P. O. BOX 1241 • 4029 NEW CASTLE AVENUE
WILMINGTON, DELAWARE 19899 • 302-655-7358

LEHIGH TESTING LABORATORIES, INC.

September 8, 1983

United States Nuclear Regulatory Commission
Region 1
631 Park Avenue
King of Prussia, Pennsylvania 19406

ATTN: James H. Joyner

SUBJ: Response to Nuclear Regulatory Commission letter regarding deficiencies at Lehigh Testing Laboratories from Mr. J. H. Joyner, dated 11 August 1983.

Gentlemen:

This letter, including Attachments A through G, constitutes our response to your August 11 letter. Referring to the eleven items in the subject letter from Mr. Joyner, we implemented several of the required corrective actions prior to our August 12 meeting at the Commission's office in King of Prussia. The remaining items have been completed since that meeting. In either case, for the sake of completeness we submit the following individual responses for each of the eleven items requested in the NRC letter:

ITEM #1 - Requirement: Cease all radiographic operations with licensed material until all RT employees complete 12 hours of formal classroom training (does not apply to RSO or to Assistant RSO).

RESPONSE TO ITEM #1: Operations ended the evening of August 10. The required training was accomplished prior to the August 12 meeting with the NRC. For documentation, see Leonard Weston's August 12 letter to the NRC (Attachment A).

ITEM #2 - Requirement: Qualify all personnel classified as Assistant Radiographer by written exam with a minimum passing score of 75%.

RESPONSE TO ITEM #2: Charles Gilkey was qualified by scoring 96% on the Assistant Radiographer's written exam administered by H. Ostroff on August 11. See Attachment A. Examination is in Attachment B.

ITEM #3 - Requirement: Qualify all personnel classified as Radiographers by written exam with minimum passing score of 80%.

RESPONSE TO ITEM #3: Leroy Menear, Wesley Nickle, and Joseph Ruzowicz were qualified by scoring 82%, 94% and 80%, respectively, on the Radiographer's written exam administered by H. Ostroff on August 11. See Attachment A. Examinations are in Attachment B.

ITEM #4 - Requirement: Administer to all Radiographers a practical examination in accordance with LTL Form 205.

8410030298 840918
NMS LIC30
07-01173-03 PDR

"OFFICIAL RECORD COPY" ML10

RESPONSE TO ITEM #4: Leroy Menear, Wesley Nickle, and Joseph Ruzowicz all scored 100% on the Radiographer's Practical Examination administered by H. Ostroff on August 12. See Attachment A. Examinations are in Attachment B.

ITEM #5 - Requirement: Document the training, written and practical exams, and allow no individual to act or assist in radiographic operations with licensed material until such training and examinations have been successfully completed.

RESPONSE TO ITEM #5: Attachments A and B, which contain a summary record, the lesson plan, and the actual examinations administered to each individual constitute our documentation of the training and examinations. No individuals act or assist in Lehigh's radiographic operations other than H. Ostroff (RSO), H. Cann (Ass't. RSO), and the four individuals named in Items #2 and #3 above.

ITEM #6 - Requirement: Perform an audit of all radiation safety training records to ensure they are complete, accurate and up-to-date.

RESPONSE TO ITEM #6: Radiation safety training records for the six individuals employed in radiography at Lehigh have been audited by Leonard Weston, General Manager, and have been found to be in conformance with all of the above requirements. Copies of the Examinations for the four newly-certified individuals who function either as Radiographers or as Assistant Radiographers are presented in Attachement B. In the future, the General Manager's audits of radiographic operations will include a review of personnel records for all radiographic personnel to assure continuing compliance. The revised form for this Management Audit is presented as Attachement C.

ITEM #7 - Requirement: Prior to September 11, 1983, install both an audible and a visible alarm system in the x-ray facility at 4027 New Castle Avenue if Lehigh chooses to continue radiography with licensed material at that location. Until the alarms are installed, provide positive measures to prevent inadvertent entry to the x-ray facility whenever a radiographic device is in use.

RESPONSE TO ITEM #7: Lehigh has elected to continue performing radiography with licensed material at this location. No isotope radiography was performed in that facility during the period from August 10, 1983 to August 25, 1983. On August 26, 1983, dead-bolt locks were installed on the insides of the two doors leading to the x-ray facility. A lock has always existed on the inside of the overhead garage door, the only other possible entrance to the facility. This overhead door is closed and locked from the inside during all radiographic operations.

On August 30, 1983, the installation of a "Gammalarm" radiation monitor was completed. The system has been set to detect radiation above the 0.5 mR level at the monitor, which is positioned on the wall near the exposure area and the storage enclosure (see the sketch in Attachment D). When this level of radiation is exceeded, the monitor light changes from a steady green to a flashing red. Simultaneously, red flashing lights are activated on the outsides of both entry doors to the facility. Radiation warning signs are posted on the outsides of both doors, and special signs explaining the red flashing lights have been added as well. These doors are not locked during radiographic operations, in the interests of safety of radiographers on duty. However, audible alarm bells have been installed at both doors. These bells will sound only when (a) radiation is present, and (b) someone ignores the flashing red light and opens the door. This audible alarm is designed not only to be heard by the person entering the door, but also is of sufficient intensity to alert the radiographer on duty that unauthorized entry to the facility has occurred.

ITEM #8 - Requirement: Prior to September 11, 1983, submit a request for a license amendment to the NRC to reflect the change of location for storage of licensed material, along with a description of the x-ray facility.

RESPONSE TO ITEM #8: A license amendment was sent to the NRC Materials Licensing Branch on September 1, 1983. See Attachments D and E.

ITEM #9 - Requirement: Insure that all utilization log information and other records required to meet the conditions of our license and 10 CFR 34 are complete, accurate, and up-to-date.

RESPONSE TO ITEM #9: Lehigh personnel have attempted to reconstruct the utilization log information found to be missing/incomplete during the Commission's recent audit. As of September 2, we have prepared utilization logs as completely as possible back to January 1, 1983. We have done this by using whatever backup information was available -- billing sheets, personal recollections by Lehigh employees, laboratory log books, etc. Despite these efforts, certain facts needed to complete the records have not been available from these secondary sources. Our efforts are continuing on this matter.

The reasons for the incomplete log information at the time of the Commission's audit has been identified as follows: (a) for certain individuals, there was a lack of understanding of recordkeeping requirements; (b) for others, there was knowledge of the requirements, but an apparent unwillingness to comply; and, ultimately, (c) inadequate management controls allowed both situations, (a) and (b), to exist and continue.

Our corrective actions for these problems consist of the following steps. First, the RSO/Department Manager, H. Ostroff will certify on each billing sheet that he has personnaly reviewed and approved the required records for each job as it is billed. See the revised

billing sheet form, Attachment F. Second, the General Manager, L. Weston, will personally conduct spot audits, on a quarterly basis, of the utilization logs, transportation records, daily equipment maintenance records and the RSO's certifications of these on corresponding billing sheets. The results of these quarterly audits will be sent to the company President, the undersigned. See the revised Management Audit form, Attachment C.

ITEM #10 - Requirement: By September 11, evaluate the whole body and extremity exposures to individuals who participated in the two source recoveries and two incidents involving radiographic sources.

RESPONSE TO ITEM #10: See the four reports dated August 15, 1983 from H. Ostroff, Radiation Safety Officer, to L. Weston. These are in Attachment G.

ITEM #11 - Requirement: Prior to resuming radiographic operations, meet with NRC Region I in King of Prussia and describe the actions taken with regard to the above matters.

RESPONSE TO ITEM #11: The initial meeting with the Commission was held on August 12, as you know. At that meeting, Lehigh was given permission to resume radiographic operations. It is anticipated, however, that one or more additional meetings with the NRC will be needed in the near future to review our responses and corrective actions.

In addition to all the above, the company President will receive and inspect the management audits of radiography. He will keep a record of these audits having been performed. Also, he will visit at least several job sites each year and will try to be, generally, more available to talk with radiographers informally during his visits to Lehigh. The purpose will be to make it easier for radiographers to suggest improvements or corrections of deficiencies.

This concludes our descriptions of corrective actions to date in this matter.

Sincerely,

David Krashes

David Krashes,
President

DK:sam

ATTACHMENT A

LEHIGH TESTING LABORATORIES, INC.

DATE: August 12, 1983
SUBJ: DOCUMENTATION OF THE TRAINING SESSIONS AND EXAMINATIONS CONDUCTED FOR RADIOGRAPHIC PERSONNEL
FROM: L. Weston
TO: Nuclear Regulatory Commission
CC: D. Krashes
H. Ostroff
L. Menear (file)
W. Nickle (file)
J. Ruzowicz (file)
C. Gilkey (file)

A formal classroom training session was conducted by H. Ostroff and L. Weston on August 11 and 12, 1983 for several employees of Lehigh's NDT Department. The employees in attendance for these sessions, in addition to the two instructors, were:

Leroy Menear
Wesley Nickle
Joseph Ruzowicz
Charles Gilkey

The training sessions covered each of the following five major areas:

(A) Principles of Radiation Safety - the nature, generation, characteristics, measurement, biological effects, and control of radiation and radioactive isotopes;

(B) Lehigh's Operating and Emergency Procedures - definitions; the functions, responsibilities and limitations of Radiographers, Assistant Radiographers, and Trainees; personnel monitoring devices; why, how, and when to conduct radiation surveys; how to control radiographic worksites; how to operate exposure devices; how to perform source changes; what to do in various types of emergency situations; transportation procedures; inspection and maintenance procedures; leak testing procedures; security and storage procedures; and recordkeeping requirements

(C) Lehigh's Administrative Manual - including discussions of Lehigh's radiographic facilities, radiation detection instruments, calibrating procedures and requirements, personnel monitoring equipment, training program, internal inspections, and organizational structure

(D) Federal Standards applicable to radiography in 10 CFR Parts 19, 20, 30 and 34

(E) A general discussion of case studies of radiation accidents and why they occur; what the deficiencies in

Lehigh's radiography program have been in the past; what immediate changes are being made and how they effect the radiographers and assistant radiographers

During the presentation of the above material by the instructors, numerous actual examples were used to reinforce the students' understanding. There were several round-robin discussions of certain key procedures, and many sample problems and hypothetical situations were analyzed. The total time for these training sessions, during which all of the above employees were present, was approximately twelve hours.

Following the classroom training, each of the four students were given a written, closed-book examination. The examinations and scores for each student are listed below:

Charles Gilkey: Assistant Radiographer Exam - 25 questions; 24 answered correctly; score = 96%; (PASSED)

Leroy Menear: Radiographer Exam - 50 questions; 41 answered correctly; score = 82%; (PASSED)

Wesley Nickle: Radiographer Exam - 50 questions; 47 answered correctly; score = 94%; (PASSED)

Joseph Ruzowicz: Radiographer Exam - 50 questions; 40 answered correctly; score = 80%; (PASSED)

Upon completion of these written examinations, further discussions of the incorrect responses were conducted until the instructor was convinced that the individuals fully understood the material.

On August 12, 1983, three of the above employees were given a Practical Examination in order to ascertain their competence to perform the duties of a radiographer in full accordance with Lehigh's procedures per paragraph 8.C(iii) of the Administrative Manual. Each practical examination included twenty different checkpoints. Results are as follows:

Leroy Menear: Practical Exam Score = 100% (PASSED)

Wesley Nickle: Practical Exam Score = 100% (PASSED)

Joseph Ruzowicz: Practical Exam Score = 100% (PASSED)

ATTACHMENT B

LESSON PLAN, August 11-12, 1983

(A) Principles of Radiation Safety - the nature, generation, characteristics, measurement, biological effects, and control of radiation and radioactive isotopes;

(B) Lehigh's Operating and Emergency Procedures - definitions; the functions, responsibilities and limitations of Radiographers, Assistant Radiographers, and Trainees; personnel monitoring devices; why, how, and when to conduct radiation surveys; how to control radiographic worksites; how to operate exposure devices; how to perform source changes; what to do in various types of emergency situations; transportation procedures; inspection and maintenance procedures; leak testing procedures; security and storage procedures; and recordkeeping requirements

(C) Lehigh's Administrative Manual - including discussions of Lehigh's radiographic facilities, radiation detection instruments, calibrating procedures and requirements, personnel monitoring equipment, training program, internal inspections, and organizational structure

(D) Federal Standards applicable to radiography in 10 CFR Parts 19, 20, 30 and 34

(E) A general discussion of case studies of radiation accidents and why they occur; what the deficiencies in Lehigh's radiography program have been in the past; what immediate changes are being made and how they effect the radiographers and assistant radiographers

During the presentation of the above material by the instructors, numerous actual examples were used to reinforce the students' understanding. There were several round-robin discussions of certain key procedures, and many sample problems and hypothetical situations were analyzed. The total time for these training sessions, during which all of the above employees were present, was approximately twelve hours.

started @ 7:45 Am } HO
Completed @ 8:10 Am } RSO

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WES NICKLE 8-12-83
H. OSTROFF RSO

LEHIGH TESTING LABORATORIES, INC.

PRACTICAL EXAMINATION FOR RADIOGRAPHERS

Paragraph 8.C(iii) of the Administrative Manual requires that prospective Radiographers be given a practical examination to assure that they are able to apply their training to actual radiographic operations. He shall perform such operations without assistance but under constant supervision. The test will include a minimum of twenty checkpoints of correct procedure, and a 100% score is required. The checkpoints will cover at least the following general operations:

1. Proper personnel monitoring equipment and procedures employed;
2. Radiation surveys conducted properly and when required;
3. Worksite properly restricted, posted and monitored as required; Checked all 4 sides for controls for occupancy ✓
4. Exposure device operated properly;
5. Transportation procedures;
6. All necessary recordkeeping properly filled out and filed
7. Source storage performed properly.

Checked for proper cable on Camera ✓
Pocket Dosimeter Cal ✓
Reading Logged ✓
Film Badge ✓
Calibrated Survey Meter ✓
Survey Source " ✓
Container ✓
Calculated Time ✓
Switched Light On ✓
Signs posted ✓
Door Locked ✓
Checks made on Crank ✓
" " " Camera ✓
~~Telephonic~~ Telescopic " " ✓
Sketch made of Rad. Room ✓
Survey made of Entire Room ✓
Returned source to Storage ✓
Survey made of Camera ✓
" " & Storage Container ✓

Note: Any failure to perform these operations correctly will necessitate re-training in the applicable areas and a delay of 1 month before appointment to radiographer.

100%
N. J. Ostroff
RSO 8-12-83

FORM 205

P. O. BOX 1241 • 4029 NEW CASTLE AVENUE
WILMINGTON, DELAWARE 19899 • 302 655-7338

Safety, Practical Test

LEHIGH TESTING LABORATORIES, INC.

RADIOGRAPHIC EQUIPMENT - UTILIZATION LOG

DATE 8-12-83 TIME 7:45 LOCATION OF USAGE 4027 New Castle Ave

ISOTOPE TYPE Ir192 S/N 7737 ACTIVITY AT TIME OF USAGE 40 CURIES

MODEL OF DEVICE IN WHICH ISOTOPE IS USED T/O 660

DEVICE S/N 3325 SURVEY READING AT SURFACE OF DEVICE (INITIAL) 20 mR

VEHICLE (IF USED) — SURVEY READING AT SURFACE OF VEHICLE — mR

NUMBER OF EXPOSURES MADE 2 TOTAL TIME OF EXPOSURES 4:30 min

SURVEY METER READING AT BOUNDARY OF RESTRICTED AREA 1 mr 2 mr at surface for shields mR

RADIOGRAPHER IN CHARGE W. Nickle DOSIMETER READING (FINAL) 0 mR

~~ASSISTANT RADIOGRAPHER~~ RSO H. Ostroff DOSIMETER READING (FINAL) 0 mR

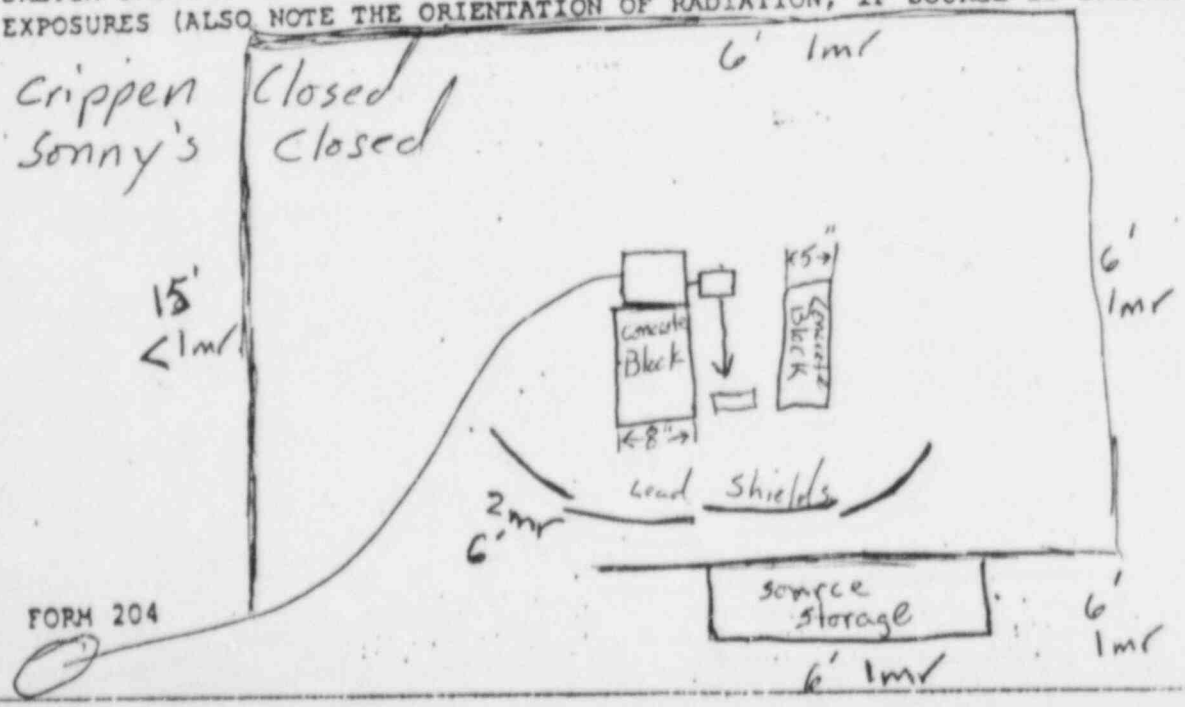
SURVEY METER READING AT SURFACE OF EXPOSURE DEVICE (FINAL) 20 mR

STORAGE LOCATION LTL DATE AND TIME STORED 8-12-83 8-10 AM

SURVEY METER READING AT SURFACE OF STROAGE ENCLOSURE 2. mR

ADDITIONAL COMMENTS Barracated w/ Lead shields Collimator used (heavy lead cylinder) Concrete walls total thickness 15"

SKETCH SHOWING BOUNDARIES OF RESTRICTED AREA, RELATIVE TO LOCATION OF ISOTOPE DURING EXPOSURES (ALSO NOTE THE ORIENTATION OF RADIATION, IF SOURCE IS COLLIMATED):



FORM 204

LEHIGH TESTING LABORATORIES, INC.

RADIOGRAPHIC DEVICE - DAILY MAINTENANCE AND INSPECTION REPORT

Exposure Device S/N 3325 Crank S/N 1377 Isotope S/N 7737

Isotope Type Ir-192

Date 8-12-83 Inspected by W. N.

INSPECTION	COMMENTS
1. Changes in operating characteristics of the device	None
2. Proper operation of crank mechanism	ok
3. Proper operation of source position indicator	"
4. Proper operation of locking mechanism	"
5. Source and drive cable and guide tube damage	None
6. Connector wear or damage of all mating components	"
7. Rust, dirt or sludge build-up in the source guide tubes	"
8. Shifting of shield and or source in the exposure device housing	"
9. Cable drive gearbox damage or wear	"
10. Proper labelling	None Herb notified 8-12-83
11. Miscellaneous (loose screws, safety caps, etc.)	"

Any damage to the radiographic device which may impair its safe operation shall be reported immediately to the Radiation Safety Officer.

Form 201

3/50 = 94% He RSO - 8-14-83 Wesley C. Nuckle 8-11 83

RADIOGRAPHER'S EXAMINATION *

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

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

True ( ) False (X)

3. The primary hazard in radiography comes from

a) Internal radiation.
(B) Gamma rays and alpha particles.
c) Beta particles.
X d) External radiation.

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

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

5. The abbreviation "r" stands for roentgen.

6. The abbreviation "mr" stands for milliroentgen.

7. The term "rad" stands for Radiation Absorb Dose.

8. The term "rem" stands for ~~Relative~~ Equivailent Man Radiation.

9. The roentgen is a measure of

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

10. The whole-body radiation dose must normally be limited to a dose of

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

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

True ( ) False (X)

12. The most serious radiation exposure is to the

(a) Whole body.
b) Feet and ankles.
c) Skin.
d) Hands and forearms.

* The questions presented here indicate the general level of difficulty and the variety of topics which may be anticipated in actural exams, but they are not necessarily the same questions that will be used.

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

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

14. It is possible to receive a dose considerabley above the regulatory limits without showing detectable radiation effects.

True (X) False ( )

15. In relation to radiation effects, MLD stands for Median Lethal Dose.

16. The MLD for humans is the radiation dose

a) That causes the first death.
b) That causes slight, temporary blood changes.
c) That is considered lethal to all persons exposed.
d) That causes 50% of those exposed to die.

17. The MLD for humans is _____ rems (fill in from below) whole body exposure within a 24 hour period.

a) 250
b) 500
c) 750
d) 1,000

18. Portable instruments used to monitor radiation areas are called

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

19. Devices attached to the clothing of people working in radiation areas for measurement of radiation are called

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

20. Radiation measuring devices operate on the principle of ionization.

True (X) False ( )

21. Survey meters provide

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

22. Pocket dosimeters depend upon a _____ (fill in from below) for their indication.

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

23. The film badge operates on the principle that _____ (fill in from below) exposes film.

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

24. Which statement about the film badge is true?

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

25. The pocket dosimeter has the advantage of

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

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

True ( ) False (X)

27. When ionizing radiation enters the ion chamber of an ionization chamber survey meter, positive ions flow to the negative electrode(s) and negative ions flow to the positive electrode(s).

True (X) False ( )

28. The Geiger-Mueller counter uses the G-M tube to

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

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

30. In most radiographic operations, the ionization chamber survey meter is more desirable than the G-M counter.

True (✓) False ( )

31. The standard dose rate of a radioisotope is expressed in

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

32. The intensity at 1 foot from a 10 curie source of Ir-192 is 59 r/hr. The standard dose rate for one curie at 1 foot for Ir-192 is

a) 590 r/hr/curie.
b) 5.9 r/hr/curie.
c) .59 r/hr/curie.
d) 59 r/hr/curie.

33. The standard dose rate at 1 foot for Co-60 is 14.5 r/hr/curie. What is the intensity at 1 foot for a 7 curie source of Co-60?

a) 14.5 r/hr
b) 75 r/hr
c) 145 r/hr
d) 101.5 r/hr

34. The three basic means of providing personnel protection from radiation are Time, Distance, and Shielding.

35. A person receives 3 mr/hr at a certain distance from a radiation source. What would be his exposure if he remained at the same distance for 3 hours? 9 mr

RADIOGRAPHER'S EXAMINATION (Cont.)

36. The inverse square law as applied to radiation protection states that

a) Radiation intensity varies inversely as the square of the time spent near the source.
b) Radiation intensity varies proportionally with distance from the source.
(c) Radiation intensity varies inversely as the square of the distance from the source.

37. The formula for the inverse square law is

a) $\frac{I_2}{I_1} = \frac{D_1^2}{D_2^2}$

b) $\frac{I_1^2}{I_2^2} = \frac{D_2^2}{D_1^2}$

c) $\frac{I_1}{I} = \frac{D_2}{D_1}$

(d) $\frac{I_1}{I_2} = \frac{D_2^2}{D_1^2}$ $I_1 \times D_1^2 = I_2 \times D_2^2$ 150 10

15000

18.75
4 | 75

38. At 2 feet from a radiation source, radiation intensity is 300 r/hr. What is the intensity at 8 feet from the source? 18.75 r/hr.

round to nearest R
(19)

39. At 10 feet from an isotope, radiation intensity is 150 mr/hr. The intensity at 1 foot would be 15000 mr/hr.

40. Radiation intensity at 6 feet from an isotope is 40 r/hr. At what distance would the intensity be reduced to 10 r/hr? 12 feet.

The following questions refer directly to Lehigh Testing Laboratories' operating and emergency procedures.

41. How often do survey meters require calibration?

90 DAYS

42. Who is responsible for filling out exposure logs?

Radiographer

43. A source is jammed and cannot be returned to a safe stored position. It is the radiographer's responsibility to do what? Rope off area - Notify RSO

RADIOGRAPHER'S EXAMINATION (Cont.)

44. On a Technical Operations 660 or 680 exposure device there are three positions in which the locking mechanism can be placed. What are those positions?
Connect - Lock - Operate

45. What range does your dosimeter register?
0 - 200 mr

46. How often are your film badges processed and by whom?
Weekly by Landuer

47. How often are sources leak tested? shielding is checked daily
6 mos.

48. Who in accordance to Lehigh Testing Laboratories' license is responsible for leak testing? [redacted] Radiographer

49. Who provides assay services in regard to leak tests?
Tech Ops

50. What is the maximum survey meter reading allowed in the car or driver's seat of your vehicle while transporting a source?
2 mr/hr

started @ 8:25 } HLO
Completed @ 8:50 } RSO

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J. Ruzowicz 8-12-83
H. Ostroff RSO

LEHIGH TESTING LABORATORIES, INC.

PRACTICAL EXAMINATION FOR RADIOGRAPHERS

Paragraph 8.C(iii) of the Administrative Manual requires that prospective Radiographers be given a practical examination to assure that they are able to apply their training to actual radiographic operations. He shall perform such operations without assistance but under constant supervision. The test will include a minimum of twenty checkpoints of correct procedure, and a 100% score is required. The checkpoints will cover at least the following general operations:

Cal. Pocket Dosimeter ✓
Reading Logged ✓
Filing Badges on
Calibrated Survey Meter used ✓
Survey Storage Container ✓
Survey Camera & Tubes ✓
" @ 3 ft ✓
Calculated 2 mr ✓
Posted Exposure ✓
Signs posted ✓
Checked all Hoses entered ✓
Door locked ✓
Checks made on Crank ✓
Hooked up Crank to Camera ✓
Survey made of Room ✓
Collimator Cap filled out ✓
Mark Cap filled out ✓
Surveyed Camera after use ✓
Returned Source to Storage ✓

1. Proper personnel monitoring equipment and procedures employed;
2. Radiation surveys conducted properly and when required;
3. Worksite properly restricted, posted and monitored as required;
4. Exposure device operated properly;
5. Transportation procedures;
6. All necessary recordkeeping properly filled out and filed;
7. Source storage performed properly.

Camera Checked for Proper Labeling ✓

Surveyed Camera ✓
" Storage Container ✓

Note: Any failure to perform these operations correctly will necessitate re-training in the applicable areas and a delay of 1 month before appointment to radiographer.

H. J. Ostroff
RSO 8-12-83

FORM 205

P. O. BOX 1241 • 4029 NEW CASTLE AVENUE
WILMINGTON, DELAWARE 19899 • 302 655-7338

Practical Test

LEHIGH TESTING LABORATORIES, INC.

RADIOGRAPHIC EQUIPMENT - UTILIZATION LOG

DATE 8-12-83 TIME 826 A LOCATION OF USAGE LTL

ISOTOPE TYPE IR-192 S/N 7814 ACTIVITY AT TIME OF USAGE 58 CURIES

MODEL OF DEVICE IN WHICH ISOTOPE IS USED Teal Ops 660

DEVICE S/N 7814 SURVEY READING AT SURFACE OF DEVICE (INITIAL) 35 mR

VEHICLE (IF USED) — SURVEY READING AT SURFACE OF VEHICLE — mR

NUMBER OF EXPOSURES MADE 1 TOTAL TIME OF EXPOSURES 55 sec. min

SURVEY METER READING AT BOUNDARY OF RESTRICTED AREA 1 mR

RADIOGRAPHER IN CHARGE Joe Lezowicz DOSIMETER READING (FINAL) 0 mR

ASSISTANT RADIOGRAPHER — DOSIMETER READING (FINAL) — mR

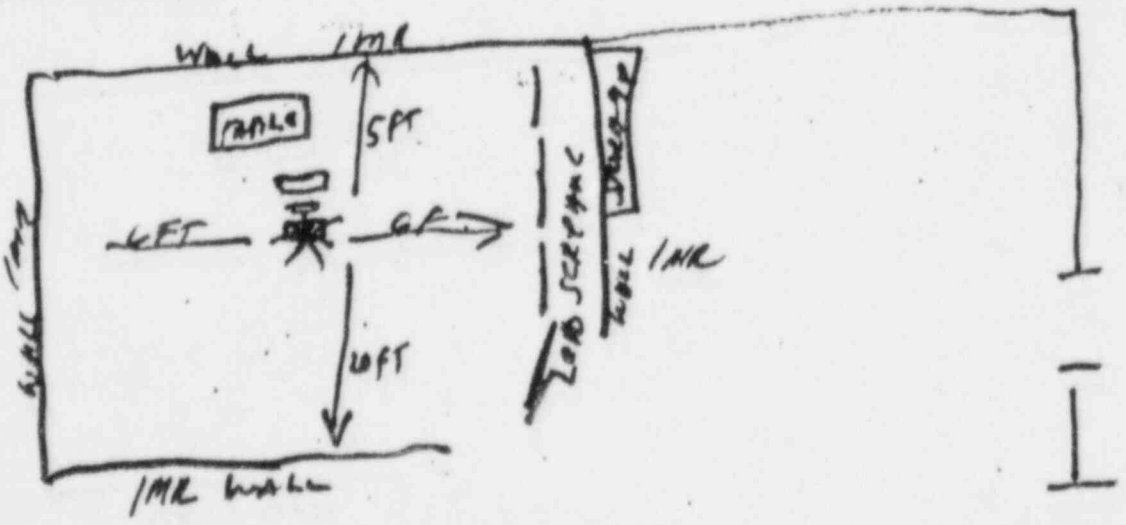
SURVEY METER READING AT SURFACE OF EXPOSURE DEVICE (FINAL) 35 mR

STORAGE LOCATION LTL DATE AND TIME STORED 8-12-83

SURVEY METER READING AT SURFACE OF STROAGE ENCLOSURE 1/2 mR

ADDITIONAL COMMENTS Barricaded, calibrator used
Survey meter, Pigpen not in

SKETCH SHOWING BOUNDARIES OF RESTRICTED AREA, RELATIVE TO LOCATION OF ISOTOPE DURING EXPOSURES (ALSO NOTE THE ORIENTATION OF RADIATION, IF SOURCE IS COLLIMATED):



FORM 204

LEHIGH TESTING LABORATORIES, INC.

RADIOGRAPHIC DEVICE - DAILY MAINTENANCE AND INSPECTION REPORT

Exposure Device S/N 7814 Crank S/N BTT Isotope S/N 7814

Isotope Type IR-192

Date 8-12-83 Inspected by Joe Lyons

INSPECTION	COMMENTS
1. Changes in operating characteristics of the device	None
2. Proper operation of crank mechanism	OK
3. Proper operation of source position indicator	OK
4. Proper operation of locking mechanism	OK
Source and drive cable and guide tube damage	None
6. Connector wear or damage of all mating components	None
7. Rust, dirt or sludge build-up in the source guide tubes	None
8. Shifting of shield and or source in the exposure device housing	None
9. Cable drive gearbox damage or wear	None
10. Proper labelling	OK
11. Miscellaneous (loose screws, safety caps, etc.)	None

Any damage to the radiographic device which may impair its safe operation shall be reported immediately to the Radiation Safety Officer.

Form 201

10/50 80% Hen 80 RSO 8-11-83

Joseph J. Rygowicz 8-11-83

RADIOGRAPHER'S EXAMINATION *

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

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

   True ( )   False (✓)

X 3. The primary hazard in radiography comes from

   a) Internal radiation.
   (b) Gamma rays and alpha particles.
   c) Beta particles.
   X d) External radiation.

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

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

5. The abbreviation "r" stands for roentgen.

6. The abbreviation "mr" stands for milli roentgen.

7. The term "rad" stands for Radiation absorbed dose.

8. The term "rem" stands for Roentgen equivalent man.

X 9. The roentgen is a measure of

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

10. The whole-body radiation dose must normally be limited to a dose of

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

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

   True ( )   False (✓)

12. The most serious radiation exposure is to the

   (a) Whole body.
   b) Feet and ankles.
   c) Skin.
   d) Hands and forearms.

* The questions presented here indicate the general level of difficulty and the variety of topics which may be anticipated in actural exams, but they are not necessarily the same questions that will be used.

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

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

14. It is possible to receive a dose considerabley above the regulatory limits without showing detectable radiation effects.

True (✓) False ( )

15. In relation to radiation effects, MLD stands for Median Lethal Dose.

~~16.~~ The MLD for humans is the radiation dose

a) That causes the first death.
b) That causes slight, temporary blood changes.
(c) That is considered lethal to all persons exposed.
~~d~~ That causes 50% of those exposed to die.

~~17.~~ The MLD for humans is 250 rems (fill in from below) whole body exposure within a 24 hour period.

(a) 250
~~b~~ 500
c) 750
d) 1,000

18. Portable instruments used to monitor radiation areas are called

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

19. Devices attached to the clothing of people working in radiation areas for measurement of radiation are called

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

20. Radiation measuring devices operate on the principle of ionization.

True (✓) False ( )

21. Survey meters provide

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

22. Pocket dosimeters depend upon a _____ (fill in from below) for their indication.

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

23. The film badge operates on the principle that _____ (fill in from below) exposes film.

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

24. Which statement about the film badge is true?

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

25. The pocket dosimeter has the advantage of

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

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

True ( ) False (✓)

27. When ionizing radiation enters the ion chamber of an ionization chamber survey meter, positive ions flow to the negative electrode(s) and negative ions flow to the positive electrode(s).

True (✓) False ( )

28. The Geiger-Mueller counter uses the G-M tube to

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

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

30. In most radiographic operations, the ionization chamber survey meter is more desirable than the G-M counter.

True (✓) False ( )

31. The standard dore rate of a radioisotope is expressed in

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

32. The intensity at 1 foot from a 10 curie source of Ir-192 is 59 r/hr. The standard dose rate for one curie at 1 foot for Ir-192 is

a) 590 r/hr/curie.
(b) 5.9 r/hr/curie.
c) .59 r/hr/curie.
d) 59 r/hr/curie.

33. The standard dose rate at 1 foot for Co-60 is 14.5 r/hr/curie. What is the intensity at 1 foot for a 7 curie source of Co-60?

a) 14.5 r/hr
b) 75 r/hr
c) 145 r/hr
(d) 101.5 r/hr

34. The three basic means of providing personnel protection from radiation are Time, Distance, and Shielding.

35. A person receives 3 mr/hr at a certain distance from a radiation source. What would be his exposure if he remained at the same distance for 3 hours? 9 MR

RADIOGRAPHER'S EXAMINATION (Cont.)

36. The inverse square law as applied to radiation protection states that

a) Radiation intensity varies inversely as the square of the time spent near the source.
b) Radiation intensity varies proportionally with distance from the source.
(c) Radiation intensity varies inversely as the square of the distance from the source.

37. The formula for the inverse square law is

a) $\frac{I_2}{I_1} = \frac{D_1^2}{D_2^2}$

2ft 300R/hr ?

b) $\frac{I_1^2}{I_2^2} = \frac{D_2^2}{D_1^2}$

c) $\frac{I_1}{I} = \frac{D_2}{D_1}$

(d) $\frac{I_1}{I_2} = \frac{D_2^2}{D_1^2}$

38. At 2 feet from a radiation source, radiation intensity is 300 r/hr. What is the intensity at 8 feet from the source? 75 R/hr.

39. At 10 feet from an isotope, radiation intensity is 150 mr/hr. The intensity at 1 foot would be 15R P/HR.

40. Radiation intensity at 6 feet from an isotope is 40 r/hr. At what distance would the intensity be reduced to 10 r/hr? 12 ft.

The following questions refer directly to Lehigh Testing Laboratories' operating and emergency procedures.

41. How often do survey meters require calibration? 3 mo.

42. Who is responsible for filling out exposure logs? R.S.O.

43. A source is jammed and cannot be returned to a safe stored position. It is the radiographer's responsibility to do what? Secure area, notify area supervisor & the R.S.O. Barrier cannot be removed until R.S.O. arrives.

RADIOGRAPHER'S EXAMINATION (Cont.)

44. On a Technical Operations 660 or 680 exposure device there are three positions in which the locking mechanism can be placed. What are those positions? spiral lock connect

45. What range does your dosimeter register? 0-200 mR

46. How often are your film badges processed and by whom? 1 week Landauer

47. How often are sources leak tested? 6 mo

48. Who in accordance to Lehigh Testing Laboratories' license is responsible for leak testing? RSO, ASST RSO

49. Who provides assay services in regard to leak tests?

50. What is the maximum survey meter reading allowed in the car or driver's seat of your vehicle while transporting a source? 2 mR

Started @ 9:00 } H&O
Completed @ 9:20 } RSO

BOX 1241 • 4019 NEW CASTLE AVENUE
WILMINGTON, DELAWARE 19801 • 302/655-7261

L. Mason 8-12-83
H. Ostroff RSO

LEHIGH TESTING LABORATORIES, INC.

PRACTICAL EXAMINATION FOR RADIOGRAPHERS

Paragraph 8.C(iii) of the Administrative Manual requires that prospective Radiographers be given a practical examination to assure that they are able to apply their training to actual radiographic operations. He shall perform such operations without assistance but under constant supervision. The test will include a minimum of twenty checkpoints of correct procedure, and a 100% score is required. The checkpoints will cover at least the following general operations:

1. Proper personnel monitoring equipment and procedures employed;
2. Radiation surveys conducted properly and when required;
3. Worksite properly restricted, posted and monitored as required;
4. Exposure device operated properly;
5. Transportation procedures;
6. All necessary recordkeeping properly filled out and filed;
7. Source storage performed properly.

Cal. Pocket Dosimeter ✓
Reading Logged ✓
Film Badge on ✓
Collimated Survey Meter used ✓
Survey Storage Container ✓
Supply Cadera & Pigtail ✓
" @ 3 ft ✓
Collimator 2 mr ✓
Pointed Collimator ✓
Area Posted ✓
Checked all Hoses entered ✓
Door Locked ✓
Chicks made on Crank ✓
Hooked " " Camera ✓
Source Outside of Room ✓
Utilization Log filled out ✓
Maint. Log filled out ✓
Surveyed Source Release ✓
Returned Source to Storage ✓
Surveyed Camera ✓
" Storage Container ✓

Note: Any failure to perform these operations correctly will necessitate re-training in the applicable areas and a delay of 1 month before appointment to radiographer.

100%
H. L. Ostroff
RSO 8-12-83

FORM 205

P. O. BOX 1241 • 4029 NEW CASTLE AVENUE
WILMINGTON, DELAWARE 19899 • (302) 655-7338

Practice Test

LEHIGH TESTING LABORATORIES, INC.

RADIOGRAPHIC EQUIPMENT - UTILIZATION LOG

DATE 8/12/83 TIME 9:15A LOCATION OF USAGE 4027 New Castle Ave

ISOTOPE TYPE Ir192 S/N 7737 ACTIVITY AT TIME OF USAGE 40 CURIES

MODEL OF DEVICE IN WHICH ISOTOPE IS USED T/O 660

DEVICE S/N 3325 SURVEY READING AT SURFACE OF DEVICE (INITIAL) 20 mR

VEHICLE (IF USED) — SURVEY READING AT SURFACE OF VEHICLE — mR

NUMBER OF EXPOSURES MADE 1 TOTAL TIME OF EXPOSURES 3 min

SURVEY METER READING AT BOUNDARY OF RESTRICTED AREA 1 mR

RADIOGRAPHER IN CHARGE L Meinear DOSIMETER READING (FINAL) 0 mR

ASSISTANT RADIOGRAPHER — DOSIMETER READING (FINAL) — mR

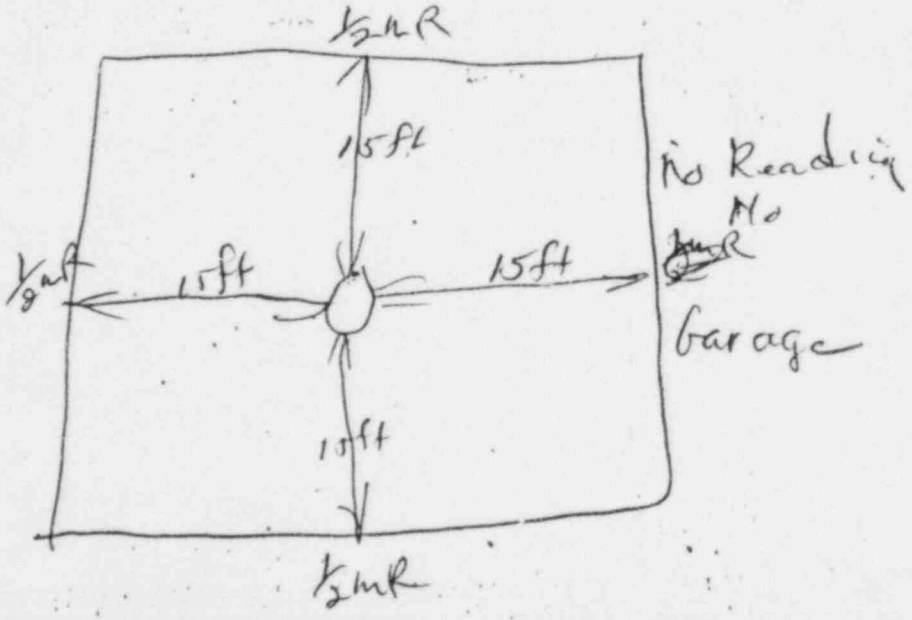
SURVEY METER READING AT SURFACE OF EXPOSURE DEVICE (FINAL) 20 mR

STORAGE LOCATION LTL DATE AND TIME STORED 8/12/83 1015A

SURVEY METER READING AT SURFACE OF STROAGE ENCLOSURE ~~1~~ -1 mR

ADDITIONAL COMMENTS Post-
Large cullminator used No one in Garage
8" cinder block placed around source

SKETCH SHOWING BOUNDARIES OF RESTRICTED AREA, RELATIVE TO LOCATION OF ISOTOPE DURING EXPOSURES (ALSO NOTE THE ORIENTATION OF RADIATION, IF SOURCE IS COLLIMATED):



FORM 204

LEHIGH TESTING LABORATORIES, INC.

RADIOGRAPHIC DEVICE - DAILY MAINTENANCE AND INSPECTION REPORT

Exposure Device S/N 3325 Crank S/N 1777 Isotope S/N 7737

Isotope Type IR192

Date 8/12/83 Inspected by Mercer

INSPECTION	COMMENTS
1. Changes in operating characteristics of the device	None
2. Proper operation of crank mechanism	OK
3. Proper operation of source position indicator	OK
4. Proper operation of locking mechanism	OK
5. Source and drive cable and guide tube damage	none
6. Connector wear or damage of all mating components	none
7. Rust, dirt or sludge build-up in the source guide tubes	none
8. Shifting of shield and or source in the exposure device housing	none
9. Cable drive gearbox damage or wear	none
10. Proper labelling	OK
11. Miscellaneous (loose screws, safety caps, etc.)	none

Any damage to the radiographic device which may impair its safe operation shall be reported immediately to the Radiation Safety Officer.

Form 201

9/50 = 82% RSO - 8-11-83 LeRoy D Meneau 8/11/83

RADIOGRAPHER'S EXAMINATION *

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

Ionization.

41/50 = 82% LW

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

True ( ) False (✓)

3. The primary hazard in radiography comes from

a) Internal radiation.
(b) Gamma rays and alpha particles.
c) Beta particles.
d) External radiation.

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

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

5. The abbreviation "r" stands for Rem.

6. The abbreviation "mr" stands for milli rems.

7. The term "rad" stands for Radiation Absorbed Dose.

8. The term "rem" stands for Roentgen equivalent Man

9. The roentgen is a measure of

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

10. The whole-body radiation dose must normally be limited to a dose of

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

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

True ( ) False (✓)

12. The most serious radiation exposure is to the

(a) Whole body.
b) Feet and ankles.
c) Skin.
d) Hands and forearms.

* The questions presented here indicate the general level of difficulty and the variety of topics which may be anticipated in actural exams, but they are not necessarily the same questions that will be used.

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

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

14. It is possible to receive a dose considerabley above the regulatory limits without showing detectable radiation effects.

True (✓) False ( )

15. In relation to radiation effects, MLD stands for Median Lethal Dose.

16. The MLD for humans is the radiation dose

a) That causes the first death.
b) That causes slight, temporary blood changes.
c) That is considered lethal to all persons exposed.
d) That causes 50% of those exposed to die.

17. The MLD for humans is 500 rems (fill in from below) whole body exposure within a 24 hour period.

a) 250
b) 500
c) 750
d) 1,000

18. Portable instruments used to monitor radiation areas are called

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

19. Devices attached to the clothing of people working in radiation areas for measurement of radiation are called

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

20. Radiation measuring devices operate on the principle of ionization.

True (✓) False ( )

21. Survey meters provide

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

22. Pocket dosimeters depend upon a _____ (fill in from below) for their indication.

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

23. The film badge operates on the principle that _____ (fill in from below) exposes film.

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

24. Which statement about the film badge is true?

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

25. The pocket dosimeter has the advantage of

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

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

True ( ) False (✓)

27. When ionizing radiation enters the ion chamber of an ionization chamber survey meter, positive ions flow to the negative electrode(s) and negative ions flow to the positive electrode(s).

True ( ) False (✓)

28. The Geiger-Mueller counter uses the G-M tube to

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

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

30. In most radiographic operations, the ionization chamber survey meter is more desirable than the G-M counter.

True ( ) False (✓)

31. The standard dose rate of a radioisotope is expressed in

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

32. The intensity at 1 foot from a 10 curie source of Ir-192 is 59 r/hr. The standard dose rate for one curie at 1 foot for Ir-192 is

a) 590 r/hr/curie.
(b) 5.9 r/hr/curie.
c) .59 r/hr/curie.
d) 59 r/hr/curie.

14.5 / 7 / 101.5

33. The standard dose rate at 1 foot for Co-60 is 14.5 r/hr/curie. What is the intensity at 1 foot for a 7 curie source of Co-60?

a) 14.5 r/hr
b) 75 r/hr
c) 145 r/hr
(d) 101.5 r/hr

34. The three basic means of providing personnel protection from radiation are Time, distance, and shielding.

35. A person receives 3 mr/hr at a certain distance from a radiation source. What would be his exposure if he remained at the same distance for 3 hours? 9

36. The inverse square law as applied to radiation protection states that

a) Radiation intensity varies inversely as the square of the time spent near the source.
b) Radiation intensity varies proportionally with distance from the source.
c) Radiation intensity varies inversely as the square of the distance from the source.

37. The formula for the inverse square law is

a) $\frac{I_2}{I_1} = \frac{D_1^2}{D_2^2}$

b) $\frac{I_1^2}{I_2^2} = \frac{D_2^2}{D_1^2}$

c) $\frac{I_1}{I} = \frac{D_2}{D_1}$

d) $\frac{I_1}{I_2} = \frac{D_2^2}{D_1^2}$

$I_1 \times D_1^2 =$

$I_1 \times D_1^2 = I_1 \times D_2^2$

$300 \times 2^2 = I_1 \times 8^2$

$1500/1200 = \times 64$

$150 \times 10^2 = I \times t^2 \times$

100

15000

$40 \times 6^2 =$

38. At 2 feet from a radiation source, radiation intensity is 300 r/hr. What is the intensity at 8 feet from the source? 19.

39. At 10 feet from an isotope, radiation intensity is 150 mr/hr. The intensity at 1 foot would be 600.

40. Radiation intensity at 6 feet from an isotope is 40 r/hr. At what distance would the intensity be reduced to 10 r/hr? 24.

The following questions refer directly to Lehigh Testing Laboratories' operating and emergency procedures.

41. How often do survey meters require calibration? 3 mon.

42. Who is responsible for filling out exposure logs? Radiographer.

43. A source is jammed and cannot be returned to a safe stored position. It is the radiographer's responsibility to do what? Call the RSO. after Securing the area

RADIOGRAPHER'S EXAMINATION (Cont.)

44. On a Technical Operations 660 or 680 exposure device there are three positions in which the locking mechanism can be placed. What are those positions?

Lock operate connect

45. What range does your dosimeter register?

0-200 mR

46. How often are your film badges processed and by whom?

Every week landauer

47. How often are sources leak tested?

6 months

48. Who in accordance to Lehigh Testing Laboratories' license is responsible for leak testing? Radiographer

49. Who provides assay services in regard to leak tests?

T/O

50. What is the maximum survey meter reading allowed in the car or driver's seat of your vehicle while transporting a source?

2 mR.

1/25 96% 10/11/83 RSO - 8-11-83

Charles R. Gilkey
Charles R. Gilkey
8/11/83

ASSISTANT RADIOGRAPHER'S EXAMINATION *

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

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

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

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

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

X 4. Radiation hazard to humans exists from

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

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

   True ( ) False (✓)

6. The most penetrating radiation from radioisotopes is

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

7. Radioactive (or physical) half-life is

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

* The questions presented here indicate the general level of difficulty and the variety of topics which may be anticipated in actual exams, but they are not necessarily the same questions that will be used.

8. Biological half-life is

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

9. Effective half-life is

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

10. The roentgen is a measure of

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

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

True (✓) False ( )

12. The whole-body radiation dose must normally be limited to a dose of

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

13. The most serious radiation exposure is to the

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

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

True (✓) False ( )

15. A person must be 18 years old to be allowed to work in a radiation area.

16. There are five variables which influence the effect that radiation doses have on individuals. List three of these variables.

a) Health
b) Age
c) Previous Radiation Exposure

17. The formula for finding permissible accumulated dose is

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

18. Some body cells are more radiosensitive than others.

True (✓) False ( )

19. The earliest indications of radiation damage may be detected in the

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

20. The MLD for humans is the radiation dose

a) That causes the first death.
b) That causes slight, temporary blood changes.
c) That is considered lethal to all persons exposed.
d) That causes 50% of those exposed to die.

21. Portable instruments used to monitor radiation areas are called

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

22. Devices attached to the clothing of people working in radiation areas for measurement of radiation are called

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

23. The normal operating range of a pocket dosimeter is

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

24. The film badge operates on the principle that Ionizing radiation (fill in from below) exposes film.

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

25. Radiation intensity at 6 feet from an isotope is 40 r/hr. At what distance would the intensity be reduced to 10 r/hr? 12 ft.

$I_1 D_1^2 = I_2 D_2^2$

$40 r/hr (6 ft^2) = 10 r/hr (x^2)$

$\frac{1440}{10} = x^2$

$144 = x^2$

$\sqrt{144} = x$

$12 = x$

40
36
240
120
1440

ATTACHMENT C

LEHIGH TESTING LABORATORIES, INC.

MANAGEMENT AUDIT OF RADIOGRAPHIC OPERATIONS

Date & time_____ Location:_____

RT personnel present during audit:_____

Type of audit: Announced:_____ Unannounced:_____

Operations observed during audit:_____

_____

Audit Checklist:	SAT	UNSAT	N/A
a. Proper personnel monitoring devices	---	---	---
b. Worksite surveyed, posted, restricted and monitored as required	---	---	---
c. Survey made after each exposure & before storage	---	---	---
d. Survey made of transporting vehicle	---	---	---
e. Exposure device handling techniques	---	---	---
f. Transportation conducted/documented properly	---	---	---
g. Daily inspection of equipment performed/recorded	---	---	---
h. Dosimeters checked periodically during shift	---	---	---
i. Proper source security and storage	---	---	---
j. Utilization log completed properly for this date	---	---	---
k. Audit of daily records previously certified by RSO	---	---	---
l. Audit of personnel records for all RT workers	---	---	---
m. Other_____	---	---	---

Description of unsatisfactory findings:_____

_____

_____

_____

_____

_____

Corrective actions:_____

_____

_____

_____

_____

Audit performed by:_____

Vice-President Date

Submitted to D. Krashes _____ Date _____

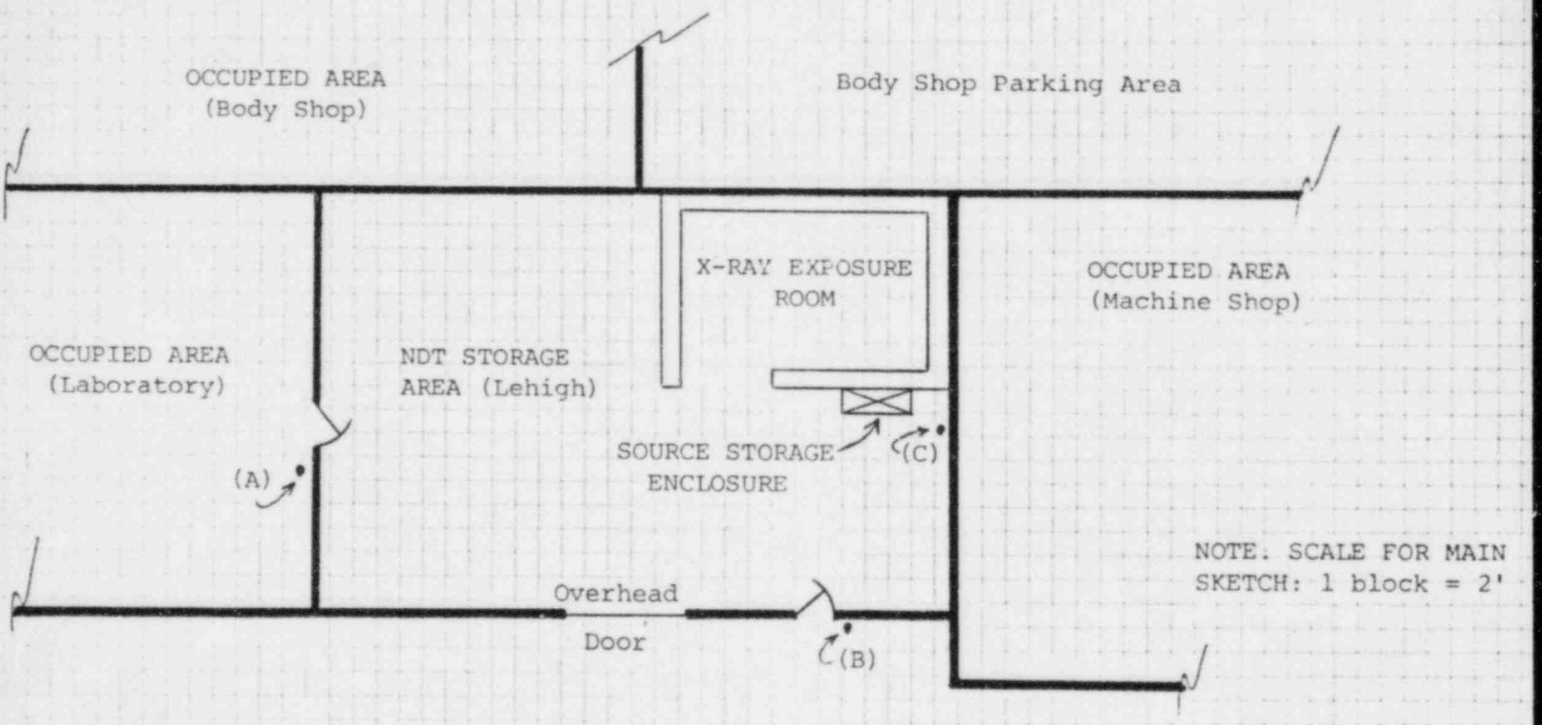
Form 207 (revised 8-30-83)

ATTACHMENT D

4. DESCRIPTION OF PERMANENT RADIOGRAPHIC FACILITIES:

There is no permanent facility at Lehigh for performing radiography with sealed sources. However, a permanent facility exists for the storage of exposure devices, shipping containers and dosimeter calibrators, located within the building at 4027 New Castle Ave., next to Lehigh's main building. This permanent storage facility consists of a locked cabinet-type enclosure, fabricated of ¼" thick steel plate with movable internal lead sheet shielding. One key to the lock is kept in the Business Office safe, and the others are assigned to Radiographers on duty. The enclosure is located adjacent to an exposure room for X-ray machines. The enclosure (see sketch at lower right) has a 12" air space at the top and along both sides of the two interior shelves, and a 24" air space below the shelves. The enclosure backs up to a 16" thick solid concrete wall.

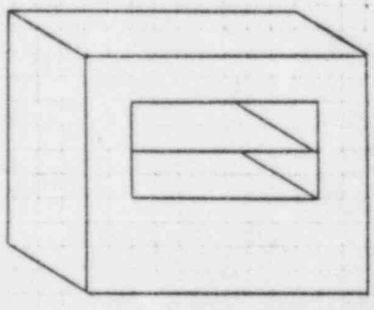
The overhead garage door to this area is locked during all operations involving radiographic sources. The two entry doors, (A) and (B) below, are equipped with radiation warning signs, visible alarms and audible alarms which activate whenever radiation exceeds 2 mR at the Gammalarm unit, located at (C).

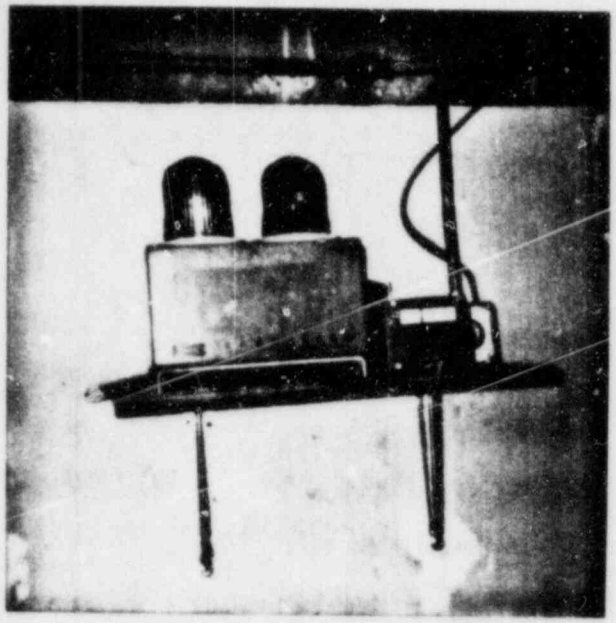


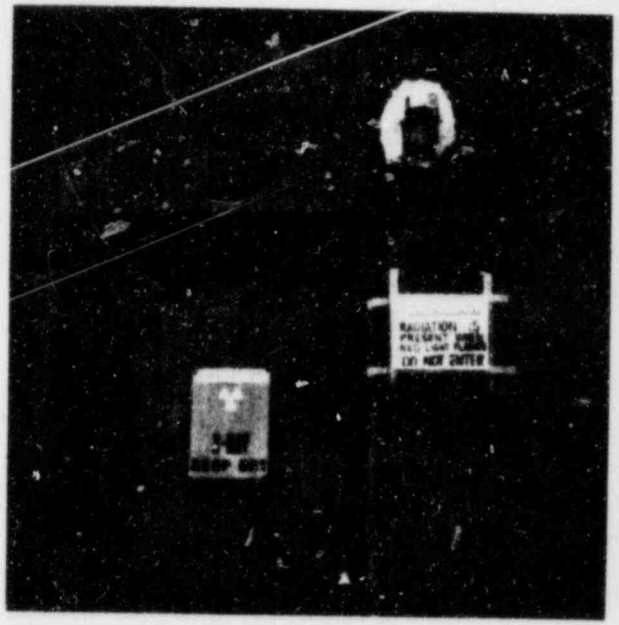
Outside Dimensions: 6'W x 5'H x 2'D
Inside Dimensions: 4'W x 2'H x 2'D

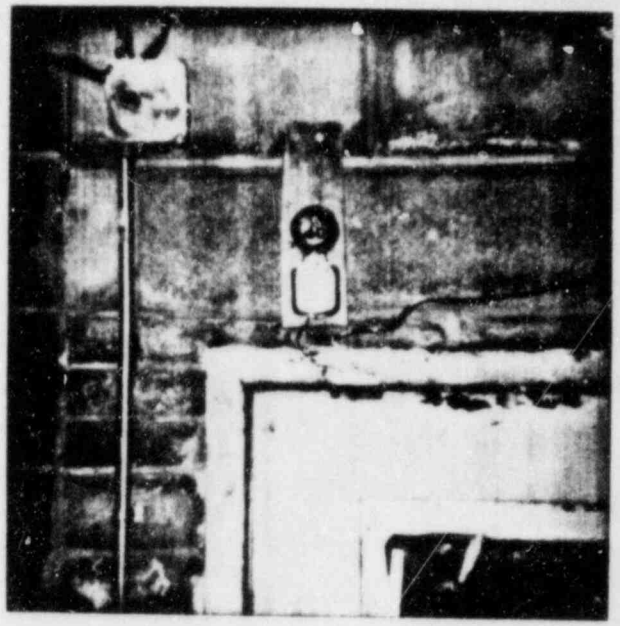
(shown without hinged front doors)

SKETCH OF SOURCE STORAGE ENCLOSURE
Scale: 1 block=6"







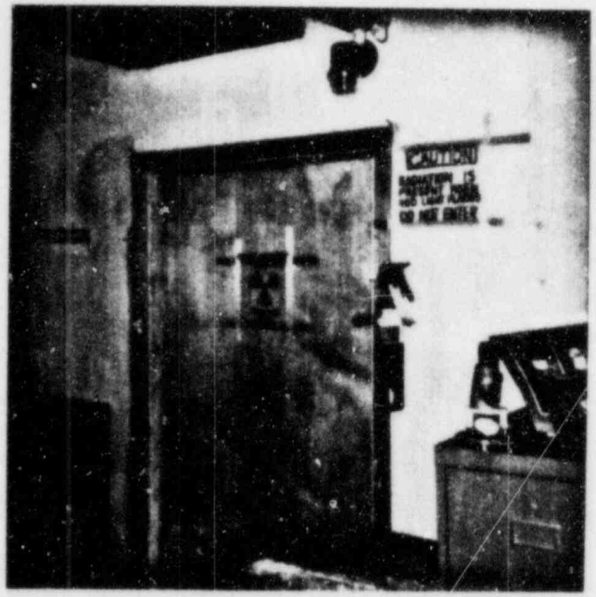


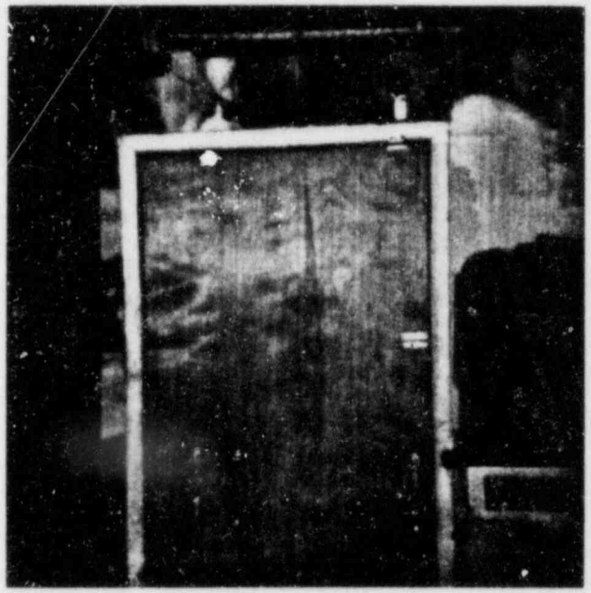
SUPPLEMENTAL DOCUMENTATION OF VISIBLE AND AUDIBLE ALARM SYSTEMS INSTALLED AT 4027 NEW CASTLE AVE. FACILITY

LEFT - "Gammalarm" monitor located on wall nearest storage enclosure.

CENTER - Outside of door leading from parking area to storage/exposure room. Note visible alarm and warning sig .

RIGHT - Inside of same door. Note audible alarm which is activated when radiation at monitor is >0.5mR and door is opened.





LEFT - Laboratory view of door leading from Laboratory Area to Lehigh's Storage/Exposure Room. Note visible alarm and warning signs.

RIGHT - Other side of same door, showing audible alarm along top of door.

ATTACHMENT E

Lehigh Testing Laboratories, Inc.
4029 NEW CASTLE AVENUE • P.O. BOX 1241 • WILMINGTON, DELAWARE 19899 • 302-655-7358

September 2, 1983

UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, DC 20555

ATTENTION: Mr. Nathan Bassin
Material Certification and Procedures Branch

REFERENCE: License 07-01173-03
Amendment Request

Gentlemen:

Enclosed is a revision to our Administrative Manual Page 3. This revision is a change in storage location for "exposure devices, shipping containers and Dosimeter Calibrators", from our main location to an adjacent buiding, at 4027 New Castle Avenue, New Castle, DE 19720.

If there are any questions, please do not hesitate to call the writer.

Very truly yours,

LEHIGH TESTING LABORATORIES, INC.

Leonard A. Weston
Vice President & General Manager

Encl.

LAW/bt

ATTACHMENT F

BILLING WORKSHEET - NONDESTRUCTIVE TESTING

CLIENT_____ LEHIGH LAB NO._____

_____ DATE RECEIVED _____

_____ DATE COMPLETED_____

ATTN_____ P.O. #_____

JOB IDENTIFICATION_____

TYPE OF EXAM: RT____ MT____ PT____ UT____ OTHER_____

WORK PERFORMED AT: LAB____ CLIENT'S PLANT____ FIELD SITE_____

JOB CHARGES BASED ON: QUOTE DATED_____ CONTRACT DATED_____ PRICE LIST_____

==========

LABOR CHARGES: NAMES DATES HOURS

A. Job Prep.- Loading Vehicles, Cassettes, etc.

B. Travel Time - To and From Worksites

C. Set-Up Time at Worksite

D. Actual Inspection Time

E. Film Processing Time

F. Evaluating & Recording Results

G. Standby Time

H. Other_____

SUMMARY OF LABOR CHARGES:

Two men, regular rates: _____hrs @ $_____/hr = $_____

Two men, overtime rates: _____hrs @ $_____/hr = $_____

One man, regular rates: _____hrs @ $_____/hr = $_____

One man, overtime rates: _____hrs @ $_____/hr = $_____

TOTAL - ALL LABOR CHARGES: $_____

==========

MATERIALS, TRAVEL EXPENSES, ETC:

A. Radiographic Film Size:_____ Quantity:_____ @ $_____each = $_____

Size:_____ Quantity:_____ @ $_____each = $_____

B. Travel Expenses

No. Roundtrips:_____ Total Mileage: _____miles @ _____ per mile = $_____

Tolls: $_____ Meals: $_____ Lodging: $_____ Total: $_____

C. Other Miscellaneous Expenses _____ $_____

==========

TOTAL JOB CHARGES: $_____

==========

NOTE FOR ALL RT JOBS: Radiation Safety Officer hereby certifies that Utilization Log, Transportation Records, and Daily Maintenance Records have been completed for this job:

Signature of RSO:_____ Date:_____