentality of the United States, or any Board, Bureau, Division, Service, Office, Officer, Authority, Administration, or other establishment in the Executive Branch of the Government.
HALF-LIFE -	The time in which half the atoms in a radioactive substance disintegrate. Half-lifes vary from millionths of a second to billions of years.

HALF-LIFE, BIOLOGICAL - The time required for a biological system, such as a man or an animal, to eliminate by natural processes, half the amount of a substance which has entered it.

HALF-VALUE LAYER - Is that thickness of material required to absorb one-half of the impinging radiation.

HIGH RADIATION AREA - Means any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material at such levels that a major portion of the body could receive in any one (1) hour a dose in excess of 100 millirem.

ELECTRON - An elementary particle with a unit negative electrical charge and a mass 1/1840 that of the proton. Electrons surround the atom's positively charged nucleus and determine the atom's chemical properties.

ELEMENT - One of the 104 known chemical substances that cannot be divided into simpler substances by chemical means. Examples: Hydrogen, Lead, Uranium.

EMERGENCY - Procedure to be followed by Radiographers and Radiographer's Assistants in the event of an accident, equipment malfunction or uncontrolled conditions existing while engaging in radiographic activities.

ENCAPSULATION - The process of sealing radioactive materials to prevent contamination.

EXPOSURE -	Radiation intensity multiplied by time.
FILM BADGE -	A package of photographic film worn like a badge by workers in the nuclear industry to measure exposure to ionizing radiation. The absorbed dose can be calculated by the degree of film darkening caused by the irradiation.
GAMMA RAYS -	High-energy short-wavelength electromagnetic radiation emitted by a nucleus. Energies of gamma rays are usually between 0.010 and 10 Mev. X-rays also occur in this energy range, but are not of nuclear origin. Gamma radiation usually accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best attenuated by dense materials like lead and depleted uranium.
HOT CELLS -	A heavy shielded enclosure in which radioactive materials can be handled remotely through the use of manipulators and viewed through shielded windows so that there is no danger to personnel.
INDUCED RADIOACTIVITY -	Radioactivity that is created by bombarding a substance with neutrons in a reactor or with charged particles produced by particle accelerations.
INVERSE SQUARE LAW -	(at distance from a point source) The intensity of radiation received varies as the inverse square of the distance of the source.

ION -	An atom or molecule that has lost or gained one or more electrons. By such "ionization" it becomes electrically charged.
IONIZATION -	The process of adding electrons to, or knocking electrons from, atoms or molecules, thereby creating ions. High temperatures electrical discharges, and nuclear radiation can cause ionization.
IONIZATION CHAMBER -	An instrument that detects and measures ionizing radiation by observing the electrical current created when radiation ionizes gas in the chamber, making it a conductor of electricity.
IONIZING RADIATION -	Any radiation that directly or indirectly displaces electrons from the orbital shell of atoms. Examples: Alpha, Beta, Gamma Radiation.
IRIDIUM-192 -	A radioisotope of the element Iridium.
ISOTOPE -	Atoms with the atomic number (same chemical element) but different atomic weights. An equivalent statement is that the nuclei have the same number of protons but different numbers of neutrons. Thus, 6C12, 6C13, an 6C14, are isotopes of the element carbon, the subscripts denoting their common atomic numbers, the superscripts denoting the varying atomic weights.
LEAK TEST -	A test on sealed sources to assure that radioactive material is not being released.

LICENSED MATERIAL -	Source material, special nuclear material, or byproduct material received, possessed, used, or transferred under a general or special license issued by the Nuclear Regulatory Commission.
MASS NUMBER -	The sum of the neutrons and protons in a nucleus. The mass number of Uranium-235 is 235. It is the nearest whole number to the atom's actual atomic weight.
MAXIMUM PERMISSIBLE DOSE (MPD)	That dose of ionizing radiation which competent authorities have established as the maximum that can be absorbed without undue risk to human health. 5 (N-18)
MEV -	Million electron volts.
MILLI -	A prefix that divides a basic unit by one thousand.
NEUTRON -	An uncharged elementary particle with a mass nearly equal to that of the proton. The isolated neutron is unstable and decays with a half-life of about 13 minutes into an electron, proton, and neutrino. Neutrons sustain the fission chain reactor in a nuclear reactor.
NONDESTRUCTIVE TESTING -	Testing to detect internal and concealed defects in materials using techniques that do not damage or destroy the items being tested.
NUCLEAR REACTOR -	A device by means of which a fission chain reaction can be initiated, maintained, and controlled. Its essential component is a core with a fissionable fuel. It usually has a moderator, a reflector, shielding, and control mechanisms.

NUCLEUS -	The small, positively charges core of an atom. It is only about 1/10,000 the diameter of the atom but contains nearly all the mass. Except for ordinary hydrogen, all nuclei contain both protons and neutrons.
OCCUPATIONAL DOSE -	Includes exposure of an individual to radiation (1) in a restricted area; or (2) in the course of employment in which the individual's duties involved exposure to radiation; provided that "Oppupational Dose" shall not be deemed to include any exposure of an individual to radiation for the purpose of medical diagnosis or medical therapy of such individual.
OPERATING PROCEDURE(S) -	As used in this part - instructions to be strictly followed for radiographic activities.
PERSON -	Means (1) any Individual, Corporation, Partnership, Firm, Association, Trust, Estate, Government Agency other than the Commission, and State, any Foreign Government or Nation or any Political Subdivision of any such Government or Nations, or other entity; and (2) any Legal Successor, Representative, Agency, or Agency of the foregoing.
PERSONNEL MONITORING EQUIPMENT -	Means devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e.g. film badges, pocket chambers, pocket dosimeters, film rings, etc.)

PHOTOELECTRIC EFFECT - A process by which electromagnetic radiation imparts energy to matter.

PHOTON - A discrete quantity of electromagnetic energy. Photons have momentum but no mass or electrical charge.

PROJECTOR - As used in this part - a radiographic exposure device containing a licensed radioactive isotope for Industrial Radiography applications.

PROTON - An elementary particle with a single positive electrical charge and a mass approximately 1840 times that of the electron. The atomic number of an atom is equal to the number of an atom is equal to the number of protons in its nucleus.

RAD - Radiation absorbed dose. The basic unit of absorbed dose of ionizing radiation. One rad is equal to the absorption of 100 ergs of radiation energy per gram of matter.

RADIATION - The propagation of energy through matter of space in the form of waves. In atomic physics the term has been extended to include fast-moving particles (alpha and beta rays, free neutrons, etc.) Gamma rays and X-rays, of particular interest in atomic physics, are electromagnetic radiation in which energy is propagated in packets called photons.

RADIATION AREA - Means any area, accessible to personnel, in which there exists radiation, originating in whole

or in part within licensed material, at such levels that a major portion of the body could receive in any one (1) hour a dose in excess of five (5) millirem, or in any five (5) consecutive days, a dose in excess of one-hundred (100) millirems.

RADIATION SAFETY DIRECTOR - An individual appointed by the President of Independent Testing Laboratories, Inc. who is responsible for Administration of the Company's Radiation Safety Program.

RADIATION SAFETY OFFICER - An individual engaged in the practices of providing Radiation Protection. He is the Representative appointed by the licensee for liaison with the Nuclear Regulatory Commission.

RADIATION SURVEY - THe process of using an instrument (survey meter) to measure the presence of ionizing radiation.

RADIATION SURVEY METER - An instrument that instantly measures radiation rate or intensity. Used for monitoring radiation area.

RADIOACTIVE - Atoms which are energetically unstable and decay to a stable condition by emitting radiation are said to be radioactive.

RADIOGRAPHER - Means any individual who performs or who, in attendance at the site where the sealed source or sources are being used, personally supervises radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of these regulations and the conditions of the licensee.

RADIOGRAPHER'S ASSISTANT - Means any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools, or survey instruments in radiography.

RADIOGRAPHIC EXPOSURE DEVICE - Means any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure. This may also refer to machines which produce ionizing radiation.

RADIOGRAPHY - Means the examination of the structure of materials by nondestructive methods utilizing sealed sources of by-product material and other sources of ionizing radiation.

RADIOISOTOPE - An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. More than 1300 natural and artificial radioisotopes have been identified.

REDUCTION FACTOR - Dose rate without a shield divided by the dose rate with a shield interposed between a source and a point at which radiation is measured.

REGISTRATION STATES - States that do <u>not</u> have jurisdictional licensing control of radioactive material but are governed by the USNRC Regulatory Requirements. However, these States require that radiation producing devices used within their State be <u>registered</u>.

RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) - The relativeness of a given kind of ionizing radiation in producing a biological response as compared with 250,000 electron volt gamma rays.

REM - Roentgen equivalent man. A unit of absorbed radiation dose in biological matter. It is equal to the absorbed dose in rads multiplied by the relative biological effectiveness of the radiation.

RESTRICTED AREA - Means any area to which access is controlled by the licensee.

ROENTGEN - A unit of exposure dose of ionizing radiation. It is that amount of gamma or x-rays required to produce ions carrying one (1) electrostatic unit of electrical charge in one (1) cubic centimeter of dry air under standard conditions.

SCATTERING - A process that changes a particle's or photon's trajectory. Scattering is caused by collisions with atoms, nuclei, and other particles. If the scattered particle's energy is unchanged by the collision, elastic scattering prevails, if there is a change in energy, the process is called inelastic scattering.

SEALED SOURCE - Means any by-product material that is encased in a capsule designed to prevent leakage or escape of the by-product material.

SHIELD - A layer or mass of material used to reduce the passage of ionizing radiation.

SOURCE - A radioactive material packaged so as to produce radiation for experimental or industrial use. In this manual, the term "source" also refers to the "target" of an x-ray tube.

SOURCE PIPE POSITIONER - A source positioning device for making single wall exposures on piping by means of radiographic access hole or opening.

STABLE ISOTOPE - A nuclide that does not undergo radioactive decay.

STORAGE CONTAINER - Means a device in which sealed sources are transported or stored.

SURVEY - Means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation.

SURVEY METER - A portable instrument which measures dose rate of esposure of radiation intensity.

UNRESTRICTED AREA - Means any area into which entry is not controlled by the licensee, and any area used for residential quarters.

USNRC - United States Nuclear Regulatory Commission.

WASTE, RADIOACTIVE - Equipment and materials (from nuclear operations) which are radioactive and for which there is no further use.

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X-RAY - Penetrating electromagnetic radiation emitted when the inner orbital electrons of an atom are excited and release energy. Thus, the radiation is not nuclear in origin and is generated in practice by bombarding a metallic target with high-speed electrons.

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Procedure

Radiation Safety Administration

1. SCOPE

1.1 This procedure describes the administration of the Radiation Safety Program as established by Independent Testing Laboratories to comply with established federal, state and local Radiation Safety requirements.

2. ORGANIZATION

2.1 The attached organizational chart (attachment 1) outlines the structure of the Radiation Safety Program with reference to management, radiographers and employees working in a Nuclear Power Plant.

2.2 The President of Independent Testing Laboratories serves as the Corporation Radiation Safety Director.

2.3 The Radiation Safety Officer is appointed by and reports to the President of Independent Testing Laboratories and acts as the Corporation Radiation Safety Officer.

2.4 The district managers are appointed as District Radiation Safety Officers by the President of Independent Testing Laboratories and report to Radiation Safety Officer.

2.5 Site Radiation Safety Officers

2.5.1 The person in charge of a project will act as site Radiation Safety Officer.

3. QUALIFICATIONS

3.1.1 The Radiation Safety Officer will be appointed by virtue of a resume submitted to the President of Independent Testing Laboratories. He shall be thoroughly familiar with all phasis of radiographic operations, as well as regulations pertaining to radioactive contaminations and applicable federal, state and local regulations.

3.1.2 Others appointed as assistant to the Radiation Safety Officer shall demonstrate a thorough understanding of Radiation Safety and the operating and record keeping procedures required.

4. RESPONSIBILITIES

4.1 Corporate Radiation Safety Director

4.1.1 The Corporate Radiation Safety Director is responsible for the overall Radiation Safety Program as required by federal, state and local regulations.

4.2 Radiation Safety Officer

4.2.2 The Radiation Safety Officer is responsible for the administration of the Independent Testing Laboratories Radiation Safety Program as required by federal, state, and local regulations. The duties of the Radiation Safety Officer include, but are not limited to the following:

a. Preparation of, revision to, and control of the Radiographic Operations Manual.
b. Administration of a Radiation Safety Training Program.
c. Serving as Independent Testing Laboratories liaison officer with the NRC and/as aggreement states on liscense matters.
d. Maintaining central of procurement and disposal of liscensed material.
e. Developing and maintaining up to date operating and emergency procedures.
f. Establishing and maintaining a personnel monitoring program.

g. Examining and determining competency of radiographic's assistants.
h. Establishing and maintaining a Leak Test Program.
i. Establishing and maintaining an Internal Inspection System.
j. Conducting quarterly inventories and maintaining source utilization reports.
k. Establishing and conducting a Survey Instrument Calibration Program.
l. Assuming control and instituting corrective action in emergency situations.
m. Investigating causes of incidents and determining necessary preventive action.
n. Acting in advisory capacity to management radiographic personnel and to personnel from nuclear services.

4.3 Assistant Radiation Safety Officers

4.3.1 The assistant Radiation Safety Officers shall perform those duties as assigned by the Radiation Officer in his respective district.

5. OPERATIONS MANUAL

5.1 Structure

5.1.1 The operations manual is composed of operating procedures which define the Radiation Safety Administration Program and the operating and Emergency procedures for implementing and maintaining an adequate Radiation Safety Program within Independent Testing Laboratories.

5.1.2 The Appendices contain:

a. USNRC Title 10CFR parts 19, 20 and 34.
b. USNRC, Arkansas State Liscense and conditions as applicable.
c. Reciprocity and notification requirements as applicable to agreement status wherein radiographic operations are conducted.

5.2 Manual Control and Assignment

5.2.1 All manuals will be assigned a control number. The control number and name of the individual to whom the manual is assigned will be identified on the cover page. A master Control Log containing the manual control number and the name of the person to whom the manual is assigned will be maintained by the Radiation Safety Officer.

5.2.2 Uncontrol manuals maybe used for teaching aids and information sources.

5.3 Manual Revision

5.3.1 When revisions are made to a procedure the entire procedure shall be reissued.

5.3.2 Revised procedures shall be submitted as required, to the NRC and/or liscensed agreement State for approval prior to release to the manual holder.

5.3.3 Appendice and/or procedure attachment revisions will be issued without NRC or State approval.

5.3.4 A transmittal as shown in attachment 2, shall accompany all manual revisions to manual holders. It will be the responsibility of the manual holder to incorporate the revision changes in his manual. The transmittal form shall be completed and returned to the Radiation Safety Officer.

5.3.5 A controlled copy of this manual that is issued to a client will become uncontrolled 30 days after Independent Testing Laboratories contract has expired with that company.

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Procedure

Personnel Monitoring Equipment and Usage

1. SCOPE

1.1 The procedure shall govern the use of personnel monitoring devices.

1.2 This procedure shall be used in conjunction with the Independent Testing Laboratories procedure entitled Radiation Safety Records.

2. EQUIPMENT

2.1 Dosimeter - direct reading from 0 to 200 mR victoreen Model 541-A or equivalent.

2.2 Dosimeter charger.

2.3 Film Badge.

3. USE:

3.1 Dosimeters

3.1.1 Dosimeters are to be zeroed at the beginning of each work day by inserting your dosimeter into the socket on the Dosimeter charger, and adjusting the knob until the indicator in the dosimeter reads "0".

3.1.2 Dosimeter shall be worn on the clothing adjacent to the film badge.

3.1.3 Dosimters shall be read at frequent intervals during work day so that you are aware of the exposure received during the course of radiographic activities.

3.1.4 Dosimeter shall be read at the end of each working day and the reading recorded on Independent Testing Laboratories survey log. (See Attachment #1)

3.1.5 In the event that a dosimeter becomes discharged beyond its capacity of 200 mR due to unknown circumstances in which the possibility exists that on excessive radiation exposure may have occurred, the individual shall contact the Radiation Safety Officer for instructions. In addition he will not be permitted to engage in Radiographic operations until the results of a film badge processing are acceptable.

3.2 FILM BADGES

3.2.1 Film badges shall be assigned to and worn by only one individual. (monthly)

3.2.2 A film badge and a survey log will be forwarded to all personnel who are working in an exposure area at the beginning of each job or a log at the beginning of each week.

3.2.3 Film badges shall be worn adjacent to the dosimeter on the clothing. Care should be taken to prevent the film badge from becoming wet or mutilated.

3.2.4 In the event that:

a. An individual dosimter is discharged beyond its capacity of 200 mR due to unknown circumstances in which the possibility exists that on excessive radiation exposure may have occurred.
b. An individual's film badge becomes lost or mutilated.
c. An individual has reason to believe that his film badge may indicate a dosage that he may not have received.

The individual shall notify his district Radiation Safety Officer or the Radiation Safety Officer so that he may disposition the situation. In addition, the applicable section of an incident data report shall be completed by the individual within 24 hours of the occurrence and the report forwarded to the Radiation Safety Officer. It will be the Radiation Safety Officer who decides if the employee can work.

4. RECORDS

4.1 Dosimeter readings must be recorded daily on Independent Testing Laboratories survey logs.

4.2 At the end of work week, survey logs are to be returned to Independent Testing Laboratories' Searcy office.

4.3 At the end of each month all film badges are to be returned to the Independent Testing Laboratories' Searcy office.

SUBJECT:	Effective Date 8-01-85	Number RS-GP-2
	Page 1 of 3	Revision 0

Procedure

Personnel Monitoring Equipment and Usage

1. SCOPE

1.1 The procedure shall govern the use of personnel monitoring devices.

1.2 This procedure shall be used in conjunction with the Independent Testing Laboratories procedure entitled Radiation Safety Records.

2. EQUIPMENT

2.1 Dosimeter - direct reading from 0 to 200 mR victoreen Model 541-A or equivalent.

2.2 Dosimeter charger.

2.3 Film Badge.

3. USE:

3.1 Dosimeters

3.1.1 Dosimeters are to be zeroed at the beginning of each work day by inserting your dosimeter into the socket on the Dosimeter charger, and adjusting the knob until the indicator in the dosimeter reads "0".

3.1.2 Dosimeter shall be worn on the clothing adjacent to the film badge.

3.1.3 Dosimters shall be read at frequent intervals during work day so that you are aware of the exposure received during the course of radiographic activities.

3.1.4 Dosimeter shall be read at the end of each working day and the reading recorded on Independent Testing Laboratories survey log. (See Attachment #1)

3.1.5 In the event that a dosimeter becomes discharged beyond its capacity of 200 mR due to unknown circumstances in which the possibility exists that on excessive radiation exposure may have occurred, the individual shall contact the Radiation Safety Officer for instructions. In addition he will not be permitted to engage in Radiographic operations until the results of a film badge processing are acceptable.

3.2 FILM BADGES

3.2.1 Film badges shall be assigned to and worn by only one individual. (monthly)

3.2.2 A film badge and a survey log will be forwarded to all personnel who are working in an exposure area at the beginning of each job or a log at the beginning of each week.

3.2.3 Film badges shall be worn adjacent to the dosimeter on the clothing. Care should be taken to prevent the film badge from becoming wet or mutilated.

3.2.4 In the event that:

a. An individual dosimter is discharged beyond its capacity of 200 mR due to unknown circumstances in which the possibility exists that on excessive radiation exposure may have occurred.
b. An individual's film badge becomes lost or mutilated.
c. An individual has reason to believe that his film badge may indicate a dosage that he may not have received.

The individual shall notify his district Radiation Safety Officer or the Radiation Safety Officer so that he may disposition the situation. In addition, the applicable section of an incident data report shall be completed by the individual within 24 hours of the occurrence and the report forwarded to the Radiation Safety Officer. It will be the Radiation Safety Officer who decides if the employee can work.

4. RECORDS

4.1 Dosimeter readings must be recorded daily on Independent Testing Laboratories survey logs.

4.2 At the end of work week, survey logs are to be returned to Independent Testing Laboratories' Searcy office.

4.3 At the end of each month all film badges are to be returned to the Independent Testing Laboratories' Searcy office.

SUBJECT:	Effective Date 8-01-85	Number RS-GP-3
	Page 1 of 3	Revision 0

Procedure

Radiation Surveys and Postings

1. SCOPE

1.1 This procedure shall govern methods of performing Radiation Surveys and define posting requirements as outline and established in USNRC Title 10CFR. Parts 20 and 34 and/or applicable established liscensed agreement state regulations.

1.2 This procedure shall be used in conjunction with Independent Testing Laboratories procedures entitled:

a. General procedure for use of Radiation Survey instruments.
b. Radiation Safety Records.

2. Posting of Notices to Workers

2.1 The site Radiation Safety Officer shall post the following documents in mobile laboratory or in the area where frequent radiation expose may occur.

2.1.1 Form USNRC-3 notice to employees or applicable state requirements.

2.2 Violation notices, as described in 10CFR 19.11 Paragraph A shall be posted immediately upon request.

3. Establishing Radiation Areas

3.1 The use of Radiation Survey Instruments allows Independent Testing Laboratories personnel to establish safety perimeter where applicable posting requirements can be accomodated and barricades can be established as required.

4. Posting of Restricted Areas and Security Requirements

4.1 Each exposure set-up must be posted to assume prevention of unauthorized access to radiation area. The exposure at the perimeter of the posted area must be such that the total quantity of radiation in anyone have does not exceed 2 mR.

4.2 Signs used at the perimeter of the radiation area and high radiation area must comply with USNRC and/or applicable liscensed agreement states requirements and must be posted as follows:

a. Radiation area - an area within which the radiation level exceeds 2 mR/hr. The signs posted conspicuously at the perimeter of this area must read "Caution - High Radiation Area".
b. High Radiation - an area within which the radiation levels exceeds 100 mR/hr. The signs posted conspicously at the perimeter of this area must read "Caution - High Radiation Area". A survey need not be made to determine the High Radiation Area since this would cause unnecessary exposure. The signs will be posted at the perimeters in which calculations show will be in excess of 100 mr/hr.

4.3 In remote areas where it is impractical to errect barriers due to constantly changing locations or physically impossible to post the 2 mR/hr. zones due to the inaccessability of the area to humans the radiographer must be prepared to immediately retract source if necessary.

4.4 When using X-ray bays at home base the radiographer or his assistant must be in continuous surviellance of the area to prevent unauthorized entry.

5. Required Radiation Survey

5.1 A physical radiation survey must be made to establish radiation areas for posting as required in Section 3 of this procedure and the results recorded on an Independent Testing Laboratories' Survey Log.

5.2 After each radiograph exposure, a physical radiation survey must be made to determine that the source has returned to the safe position of the projector.

5.3 At the conclusion of each radiographic operation and at the time of securing the source, a physical radiation survey must be made to determine that the source is in the safe position. This survey is to be made after the source has been disconnected and locked in the projector at the time of storage. Records of this survey must be recorded on survey log.

5.4 After the projector has been placed in the area designated for storage, another survey is required at the surface of the storage container, box, building or mobile lab which must be posted "Caution-Radioactive Material". The outside perimeter on the storage unit must not exceed 2 mR/hr.

SUBJECT: General Procedure for Use of Radiation Survey Instruments	Effective Date 8-01-85	Number RS-GP-4
	Page 1 of 2	Revision 0

1. SCOPE

1.1 This procedure shall govern the use of Survey Instruments authorized by Independent Testing Laboratories, Inc.

1.2 This procedure is to be used in conjunction with the procedure entitled Radiations Survey and Posting.

2. EQUIPMENT

2.1 Only Survey Instruments that are approved and accepted by USNRC and/or licensed Agreement State Regulations will be used by Independent Testing Laboratories.

2.2 These Survey Instruments must be capable of measuring from 2 mR/hr through 1 R/hr.

3. CALIBRATION

3.1 No Radiation Survey Instrument can be used without the evidence of quarterly calibration shown on a sticker placed on the side of the instrument indicating when the instrument was calibrated by either Independent Testing Laboratories, Inc. using a USNRC or State approved procedure, or by a designated representative who used a USNRC or State approved procedure.

3.2 Instruments with evidence of calibration and showing no indication of malfunction can be used for three (3) months after the date of calibration.

3.3 Calibration certification will be retained in Independent Testing Laboratories, Inc., Main Office and/or respective District Office.

4. USE

4.1 Survey Instruments, since they are delicate, must be handled and used with utmost care to avoid damage.

4.2 Precautionary measures must be taken to avoid exposure of the instrument to excessive moisture and/or dirt.

4.3 Use of Survey Instruments in prolonged periods of excessive cold should be avoided since batteries may prove inefficient at colder temperatures.

4.4 Batteries should be replaced when their condition becomes questionable.

(Battery check ?)

5. STORAGE

5.1 After use, Survey Instruments are to be turned to the "OFF" position and stored to preclude tampering. Additionally, the instruments are to be stored in a clean, dry environment.

	Approved	Effective Date	Number
		8-01-85	GS-GP-4-1
		Page 1 of 2	Revision 0

SUBJECT:

Procedure

Operating Instructions for the use of
Gamma Industries Model No. 250B Gieger Counter

1. SCOPE

1.1 This procedure descibes the operations of the Gamma Industries Model No. 250B Gieger Counters.

1.2 This procedure is to be used in conjunction with Independent Testing Laboratories procedure entitled General Procedure for the use of Radiation Survey Instruments.

2. RANGE

2.1 The Gamma Industires Model No. 250B has three scales covering the following ranges.

A. X 1 - 0 to 10 mr/hr
B. X 10 - 0 to 100 mr.hr
C. x 100 - 0 to 1000 mr/hr

3. OPERATIONS

3.1 Warm-up
The instrument should be allowed to have a two minute warmup period with the selector switch set at the Xl position.

3.2 After the warmup period, switch the selector knob to the "Battery Check" position. If the meter needle does not fall within the area marked "Battery" on the right side of the meter face, the batteries are defective and the meter is considered inoperable until either the batteries are replaced or maintenance is performed.

3.3 USE

If the battery check is successful, the selector knob should be turned to the desired intensity range and the radiation level read from the meter indication.

3.4 AFTER USE

The selector knob should be turned to the off position so that the batteries are preserved.

SUBJECT:	Effective Date 8-01-85	Number RS-GP-4-2
	Page 1 of 2	Revision 0

Procedure

Operating Instructions for use of
Eberline Model No. E-140 Counter

1. SCOPE

1.1 This procedure describes the operation of the Eberline Model E-140 Counter.

1.2 This procedure is to be used in conjunction with Independent Testing Laboratories procedure entitled General Procedures for the use of Radiation Survey Instruments.

2. RANGE

2.1 The Eberline Model No. E-140 Counter has three scales covering the following ranges.

A. 1 x Scale 0 to .5 mR/hr - 0 to 600 CPM
B. 10 X Scale 0 to 5 mR/hr - 0 to 6000 CPM
C. 100 X Scale 0 to 50 mR/hr - 0 to 60,000 CPM

3. OPERATION

3.1 Warm-up
The instrument should be allowed to have a two minute warmup period with the switch set at the x 10 position.

3.2 Battery Check
After the warmup period, turn the selector knob to the battery position. If the needle does not fall within the area marked "Batt-O.K." on the right side of the meter face, the batteries are defective and the meter is considered inoperable until either the batteries are replaced or maintenance is performed.

3.3 USE

If the battery check is successful, the selector knob should be turned to the desired intensity range and the radiation level read from the meter indicator.

3.4 AFTER USE

The selector knob should be turned to the off position so that the batteries are preserved.

Procedure

Operating Instructions for the use of
G.E. Smith Model No. GS-1000
Radiation Survey Instruments

1. SCOPE

1.1 This procedure descibes the operations of the G.E. Smith Model No. GS-1000.

1.2 This procedure is to be used in conjunction with Independent Testing Laboratories procedure entitled General Procedure for the use of Radiation Survey Instruments.

2. RANGE

2.1 The G.E. Smith Model No. GS-1000 has three scales covering the following ranges.

A. X 1 - 0 to 10 mR/hr
B. X 10 - 0 to 100 mR.hr
C. x 100 - 0 to 1000 mR/hr

3. OPERATIONS

3.1 Warm-up
The instrument should be allowed to have a two minute warmup period with the selector switch set at the X1 position.

3.2 After the warmup period, switch the selector knob to the "Battery Check" position. If the meter needle does not fall within the area marked "Battery" on the right side of the meter face, the batteries are defective and the meter is considered inoperable until either the batteries are replaced or maintenance is performed.

3.3 USE

If the battery check is successful, the selector knob should be turned to the desired intensity range and the radiation level read from the meter indication.

3.4 AFTER USE

The selector knob should be turned to the "off" position so that the batteries are preserved.

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	Q.A. Manager:	Page 1 of 2	Revision 0

SUBJECT:

Procedure

Operating Instructions for the use of
Victoreen Model No. 592B
Radiation Survey Instruments

1. SCOPE

1.1 This procedure descibes the operations of the Victoreen Model No. 592B.

1.2 This procedure is to be used in conjunction with Independent Testing Laboratories procedure entitled General Procedure for the use of Radiation Survey Instruments.

2. RANGE

2.1 The Victoreen Model No. 592B has three scales covering the following ranges.

A. X 1 - 0 to 10 mr/hr
B. X 10 - 0 to 100 mr/hr
C. x 100 - 0 to 1000 mr/hr

3. OPERATIONS

3.1 Warm-up
The instrument should be allowed to have a two minute warmup period with the selector switch set at the X1 position.

3.2 After the warmup period, switch the selector knob to the "Battery Check" position. If the meter needle does not fall within the area marked "Battery" on the right side of the meter face, the batteries are defective and the meter is considered inoperable until either the batteries are replaced or maintenance is performed.

3.3 USE

If the battery check is successful, the selector knob should be turned to the desired intensity range and the radiation level read from the meter indication.

3.4 AFTER USE

The selector knob should be turned to the "off" position so that the batteries are preserved.

	Level III	Effective Date 8-01-85	Number RS-GP-5
	Q.A. Manager:	Page 1 of 2	Revision 0

SUBJECT: GENERAL PROCEDURE FOR USE OF RADIOGRAPHIC EXPOSURE DEVICES

1. SCOPE

1.1 This procedure provides instructions to Radiographers and Radiographer's Assistants for the use of all Radiographic Exposure Devices licensed by Independent Testing Laboratories, Inc.

1.2 This procedure shall be used in conjunction with (1) Independent Testing Laboratories, Inc. procedure Radiation Surveys and Posting and (2) the applicable procedure governing each specified Radiographic Exposure Device.

2. EQUIPMENT

2.1 Only Exposure Devices authorized for use by Independent Testing Laboratories, Inc. as approved and stipulated on the USNRC and/or applicable Agreement State (s) Radioactive Material License (s) may be used.

2.2 At least one (1) calibrated and operable survey instrument must be present during radiographic actitivies for radiation monitoring.

3. QUALIFICATION OF PERSONNEL

3.1 Only personnel qualified as Radiographers and Radiographer's Assistants shall be authorized to use Radiographic Exposure Devices and sealed sources licensed by Independent Testing Laboratories, Inc.

4. GENERAL PROCEDURES

4.1 The Radiographer and/or Radiographer's Assistant shall perform the following prior to engaging in radiographic operations.

4.1.1 Conduct the daily inspection as required and record results.

4.1.2 Perform all the necessary radiographic setups.

4.1.3 Establish the restricted area as described in Procedure Radiation Survey and Posting.

4.1.4 Assemble Exposure Device in accordance with specific operating procedure.

4.1.5 Prior to exposuring the source check the established restricted area to assure that no one has entered.

4.1.6 Expose source for radiographic exposure.

4.1.7 Conduct a physical radiation survey during the exposure to assure that the radiation level at the established restricted area is not in excess of 2 MR/HR. The results of this survey shall be recorded on survey logs.

4.1.8 Maintain direct surveillance during each radiographic exposure to prelude entry into the restricted area by unathorized personnel.

4.1.9 After the desired exposure time has elapsed, retract source to the stored position.

4.1.10 A physical radiation survey of the projector and guide tube (if applicable) shall be conducted after each radiographic exposure to assure that the source is returned to its properly shielded position.

4.1.11 After conducting the physical radiation survey, lock and secure the projector as stipulated in the applicable operating procedure.

4.1.12 At the completion of radiographic activities and prior to storing the projector, a final survey shall be made to determine again that the source is in its properly shielded position.

4.1.13 The results of the survey required in Paragraph 4.1.12 of the procedure shall be recorded on Radiographic Survey Logs.

Wrong

Not in compliance 34.43(b)(c)

5.0 When as assistant radiographer is permitted to conduct radiographic operations in accordance with paragraphs 4.1.1 and 4.1.9 through 4.1.13 the radiographer must be in direct attendance and provide personal supervision in accordance with 10 CFR 34 Section 34.44.

	Level III	Effective Date 8-01-85	Number RS-GP-5-1
	Q.A. Manager:	Page 1 of 4	Revision 0

SUBJECT: OPERATING INSTRUCTIONS FOR USE OF GAMMA INDUSTRIES PIPELINER MODEL GP

1. SCOPE

1.1 This procedure shall govern the specific operation of Gamma Industries, Inc. Pipeliner Model GP Radiographic Projector.

1.2 This procedure shall be used in conjunction with General Procedure titled General Procedure for use of Radiographic Exposure Devices.

2. METHODS OF OPERATION

2.1 The method of operation should be determined by the radiographer prior to beginning radiographic operations.

2.1.1 Local control should be used:

2.1.1.1 As the Primary Method of operation.

2.1.2 Remote control nay used optionally:

2.1.2.1 When required to minimize excessive personnel exposure to scatter radiation.

2.1.2.2 When short exposure times would not allow the radiographer sufficient time to leave the immediate area during exposures.

3. PRECAUTIONS

3.1 Monitor all operations with a calibrated operable survey instrument.

3.2 Never attempt to move the projector unless the locking plunger is depressed in the lock position.

4. OPERATING INSTRUCTIONS

4.1 Refer to General Procedure for instructions prior to operation of projector for Radiographic activities.

4.1.1 This projector is exempted from the daily maintance requirements described in General Procedure as follows.

4.2 Select the method of operation to be used in accordance with Section 2 of this procedure.

4.2.1. For local control operation proceed to Step 4.3.
4.2.2. For remote control operation proceed to Step 4.4.

4.3 Local Control Operation

4.3.1. Position the projector in the proper location to begin radiographic operations.
4.3.2. Ensure the projector is pointed toward an area where personnel exposure would be minimized prior to operating the device.
4.3.3. Unlock the key lock plunger.
4.3.4. Check the restricted area to assure that the area is clear of personnel.
4.3.5. Ensure the radiographer is on the proper side of the projector for operation as indicated by the warning labels on the projector.
4.3.6. While using the "streach out" technique rotate the source control knob 180 degrees to the expose position and IMMEDIATELY move as far away as exposure time permits. CAUTION: The source is now exposed.
4.3.7. Monitor operations with a calibrated survey instrument in accordance with General Procedure RS-GP-5.
4.3.8. After the desired exposure time has elapsed approach the projector, with survey instrument, and rotate the control knob 180 degrees to return the source to the shielded position as quickly as possible.
4.3.9. Depress the key lock plunger and monitor the projector to assure the source has been returned to the shielded position.
4.3.10. Continued Operation - reposition the projector for the next intended radiograph and proceed with Steps 4.3.2 through 4.3.9.
4.3.11. Final Exposure - conduct final radiation survey at six (6) inches from all exterior sides of the projector and record as required in General Procedure.

4.4 Remote Control Operation

4.4.1. Position the projector in the desired location to begin radiographic operations.

4.4.2. Ensure the key locking plunger is depressed in the lock position.

4.4.3. Remove the knurled knob and collar by rotating the collar assembly in the counter clockwise direction.

4.4.4. Carefully install the gearbox and mounting adaptor while assuring the slotted gear shaft is aligned with the source rotor shaft and secure with the mounting screws.

4.4.5. Layout the control assembly for maximum distance and shielding from the projector.

4.4.6. Unlock the key lock plunger.

4.4.7. Check the restricted area to assure that the area is clear of personnel.

4.4.8. Expose the source by rotating the control crank handle 180 degrees and move as far away as exposure time permits. CAUTION: The source is now exposed.

4.4.9. Monitor operations with a calibrated survey instrument in accordance with Procedure for Radiation Surveys and Posting.

4.4.10. After the desired exposure time has elasped return to the control crank assembly, with survey instrument, and rotate the control handle 180 degrees to return the source to the shield position.

4.4.11. Carefully approach the projector while monitoring with survey instrumentation and depress the key locking plunger to lock the projector.

4.4.12. Survey the projector to assure the source has returned to the shielded position.

4.4.13. Continued Operation - reposition the projector for the next intended radiograph and proceed with Steps 4.4.6 and 4.4.12.

4.4.14. Final Exposure:

4.4.14.1 Remove the control gearbox and mounting adaptor and replace the knurled knob and collar assembly.

4.4.14.2 Conduct final storage survey as required by Paragraph 4.3.11.

5. SECURING OPERATIONS

5.1 After completion of all operations the projector shall be returned to its approved shipping container and prepared for transport, as required, in accordance with RS-GP-11.

5.2 The Radiographer shall review all records to ensure proper completion in accordance with Locking and Securing Radiographic Devices, Storage containers and Sealed Sources.

SUBJECT:	Effective Date	Number
Operating Instructions for Gamma Industries Models 100 Century and 35 Exposure Devices	8-01-85	RS-GP-5-2
	Page 1 of 2	Revision 0

1. SCOPE:

1.1. This procedure shall govern the specific operating instructions for Gamma Industries Models 100 Century and 35 Exposure Devices.

1.2 This procedure shall be used in conjunction with General Procedure No. RS-GP-5 titled General Procedure For Use of Radiographic Exposure Devices.

2. OPERATING INSTRUCTIONS:

2.1 Refer to General Procedure RS-GP-5 before assemblying projector for engaging in radiographic activities.

2.2 NOTE: Monitor all operations with calibrated survey meter.

2.3 Locate projector at desired distance from specimen to be radiographed.

2.4 Unreel control unit in a straight line from the projector to allow as great a distance as possible.

2.5 Unlock and remove shipping plug from the projector.

2.6 Attach the guide tube. Lay out guide tubes as straight as possible. Position the guide tube for making the radiographic exposure.

2.6.1 Attach the control cables and lay out as straight as possible.

DO NOT SUBJECT THE GUIDE TUBE TO ANY SHARP BENDS WHICH WOULD RESTRICT MOVEMENT OF SOURCE IN GUIDE TUBE !

! C A U T I O N !

(1) NEVER OPERATE THE SYSTEM WITH MORE THAN THREE (3) GUIDE TUBES SECTIONS (INCLUDING THE MASTER STOP)

2.7 Check the restricted area to assure that the area is clear of Personnel.

2.8 Turn the hand crank in a counter-clockwise direction to move the source out of the projector to the exposure position.

2.9 Monitor the operation with a calibrated survey meter in accordance with General Procedure RS-GP-5.

2.10 After the desired exposure time has elapsed rapidly turn the hand crank in the "RETRACT" (clockwise) direction. Continue to rotate until source reaches the properly stored position.

2.11 After each exposure, monitor with survey meter as described in General Procedure RS-GP-3 and RS-GP-5.

2.12 At the completion of radiographic activities remove the guide tube from the projector, install shipping plug and lock exposure device.

2.13 Carefully coil control cable around control unit for storage.

2.14 Conduct final radiation survey and record as required in General Procedure RS-GP-5.

SUBJECT:	Effective Date	Number
Operating Instructions for Cumberland Research Model 120 Exposure Devices	8-01-85	RS-GP-5-3
	Page 1 of 2	Revision 0

1. SCOPE:

1.1 This procedure shall govern the specific operating instructions for Cummberland Research Model 120 exposure devices.

1.2. This procedure shall be used in conjuction with General Procedure No. RS-GP-5 titled General Procedure For Use Of Radiographic Exposure Deivices.

2. OPERATING INSTRUCTIONS:

2.1 Refer to General Procedure RS-GS-5 before assemblying projector for engaging in radiographic activities.

2.2 NOTE: Monitor all operations with calibrated survey meter.

2.3 Locate projector at desired distance from specimen to be radiographed.

2.4 Unreel control unit in a straight line from the projector to allow as great a distance as possible.

2.5 Unlock and remove shipping plug from the projector.

2.6 Attach the Guide Tubes. Lay out Guide Tubes as straight as possible.

2.6.1 Attach the Control Cables and lay out as straight as possible.

DO NOT SUBJECT THE GUIDE TUBE TO ANY SHARP BENDS WHICH WOULD RESTRICT MOVEMENT OF SOURCE IN GUIDE TUBE !

! C A U T I O N !

(1) NEVER OPERATE THE SYSTEM WITH MORE THAN THREE (3) GUIDE TUBES (INCLUDING THE MASTER STOP)

2.7 Check the restricted area to assure that the area is clear of Personnel.

2.8 Turn the hand crank in a counter-clockwise direction to move the source out of the projector to the exposure position.

2.9 Monitor the operation with a calibrated survey meter in accordance with General Procedure RS-GP-5.

2.10 After the desired exposure time has elapsed rapidly turn the hand crank in the "RETRACT" (clockwise) direction. Continue to rotate until source reaches the properly stored position.

2.11 After each exposure, monitor with survey meter as described in General Procedure RS-GP-3 and RS-GP-5.

2.12 At the completion of radiographic activities remove the guide tube from the projector, install shipping plug and lock exposure device.

2.13 Carefully coil control cable around control unit for storage.

2.14 Conduct final radiation survey and record as required in General Procedure RS-GP-5.

	Level III	Effective Date 8-01-85	Number RS-GP-6
	Q.A. Manager:	Page 1 of 1	Revision 0

SUBJECT: LOCKING & SECURING RADIOGRAPHIC EXPOSURE DEVICES, STORAGE CONTAINERS & SEALED SOURCES

1. SCOPE

1.1 This procedure shall govern the methods of locking and securing Radiographic Exposure Devices, Storage Containers and Sealed Sources used by Independent Testing Laboratories, Inc.

1.2 This procedure conforms to the requirements of USNRC title 10-CFR Parts 34.22 and 34.23 and any applicable Licensed Agreement State Regulations.

2. CONTROL

2.1 Each Radiographic Exposure Device used by Independent Testing Laboratories, Inc. shall be provided with a lock designed by the manufacturer to prevent unauthorized or accidental removal or exposure of a sealed source and shall be kept locked at all times except when under the direct surveillance of a Radiographer or Radiographer's Assistant or where the high radiation area is equipped with a control device or alarm system or locked and/or barricaded to protect against unauthorized or accidental entry.

2.2 Each Radiographic Exposure Device Storage Container used by Independent Testing Laboratories, Inc. shall be provided with a means to control and limit access to the exposure device to only AUTHORIZED PERSONNEL.

2.3 Radiographic Exposure Devices and Storage Containers located in the laboratories shall be stored in a designated storage area and sufficient means shall be used to limit access to this area to AUTHORIZED PERSONNEL.

3. SECURING STORAGE CONTAINERS

3.1 In a mobile or portable laboratory, or at a construction site, Storage Containers housing radiographic exposure devices shall be sufficiently secured so as to prelude unauthorized and/or accidential removal.

SUBJECT:	Effective Date	Number
	8-01-85	RS-GP-7
RADIOGRAPHER'S PERFORMANCE REVIEW	Page 1 of 1	Revision 0

1. SCOPE:

1.1 This procedure establishes the guidelines for reviewing an individuals performance to assure compliance with Independent Testing Laboratories Operating and Emergency Procedures and applicable USNRC and/or State Regulations.

2. RESPONSIBILITIES:

2.1 Performance reviews shall be conducted by the Radiation Safety Director, District Radiation Safety Officer(s) and/or Assistant Radiation Safety Officer(s).

3. PERFORMANCE REVIEWS:

3.1 Performance Reviews shall be conducted on an announced and unannounced basis at the discretion of the auditor.

3.2 A quarterly review shall be conducted on each Radiographer and/or Assistant Radiographer for compliance with the requirements contained in this manual.

3.3. The elements to be audited are listed in the Radiographer's Performance Review - Form.

3.4 The auditor shall observe an actual radiographic operation.

4. DISQUALIFICATION/UPGRADING:

4.1 If an individual cannot demonstrate thorough understanding of the items listed in the Radiographer's Performance Review (Attachment No. 1), he shall:

4.1.1 Be disqualified from working with Radioactive Material until he:

A. Completes additional training in the deficient areas.

B. Depending upon the severity of the deficiency be terminated from employment with ITL.

5. RECORD:

5.1. When completed, a record of each Radiographer's performance review shall be retained by the District Radiation Safety Officer and/or Radiation Safety Director.

INDEPENDENT TESTING LABORATORIES

A DET NORSKE VERITAS COMPANY

P. O. BOX 657 · 1 RESEARCH DRIVE

SEARCY, ARKANSAS 72143

501 / 268-7191

"RADIOGRAPHER'S PERFORMANCE REVIEW"

ANNOUNCED [ ]
UNANNOUNCED [ ]

CUSTOMER: _____ DATE _____

ADDRESS: _____

USNRC REGION: I II III IV V STATE _____

RSO OR JOB RADIOGRAPHER _____ ASSISTANT RADIOGRAPHER _____

PROJECTOR SERIAL NUMBER _____ RADIOACTIVE CONTENT _____

PROJECTOR SERIAL NUMBER _____ RADIOACTIVE CONTENT _____

"SURVEY COMMENTS"

1. DOSIMETERS CHARGED DAILY AND READINGS RECORDED S/N _____ S/N _____ COMMENT: _____

2. RADIATION SURVEY METER IN PROPER WORKING ORDER INCLUDING CALIBRATION DATE AND PROPERLY USED. S/N _____ COMMENT: _____

3. FILM BADGES PROPERLY WORN AND STORED. COMMENT: _____

4. COPY OF RADIOGRAPHIC OPERATIONS MANUAL AVAILABLE-COPY OF USNRC OR APPLICABLE STATE LICENSE. COMMENT: _____

5. COPY OF THE APPLICABLE USNRC/OR STATE RULES AND REGULATIONS AVAILABLE. COMMENT: _____

6. COPIES OF USNRC FORM NO. 3 OR APPLICABLE STATE FORM PROPERLY POSTED. COMMENT: _____

7. PROJECTORS POSTED TO INDICATE CONTENTS. COMMENT: _____

8. RADIOISOTOPE STORAGE BUILDING OR MOBILE LAB PROPERLY POSTED TO INDICATE RADIOACTIVE MATERIAL. COMMENT: _____

9. RECORDS OF SOURCE STORAGE, EQUIPMENT MAINTENANCE AND UTILIZATION. COMMENT: _____

10. RECORDS OF VEHICLE SURVEY (WHEN APPL.) COMMENT: _____

11. RADIATION AREA POSTING. COMMENT: _____

REMARKS:

NAME: _____

Procedure

Emergency Procedure

1. SCOPE

1.1 The procedure, as defined herein, shall govern the steps to be taken by all Independent Testing Laboratories employees in the event of an emergency situation concerning radiation producing equipment. This procedure is designed to comply with Federal, State, and Local Requirements concerning emergency situations.

2. RESPONSIBILITIES

2.1 It is the Authorized Radiographer's responsibility to notify Independent Testing Laboratories, Inc. of any emergency situation wherein you feel that an emergency situation exist whether it be in the transportation, use, and/or storage of source material.

2.2 The Authorized Administration Personnel (See Attachment No 1.) at Independent Testing Laboratories, Inc. to be notified via telephone "COLLECT" are:

A. Searcy, Arkansas Corporate Office:

Telephone Number - 501-268-7191 or 1-800-643-8163

Bill Swain - (501) 268-8333 Pesidence
President of Independent Testing Laboratories

Homer Wilson - (501) 268-6676 Residence
Radiation Safety Director

John Sanderson - (501) 268-8257 Residence
District Radiation Safety Officer

David Stracener - (501) 268-0609 Residence
Ass't District Radiation Safety Officer

3. EMERGENCY SITUATION

3.1 Emergency situations are defined but not limited to the following:

A. Dosimeter goes off 200 mR scale.
B. Radioactive source becomes stuck in source guide tube.
C. Source Projector is dropped in rigging to work location.
D. Radiation survey instrument does not function properly. (Check back-up radiation survey instrument first)
E. Accident in transportation of source material via mobile laboratory or company car.

NOTE: In the event of a Radiographer becoming incapacitated during an accident, placecards should be in an appropriate place in the vehicle to inform Local, State, and/or Civil Authorities who they should contact.

NEVER LEAVE THE SCENE OF THE ACCIDENT UNLESS YOU NEED MEDICAL ATTENTION - until you are sure of the security of source material.

F. Fire in storage building where sources are temporarily stored at construction sites. You as a radiographer shall post the telephone number where you can be reached by site management personnel and/or the local fire department.
G. Broke connector of source material to drive cable preventing retracting of source to its shielded position.
H. Lost or stolen material.
I. Any situation wherein you as a radiographer have reason to believe that an overexposure to radiation has occurred to radiation workers and/or non-radiation workers or any property damage occurring out of source material.

4. EMERGENCY SITUATION ASSESSMENT

4.1 In the event of an emergency situation, you as a Radiographer shall assess the situation as follows:

A. Restrict and post the radiation or suspected radiation area to a 2 mR/hr level. This can be done either with a radiation survey instrument or by calculations.

B. "Calmly" review and assess the situation -

For Example:

1. You have reason to believe that an individual has received an over-exposure (over 100 mR) - calculate the exposure based on time-distance and the source activity. If your calculation shows 1 R or more, the individual shall be scheduled for an immediate blood test.

2. Damage of source material projector controls due to accident. They can become damaged by cranes, etc.

3. Crushed source material guide tubes (something fell on them).

4.2 After assessment, "IMMEDIATELY" notify via telephone -"COLLECT"-the respective Radiation Safety Officer for direction and resolution of the situation.

5. REPORTING/NOTIFICATION

5.1 It shall be the responsibility of the Radiation Safety Officer (Company RSO) to file the appropriate regulatory body reports as required for emergency situation.

5.2 In the event that you as a Radiographer cannot locate one (1) of the Company's Radiation Safety Officer you shall be required to notify the appropriate Federal, and/or State Radiation Control body by telephone. The telephone number of the USNRC Compliance Region can be found on USNRC Form III and/or the equivalent for respective Agreement States which shall be posted in the laboratory or field location. Phone number for licensed Agreement States will be located on the applicable "State Notice To Employees Form."

5.3 After any emergency situation involving source material or equipment you shall complete Attachment 2 to this procedure giving detailed information as required concerning the emergency situation.

SUBJECT: Inspection and Maintenance of Radiographic Exposure Devices and Storage Containers	Effective Date 8-01-85	Number RS-GP-9
	Page 1 of 2	Revision 0

1. SCOPE

1.1 This procedure covers any malfunction of, or damage to, the radiation sources, their containers and associated equipment, or the radiation survey meters, dosimeters and film badges, must be reported immediately to the radiation safety officer.

1.1.1 Source is not to be used until malfunction or damage is corrected.

2. PRIOR TO EACH USE

2.1 The radiographer shall complete an equipment inspection check list each time a source is used. The check list shall be completed prior to performing any radiographic exposures and will include the following items:

2.1.1
1. Date of removal.
2. Time of removal.
3. Maximum mRem/hr. in storage.
4. Maximum mRem/hr. reseal.
5. Any damage to storage cabinet or its shielding material.
6. Storage cabinet properly labeled.
7. Proper operation of source indicator.
8. Any drive cable tube damage.
9. Any source guide tube damage.
10. Proper operation of source locking mechanism.

3. EQUIPMENT CHECK

3.1 The radiographer shall perform a check of his equipment daily prior to source use and shall record such checks by notation on his Survey Log sheet. This daily check shall consist of the following:

3.1.1 Abnormal radiation level when removed from storage.

3.1.2 Device crank-out and guide tube free from visible damage.

3.1.3 Device properly labelled.

3.1.4 Source identification plate in place.

3.1.5 Proper operation of lock mechanism.

3.1.6 Proper operation of crank mechanism.

3.1.7 Normal connection of course pigtail to drive cable connector, and of drive cable and source guide tube to device.

3.1.8 Normal operation of entire assembly.

3.2 Radiation Survey Meter

3.2.1 Meter free from visible damage.

3.2.2 Calibration due date not exceeded.

3.2.3 Battery check.

3.2.4 Proper response to radiation (compare to known level of radiation from radiography device - SOURCE INSIDE)

3.3 Pocket Dosimeter and Film Badge

3.3.1 No visible damage.

3.3.2 Dosimeter hair-line visible and set on zero.

3.3.3 Clips in place and both devices being worn.

4. QUARTERLY SHIPPING Inspection

4.1 The equipment shall be inspected and maintenance performed, both preventive and corrective, at intervals not to exceed three months to determine the extent of equipment deterioration and whether operation has been affected by wear, corrosion, or physical abuse. A record of the date and results of such inspections shall be entered in the source usage log book. These periodic inspections shall consist of all the items listed in Part A, above, plus a check of the following:

4.2
1. Changes in operating characteristics of the device.
2. Proper operation of the crank mechanism.
3. Source and drive cable wear.
4. Source and drive cable tube and connector wear.
5. Clean and lubricate drive cable and connectors if necessary.
6. Clean any rust, dirt, or sludge buildup in the source tube.
7. Proper connection of all components.
8. Cable drive gear box damage or wear.
9. All defective and excessively worn components shall be repaired or replaced.

	Level III	Effective Date 8-01-85	Number RS-GP-10
	Q.A. Manager:	Page 1 of 1	Revision 0

SUBJECT: GENERAL PROCEDURE FOR EXCHANGING SEALED SOURCES

1. SCOPE

1.1 This procedure shall govern the Exchange of Sealed Sources by Independent Testing Laboratories, Inc. Radiographers.

1.2 This procedure shall be used in conjunction with Independent Testing Laboratories, Inc. procedure entitled Radiation Surveys and Posting and the specific procedure governing the operation of the operations of the applicable source changer.

2. EQUIPMENT

2.1 Only source changers authorized for use by Independent Testing Laboratories, Inc. as approved and shown on the USNRC and/or applicable Agreement State (s) License(s) may be used.

3. QUALIFICATION OF RADIOGRAPHERS TO PERFORM SOURCE CHANGES

3.1 Only qualified Radiographers who have been instructed in the operation of source changers and have demonstrated satisfactory performance of a source exchange to the cognizant District Radiation Safety Officer and/or Radiation Safety Director, may conduct such source exchanges.

4. LEAK TEST

4.1 No sealed source will be put into a projector without evidence of a currently valid leak test. New sources show evidence of a leak test on the source decay curve. Sources that are more than six (6) months old will show evidence of the leak test on a approved leak test report form.

5. SURVEY METER

5.1 A calibrated and operable survey meter must be present at all source exchanges.

SUBJECT: OPERATING INSTRUCTIONS FOR USE OF GAMMA INDUSTRIES MODEL #C-10 AND GULF NUCLEAR U110 SOURCE CHANGER.	Effective Date 8-01-85	Number RS-GP-10-1
	Page 1 of 3	Revision 0

1. SCOPE

1.1 This procedure shall govern the operation of the Gamma Industries Model C-10 and Gulf Nuclear U110 Source Changer.

1.2 This procedure shall be used in conjunction with Independent Testing Laboratories, Inc., procedure entitled General Procedure for Exchanging Sealed Sources.

2. DESCRIPTION

2.1 The Source Changer has a capacity of containing up to 200 curies of Iridium 192.

2.2 These Source changers are is not a DOT type B approved container for shipping and should always be received and transported within its approved shipping container.

3. INSTRUCTIONS FOR USE

A. Position the projector and source changer in an area where the source can be exposed.
B. Check the short exchange tube (provided in the shipping barrel for proper fittings, crimp, cuts, and loose fittings.
C. Place the projector and source changer in a relationship to minimize any bends in the exchange tube and control cable.
D. Open the lower lock of the source changer and remove the safety plug. Connect the exchange tube to the lower lock box.
E. Connect projector in accordance with the applicable projector operating instructions.
F. While monitoring the radiation levels, crank the source into the source changer. Insure, by survey, that the source is completely transfered from the projector to the changer.
G. Make a radiation survey of the changer to assure that the surface reading is less than 200 mR/hr and lock the lower lock of the source changer onto the old pigtail locking ball.

CAUTION: The source could be removed from the lock box if the lock is not locked.

H. Remove the exchange tube from the lower lock box and disconnect the control cable from the source pigtail.

I. Carefully attempt to move the pigtail into and out of the lock box to assure the lock is depressed upon the pigtail locking ball. If the pigtail can be moved, open the lower lock and carefully move the pigtail and lock the lock upon the pigtail locking ball.

CAUTION: Do not move the pigtail in excess of 1/2 inch - this would move the source from its shielded position.

J. Remove the source protector cap from the upper lock box (labeled new source) and attach the source protector cap over the old source pigtail in the lower lock box.

K. Attach the control cable to the new pigtail which is in the upper lock box.

L. Attach the short exchange tube to the source changer upper lock box.

M. Minimize any bends in the exchange tube.

N. Unlock the upper lock from the new source.

O. Return to the crank handle and retract the new source into the projector while monitoring radiation levels. Insure, by survey that the source is completely transfered into the projector.

P. Make a radiation survey of the projector to assure radiation levels are less than 200 mR/hr at the surface and lock the projector as specified in the applicable operating procedure.

Q. Remove the exchange tube from the source changer and insert the safety plug into the upper lock box. Lock the upper lock of the source changer.

R. Affix the new source ID to the projector and old ID to the lower lock box source protector cap.

S. Secure Projector as required by applicable operating procedure (RS-GP-5).

4. SECURING OPERATIONS

4.1 Conduct radiation survey of source changer to assure surface reading is less than 200 mR/hr.

4.2 Place C-10 into shipping barrel in the same orientation which it was received. Place exchange tube and evidence of leak test along with old decay chart into shipping barrel.

4.3 Insert a safety seal into the barrel locking ring and seal closed.

4.4 Label barrel with appropriate "Radiactive Yellow Label" and prepare for shipment in accordance with procedure for shipping containers.

4.5 Insure all operations reports are properly completed.

SUBJECT: TRANSPORTATION OF RADIOACTIVE MATERIAL

1.0 SCOPE

1.1 This procedure describes the packaging and labeling requirements for Transportation of Radioactive Material via Independent Testing Laboratories, Inc. vehicle and common carrier.

1.2 This procedure conforms to the requirements of USNRC Title 10-CFR-Part 71, the Department of Transportation, Title 49 - Parts 171 through 177.

1.3 This procedure shall be used in conjunction with Independent Testing Laboratories, Inc. procedure entitled, "Radiation Surveys and Posting" No. RS-GP-3 and "General Procedure for Use of Radiation Survey Instruments", No. RS-GP-4.

2.0 PACKAGING

2.1 When shipping an exposure device or source changer containing a source, assure that the source is in the properly stored position.

2.2 The exposure device or source changer shall be prepared for shipment as follows:

2.2.1 EXPOSURE DEVICE - Assure that the shipping plug is securely in place and sealed and the device is locked.

2.2.2 SOURCE CHANGER - Assure that the source hold down and cover are properly bolted on and sealed.

3.0 MARKING

3.1 Each package of radioactive material prepared for transport shall contain the following information marked on the exterior surface of the package.

3.1.1 PROPER SHIPPING NAME

	SOURCE CHANGER OR PACKAGE CONTAINING EXPOSURE DEVICE	PROPER SHIPPING NAME
A.	Containing Source	Radioactive Material Special Form N.O.S.
B.	Empty (except lead shielded devices)	Radioactive Material L.S.A., N.O.S.

3.1.2 The name and address of Independent Testing Laboratories, Inc.

3.1.3 The USNRC Compliance Number or Type of Package.

4.0 LABELING

4.1 Survey the package to determine the proper shipping label as described in the following:

	REQUIRED LABEL	RADIATION LEVEL AT SURFACE IN MR/HR	RADIATION LEVEL AT 3 FT IN MR/HR
A.	Radioactive White I (See attachment #1, figure A	0 - 0.5 Max.	N/A
B.	Radioactive Yellow II (See attachment #1, Figure B)	0.5 - 50.0 Max. (and)	0.1 - 1.0 Max.
C.	Radioactive Yellow III (See attachment #1, Figure C)	50.0 - 200.0 Max. (and/or)	1.1 - 10.0 Max.

*NOTE The transport index is the highest radiation level in millirem per hour at three (3) feet from any accessible external surface of the package. This number shall be expressed in the next highest tenth and written in the transport box on RADIATION YELLOW II AND III LABELS. eg., 1.1 millirem. Enter 1.1 in transport index, or 0.0 millirem. Enter 0.1 in transport index.

4.2 Complete two (2) appropriate labels indicating the contents, Iridium 192 or Cobalt 60 and the number of curies. For RADIOACTIVE II and III labels, record the transport index in the box. (See NOTE above). The label shall be attached to opposite sides of the package - one being placed near the shipping label.

4.3 Empty exposure devices or source changers do not require labeling if the following conditions exist:

4.3.1 THE RADIATION LEVEL AT THE SURFACE IS LESS THAN .5 MR/HR

4.3.2 THERE IS NO MEASURABLE RADIATION LEVEL AT THREE (3) FROM THE SURFACE.

4.3.3 IF THE ABOVE CONDITIONS EXIST, THE PACKAGE SHALL BE MARKED WITH THE FOLLOWING STATEMENT:

EXEMPT FROM THE SPECIFICATION, PACKAGING, MARKING, LABELING AND EXEMPT FROM THE PROVISIONS OF 49CFR173-393 PER 49CFR173.391.

5.0 SHIPPING PAPERS

5.1 Shipments via commercial carrier:

5.1.1 A separate bill of lading or air bill shall be completed for EACH PACKAGE of Radioactive Material.

5.1.2 The proper shipping name as described below shall be entered on the bill of lading or air bill:

	PACKAGE CONTAINING EXPOSURE DEVICE OR SOURCE CHANGER	PROPER SHIPPING NAME
A.	Containing a Source	Radioactive Material Special Form N.O.S.
B.	Empty Device	Radioactive Material L.S.A., N.O.S.

5.1.3 When shipping a package of Radioactive Material that requires a Radioactive Yellow III Label by Motor Freight, the bill of lading shall also contain the statement, "RADIOACTIVE PLACARDS SUPPLIED".

5.1.4 The bill of lading or air bill shall contain two (2) copies of Shipping and Certification Documents described in paragraph 6.

6.0 SHIPPING/CERTIFICATION DOCUMENT

6.1. As a minimum, three (3) copies of the Shipper/ Certification Document shown in Attachment No. 2 shall be completed for each package of Radioactive Material. Distribution of the Shipper/Certification Document shall be as follows:

1. Two (2) copies shall be attached to the bill of lading, or air bill.
2. One (1) copy forwarded to the Radiation Safety Director.
3. A copy should remain at the respective District Office.

7.0 TRANSPORTATING RADIOISOTOPES VIA INDEPENDENT TESTING LABORATORIES, INC. AUTHORIZED VEHICLE

7.1 The requirements of Paragraphs 1, 2, 3, and 4, shall apply with additional requirements as follows:

7.1.1 A calibrated, operable Survey Meter shall be located in the vehicle near the driver.

7.1.2 A Radiation Survey shall be conducted to insure that the radiation level at the external surface of the vehicle and at the driver is 2 MR/HR or less.

7.1.3 Each vehicle, while transporting a radioisotope requiring a RADIOACTIVE YELLOW III Label, shall display on the front, rear, and both sides of the vehicle, placards consisting of a diamond shaped sign containing the word "RADIOACTIVE".

7.1.3.1. These placards shall be removed or covered when the vehicle does not contain the article for which such marking is required. (D.O.T. 49 Part 177.823, D)

7.1.4 Each vehicle requiring placarding as specified in Paragraph 7.1.3 above shall have posted in a conspicuous place as shown in Attachment No. 3 notifying authorities who to call in the event of an accident.

7.1.5 A Radiographic operations Report shall be completed for each movement vehicle when transporting radioactive material.

8.0 SHIPMENT BY CARGO AIRCRAFT

8.1 In addition to the requirements of Paragraphs 1 through 6, the following requirements shall also apply for shipment of Radioactive Material via Cargo Aircraft.

8.1.1 The package shall have a "CARGO AIRCRAFT ONLY" label affixed to the exterior surface.

9.0 SHIPMENT BY MOTOR FREIGHT

9.1 In addition to the requirements of Paragraphs 1 through 6, when shipping via Motor Freight, four (4) Placards bearing the word "RADIOACTIVE" shall be supplied to the driver.

	Level III	Effective Date 8-01-85	Number RS-GP-12
	Q.A. Manager:	Page 1 of 2	Revision 0

SUBJECT:

PROCEDURE FOR:
RECEIVING AND OPENING PACKAGES
CONTAINING RADIOACTIVE MATERIAL
AND OR RADIOACTIVE CONTAMINATED
EQUIPMENT AND SAMPLES

1.0 SCOPE

1.1 This procedure shall establish guidelines for receiving packages containing radiation material or suspected of containing items that are contaminated with Radioactive particles.

1.2 This procedure conforms to the requirements of Title 10CFR part 20.205 and Title 49CFR and applicable licensed Agreement States Regulations

1.3 This procedure shall be used in conjuction with Independent Testing Laboratories procedure for the use of Radiation Survey Instruments.

2.0 GENERAL:

2.1 Packages containing Radioactive material and all equipment returned from nuclear power plants are to be received according to the following procedure.

2.1.1 If the package is to be delivered to any Independent Testing Laboratory facility or site by a carrier, make arrangements to receive the package when it is offered for delivery by the carrier. If the package is to be picked up by Independent Testing Laboratory at the carriers terminal, make arrangements to receive notification from the carrier of the arrival of the package, at the time of arrival.

2.1.2 Upon receipt of a package of radioactive material equipment from a nuclear power plant. You shall monitor the external surfaces of the package for radioactive contamination caused by leakage from the package. The monitoring shall be performed as soon as practical after receipt, but no later than three hours after the package is received or eighteen hours if received after normal working hours.

2.1.1.1 A. If removable radiation contamination in excess of 0.01 microcuries per 100 sq. centimeters of package surface is found on the external surfaces of the package, Independent Testing Laboratories shall immediately notify the final delivery carrier and by telephone, telegram or mailgram the appropiate NRC Regional Office. If removable radioactive contamination in excess of 100 counts per minute above background radiation is found on the contents of the package. The Independent Testing Laboratories Radiation Safety Officer will notify immediately. The package will then be secured inside resticted contamination area building and log on inventory log.

2.1.1.2 If radiation levels are found on the external surface of the package in excess of 200mr per hour, or at three feet from the surface of the package in excess of 10mr per hour. Immediate notification as per A will be used.
If exposure limits from a sealed source exceeds 2mr per hour it shall be placed in radiation safe.

2.2 Only personnel certified by the Radiation Safety Officer may survey and open these packages.

SUBJECT:	Effective Date 8-01-85	Number RS-GP-13
CONDUCTING A LEAK TEST OF SEALED SOURCES	Page 1 of 1	Revision 0

1. SCOPE:

1.1 This procedure shall govern the method of performing Leak Test on radioisotopes used by Independent Testing Laboratories.

1.2 This procedure conforms to the requirements of USNRC Title 10 CFR part 34.25 and applicable licensed Agreement State Regulations.

2. GENERAL:

2.1 Only those personnel authorized to perform Leak Tests by the Radiation Safety Officer may perform such test.

2.2. One of the following Leak Test Kits shall be used to wipe testing sealed sources possessed by Independent Testing Laboratories.

A. Atomic Energy Laboratories of The Southwest will supply leak test kits.

2.3 Each sealed source shall be tested for leakage at intervals not to exceed six (6) months.

2.4 Applicable Radiation Safety Precautions shall be maintained throughout the performance of this test.

3. PERFORMANCE OF TEST

3.1 The wipe test shall be performed in accordance with the supplier's instructions, a copy of which is included in each kit.

3.2 If indicated surface activity of the wipe test sample exceeds 2 MR/HR the cognizant District Radiation Safety Officer or Radiation Safety Director should be notified immediately.

RECORDS

4.1 Records of Leak Test Results shall be kept in units of microcuries and maintained for inspection of the USNRC or applicable Agreement State.

SUBJECT:	Effective Date 8-01-85	Number RS-GP-14
RADIATION SAFETY RECORDS	Page 1 of 3	Revision 0

1. SCOPE:

1.1 This procedure shall govern the maintenance of reports and records that each Radiographer is required to generate as applicable and retain in compliance with the USNRC and/or State Regulations.

1.2 The following reports and records are included in this procedure not only in text, but also as attachments:

A. RADIOGRAPHIC OPERATIONS REPORT CONSISTING OF:

1. Source Utilization Record
2. Daily Maintenance and Inspection of Radiographic Exposure Device
3. Radiation Survey of Operations
4. Source Storage
5. Vehicle Survey

B. LEAK TEST RECORD
C. INCIDENT DATA REPORT
D. RADIOACTIVE MATERIAL RECEIVING REPORT
E. SHIPPING/CERTIFICATION DOCUMENT

2 INTENT:

2.1 It is the intent of this procedure to provide a ready reference to a Radiographer showing the reports that he is responsible for completing. Since many of the reports are self-explanatory, no report is to be completed after the performance of an operation for which there is an Independent Testing Laboratories procedure, that procedure will be referenced in the applicable part of this procedure and any special instructions for the use of that report will be found in the referenced procedure.

3. REPORTS:

3.1 Radiographic Report No. 2. A Radiographic Operations Report must be completed daily by radiographic personnel. At the end of the work week, these reports must be forwarded to the respective District Radiation Safety Officer for transmittal to the Radiation Safety Director.

3.1.1 Film Badges are to be forwarded to Radiation Safety Officer at the end of each month.

3.2 Independent Testing Laboratories Radiographic Operations Report No.1

The Independent Testing Laboratories Radiographic Operations Report No. 1 is to be completed as applicable for each time a source is transported or used. This report consist of:

A. SOURCE UTILIZATION RECORDS AS REQUIRED BY USNRC TITLE 10CFR PART 34.27 AND APPLICABLE LICENSED STATE REGULATIONS.

B. A MAINTENANCE AND INSPECTION OF THE RADIOGRAPHIC EXPOSURE DEVICE AS REQUIRED BY USNRC TITLE 10 CFR PART 34.28 AND APPLICABLE LICENSED STATE REGULATIONS.

C. A RADIATION SURVEY OF RADIOGRAPHIC OPERATIONS SHOWING SOURCE LOCATIONS AND RADIATION LEVELS AT BOUNDARIES OF RESTRICTED AREAS.

D. A SURVEY RECORD PRIOR TO SECURING A SOURCE FOR STORAGE AS REQUIRED BY USNRC TITLE 10 CFR PART 34.43 PARAGRAPHS C AND D AND APPLICABLE LICENSED STATE REGULATIONS.

E. A VEHICLE SURVEY RECORD TO ASSURE COMPLIANCE WITH DEPARTMENT OF TRANSPORTATION REGULATIONS CONTAINED IN TITLE 49 CFR PARTS 170-178 AND APPLICABLE USNRC AND/OR STATE REGULATIONS.

The Independent Testing Laboratories Radiographic Operations Report No. 1 is to be completed in triplicate, two (2) copies of which are forwarded to the respective District Office at the end of the work week and one (1) copy retained by the Radiographer.

3.3 LEAK TEST RECORD

A Leak Test Record (See Attachment) shall be completed in accordance with instructions contained in the procedure entitled Conducting A Leak Test RS-GP-13.

3.4 INCIDENT DATA REPORT

An Incident Data Report (See Attachment) shall be completed in the circumstance that:

1. A DOSIMETER IS DISCHARGED BEYOND ITS CAPACITY AND IMMEDIATE PROCESSING OF A "FILM BADGE" IS REQUIRED.

2. A "FILM BADGE" BECOMES WET, LOST OR MUTILATED.

3. A "FILM BADGE" MAY INDICATE AN EXCESSIVE EXPOSURE WHICH THE USER DID NOT RECEIVE.

This report shall be forwarded to the Radiation Safety Director as as soon as possible.

3.5 RADIOACTIVE MATERIAL RECEIVING REPORT

A Radioactive Material Receiving Report (see attachment) shall be completed in accordance with Independent Testing Laboratories, Procedure entitled "Receiving and Opening Packages Containing Radioactive Material. These reports are to be completed in duplicate, one (1) copy to be forwarded to the Independent Testing Laboratories, Searcy, Arkansas office and one(1) to be forwarded or maintained in the District Office.

3.6 SHIPPING/CERTIFICATION DOCUMENT

A Shipping/Certification Document (see attachment) shall be completed in accordance with Independent Testing Laboratories Procedure entitled, "Transportation or Radioactive Material", RS-GP-11.

SURVEY LOG

INDEPENDENT TESTING LABORATORIES

DATE FROM	DATE TO

CUSTOMER	TECHNICIAN
LOCATION	ASSISTANT TECHNICIAN
JOB NUMBER	CAMERA (MAKE)

ITEM	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
STORAGE READING: START/FINISH							
TIME: OUT/IN							
TOTAL EXPOSURE							
SOURCE NUMBER							
CURIES TO DATE							
DOSIMETER READING: START/FINISH							
TOTAL MR'S							

AREA SURVEY DISTANCE TO 2 mr/hr LEVEL OR GREATER, IF UNAVOIDABLE

PHYSICAL DESCRIPTION OF AREA, INCLUDING BOUNDRIES AND SHIELDING

WEEKLY TOTAL

Ft.) /mr level

mr level (Ft.) (Ft.) /mr level

Ft.) /mr level

CAMERA & CONTROLS DAILY CHECK LIST

OK	NR*	
☐	☐	Storage Cabinet
☐	☐	Shielding Material
☐	☐	Operation Of Crank
☐	☐	Drive Cable Tube
☐	☐	Source Guide Tube
☐	☐	Locking Devices

* Need Repair

Vehicle

_____ MR/HR Outside Surface

_____ MR/HR Driver's Seat

_____ MR/HR Camera Surface

SURVEY METER TYPE	SERIAL NUMBER	DOSIMETER TYPE	DOSIMETER NUMBER

CALIBRATION DUE	FILM BADGE NUMBER

SIGNATURE	TITLE

FORM 003

WHITE- OFFICE COPY
CANARY- TECHNICIAN'S COPY

INDUSTRIAL RADIOGRAPHY
DAILY JOB REPORT

REPORT # 2

INDEPENDENT TESTING LABORATORIES

CUSTOMER	LOCATION	JOB NUMBER
ADDRESS	JOB DESCRIPTION	
CUSTOMER JOB NUMBER	UNIT NUMBER	CAMERA NUMBER

No.	IDENTIFICATION NUMBER	STATION MARKER	ITEM NUMBER	DEFECTS	WITHIN CODE	OUT OF CODE	REMARKS FILM SIZE - QUANTITY
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

INSPECTORS SIGNATURE VERIFIES ALL ABOVE INFORMATION TO BE CORRECT

HOURS WORKED	MILES TO JOB SITE	TECHNICIAN	
HOURS TRAVELED	MILES FROM JOB SITE	ASSISTANT TECHNICIAN	
JOB CODE			PHONE
INSPECTOR		DATE	

FORM 004

OFFICE COPY

SUBJECT:	Effective Date 8-01-85	Number RS-GP-15
DESCRIPTION AND LOCATION OF RADIOGRAPHY FACILITIES	Page 1 of 3	Revision 0

1. PERMANENT STORAGE:

Permanent office and source storage facilities for the Testing and Inspection Department of Independent Testing Laboratories, are located at #1. Research Drive, Searcy, Arkansas 72143.

This facility is a Star Metal Building, owned by ITL. Two radiographic shot rooms and a rapid process darkroom are located in the bay area. (see drawing).

Inside the shop area, a Mosler lead-lined safe contains the exposure devices in four compartments. This safe is approximately 24" wide X 33" deep X 54" high. It is equipped with a separate lock and key.

Radiation levels with radioactive material inside the safe are less than 2mR/hr outside the storage area in the high bay area and also outside the building. "Caution - Radiation Area" signs are posted on the safe.

A sketch of the property, building, and storage area are attached. Dimensions are included on the sketch.

2. USE:

Locations of use under this license shall include temporary sites in which work will be performed from mobile laboratories.

3. Temporary Storage:

When radioactive material covered by this license is utilized at job sites remote from the Searcy office, the devices being utilized will be stored in a locked box in the darkroom section of a company truck under lock and key. Separate locks are on the box and the darkroom.

The storage box is posted "Caution - Radioactive Materials" and "Radioactive" signs are posted on the four sides of the vehicles, in accordance with DOT regulations. The latter signs are removed when there are no radioactive materials in the truck. The former sign is also posted on the darkroom door if the truck is used for temporary storage.

For leased service station (24 hour attendants) parking, place the truck in the designated, well lighted area. Perform step 10 above. Check with the attendant before leaving to assure that he will keep personnel away from the truck and that he knows how you can be reached if necessary.

NOTE: If leased parking is utilized Independent Testing Laboratories will in no manner create Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour or Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 millirems in any seven consecutive days.

CALCULATIONS FOR RADIATION EXPOSURE BAYS:

A. 1.9 inches of concrete equals one half-value-layer for Iridium 192.

B. One curie of Iridium 192 emits : 5900 mR/hr at one foot.

C. Radiation decreases in intensity by the square of the distance.

D. The center or exposure area of the bay is a minimum of 4 feet to the surface of the inside wall.

E. The walls are 24" of solid concrete.

F. The X-ray bay has no leakage at surface with the 200B X-Ray machine.

Therefore: 70 Curies = 413,000 mR/hr @ 1'
= 103,250 mR/hr @ 2'
= 25,812 mR/hr @ 4'

24 inches of concrete = 12.63 half - value - layers or
2 mR/hr at outside surface