Quality Systems NDE, Ltd. 2727 Philmont Avenue Huntingdon Valley, PA 19006

Radiation Safety; Operating and Emergency Procedures

> Vol. I April 12, 1988

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8903160292 880429 REG1 LIC30 37-28085-01 PNU

"OFFICIAL RECORD CUTY" ML10 107706

RADIOACTIVE MATERIAL

Type of licensed material to be used:

Iridium 192 Sealed Sources (Amersham Tech/Ops - Model A-424-9) for use in Tech/Ops - Model 660 exposure devices for industrial radiography, and Tech/Ops - Model 650 Source Changer for storage and replacement of sources - not to exceed 120 Curies per Source.

Iridium 192 Sealed Sources (Gulf Nuclear - Model RT 15) for use in Tech/Ops - Model 660 exposure devices for industrial radiography and Gulf Nuclear - Model U 110 B Source Changers for storage and replacement of sources - not to exceed 120 Curies per source.

The above licensed material is used for industrial radiography and /or source exchange.

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ORG - 1

ORGANIZATIONAL CHART



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10 CFR PART 71 QA PROGRAM RADIOACTIVE SHIPPING PACKAGES FOR INDUSTRIAL RADIOGRAPHY LICENSES

I. ORGANIZATION

A. The final responsibility for the Quality Assurance (QA) Program for Part 71 Requirements rests with Quality Systems NDE, Ltd. Design and fabrication shall not be conducted under this QA Program. The QA Program is implemented using the following organization, as per the attached organization chart:

The Radiation Protection Officer (RPO), is responsible for overall administration of the program, training and certification, document control, and auditing.

<u>The Radiographers</u> are responsible for handling, storing, shipping, inspection, test and operating status and record keeping.

- II. QUALITY ASSURANCE PROGRAM
 - A. The management of Quality Systems NDE, Ltd., establishes and implements this QA Program. Training, prior to engagement, for all QA functions is required according to written procedures. QA Program revisions will be made according to written procedures with

management approval. The QA Program ensures that all defined QA procedures, engineering procedures, and specific provisions of the package design approval are satisfied. The QA Program emphasizes control of the characteristics of the package which are critical to safety.

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B. The Radiation Safety Officer shall assure that all radioactive material shipping packages are designed and manufactured under a QA Program approved by the Nuclear Regulatory Commission for all packages designed or fabricated after January 1, 1979. This requirement is satisfied by receiving a certification to this effect from the manufacturer.

III. DOCUMENT CONTROL

- A. All documents related to a specific shipping package is controlled through the use of written procedures. All document changes are performed according to written procedures approved by management.
- B. The Radiation Safety Officer shall insure that all QA functions are conducted in accordance with the latest applicable changes to these documents.

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IV. HANDLING, STORAGE, AND SHIPPING

- A. Written safety procedures concerning the handling, storage, and shipping of packages for certain special form radioactive material, are followed. Shipments are not made unless all tests, certifications, acceptances, and final inspections have been completed. Work instructions are provided for handling, storage, and shipping operations.
- B. Radiography personnel shall perform the critical handling, storage and shipping operations.
- V. INSPECTIONS, TEST AND OPERATING STATUS
 - A. Inspection, test and operating status of packages for certain special form radioactive material are indicated and controlled by written procedures. Its status is indicated by tag, label, marking, or log entry. Status of non-conforming parts or packages are positively maintained in accordance with (IAW) written procedures.
 - B. Radiography personnel shall perform the regulatory required inspections and tests IAW written procedures. The Radiation Protection Officer shall ensure that these functions are performed.

VI. QUALITY ASSURANCE RECORDS

 Records of package approvals (including references and drawings), procurement, inspections, tests, operating logs, audit results, personnel training and qualifications, and records of shipments shall be maintained. Descriptions of equipment and written procedures shall also be maintained.

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B. These records shall be maintained IAW written procedures. The records shall be identified and retrievable. A list of these records, with their storage locations, are maintained by the Radiation Protection Officer.

VII. AUDITS

A. Established schedules of audits of the QA Program shall be performed using written check lists. Results of audits are maintained and reported to management. Audit reports are evaluated and deficient areas corrected. The audits shall be dependent on the safety significance of the activity being audited, but each activity shall be audited at least once per year. Audit reports shall be maintained as part of the quality Assurance records. Members of the audit team shall have no responsibility in the activity being audited.

Michael Lange Radiation Protection Officer

Over seven (7) years experience directly related to Gamma Radiography, Magnetic Particle, and Liquid Penetrant Inspection.

Experience:

Quality Systems NDE, Ltd., Huntingdon Valley, 1986 to Present Radiation Protection Officer; Manager, PA. NDE Operations. Duties include planning, preparation and performance of various NDE by the functions marketed company. responsibilities include: Additional indoctrination and training of new personnel, calibration control, and procurement of NDE test equipment and consumables. Certified Level III to the requirements of SNT-TC-1A for radiography, liquid penetrant, and magnetic particle inspection. Utilizing Iridium 192 to 110 cu. with Tech/Ops devices.

1982 to 1984 United Examinations, Inc., Philadelphia, PA. Level II Radiographer. Duties included: indoctrination of new radiographers. RT

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Supervisor and Assistant Radiation Safety Officer. Utilization of Iridium 192 to 110 cu. with Automation Industries exposure devices models 520 and 100A exposure devices. Projects included Philadelphia Gas Works Station, B.P. Oil Refinery, Mobil Oil Refinery, Sun Oil Refinery, and Arco Oil Refinery.

1981 to 1982
E.L. Conwell Company, Philadelphia, PA. Performed 2000 hours of industrial radiography. Initially hired as a Level I RT Technician, completed training and became Level II RT Technician in 1982. Utilizing Automation Industries model 520 and 100A and Tech/Ops 660 exposure devices to 110 cu. of Iridium 192. Primary projects included Philadelphia Gas Works Station, Mantua Oil Refinery, B.P. Oil Refinery, Sun Oil Refinery, Mobil Oil Refinery, and Arco Oil Refinery.

Michael Lange Radiation Protection Officer

Related Training:

- 1979 to 1981 Sparton School of Aeronautics Graduated with Associates Degree in Science. Courses included Radiation Safety, RT, MT, PT.
- 1981 60 hour course concerning Gamma Radiography. Included requirements of Title 10 to the Code of Federal Regulations, Parts 19, 20, 21, and 34. Radiography and Radiation Safety taught by George Raven.
 - 1982 40 hour course concerning Gamma Radiography, preparation for Level II Certification Radiography, Radiation Safety and Emergency Operating Procedures, taught by George Raven.
- 1983 21.5 hour course pertaining to Title 10 to the Code of Federal Regulations Parts 19, 20, 21, and 34. Emergency Operating Procedures and Radiation Safety taught by Radiation Safety Officer George Raven.

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United Examination: 21.5 hour course pertaining to Title 10 to the Code of Federal Regulations Parts 19, 20, 21, and 34. Emergency Operating Procedures and Radiation Safety taught by Radiation Safety Officer George Raven.

1986

1984

Quality Systems, Ltd.: 21.5 hour course; Indoctrination fundamentals, history of Industrial Radiography, Radiation detection instruments, Radiation Sources, Radiation Protection, Requirements of rules and regulations, Process, test results and Interpretation and operation of Tech/Ops 660 Exposure devices taught by Radiation Safety Officer George Raven. Personnel Qualification and Certification Procedure QC - 1 1.0 SCOPE

- This procedure has been prepared to establish criteria for qualification and certification of radiography personnel.
- 1.2 A supplementary document forming a part of this procedure establishes the principles for radiography personnel training.

2.0 DEFINITIONS

- 2.1 Terms included in this document are defined at follows:
 - Qualification compliance with the requirements of certification.
 - b. Certification written testimony of qualifications.
 - Certifying Agency the employer of the personnel being certified.

3.0 LEVELS OF QUALIFICATION

- 3.1 There shall be two levels of qualification.
 - a. Radiographer
 - b. Radiographer's Assistant

4.0 REQUIREMENTS

4.1 Education and experience

| 4.1.1 | Radiography | Fersonnel | consi | dered | for |
|-------|----------------|-----------|-------|--------|------|
| | qualifications | shall | have | suffic | ient |

- Personnel Qualification and Certification Procedure QC 2 education and experience to insure understanding of the principles and procedures of these areas in which they are being considered for qualification.
 - 4.1.2 To be considered for qualification a candidate shall satisfy all of the requirements:
 - a. Classroom training courses
 - b. Sufficient job experience
 - c. On the job training

5.0 EXAMINATION

- 5.1 To be considered for examination and certification, radiography personnel shall meet the requirements in paragraph 4.0.
 - 5.1.1 Examination to verify physical and technical qualification shall consist of four segments:

a. PHYSICAL

 An eye examination to assure natural or corrected near distance acuity such that the applicant is capable of reading J-1 letters on standard Jaeger test type. The examination shall be on an annual basis unless otherwise specified by the bureau or agency concurred. Personnel Qualification and Certification Procedure QC - 3

- Distant vision shall equal 20/30 in at least one eye; either uncorrected or corrected.
- Personnel shall be capable of distinguishing and differentiating between colors used in the process involved.

b. <u>GENERAL</u>

- The general examination shall cover the basic test principles of radiography.
- Written examinations shall be supplied by the Radiation Protection Officer.
- Oral examination may be used to clarify any test questions that may have been misinterpreted on the written test.

c. <u>SPECIFIC</u>

 The specific examination shall cover the equipment, operating procedures, and test techniques that the applicant may encounter.

d. PRACTICAL

 The person considered for certification shall demonstrate to the satisfaction of Personnel Qualification and Certification Procedure QC - 4 the Radiation Protection Officer that he is familiar with and can operate the necessary test equipment and analyze the resultant information to the degree required.

5.0 GRADING OF EXAMINATIONS

- 6.1.0 The Radiation Protection Officer shall be responsible for conducting and grading of examination of all radiography personnel.
- 6.1.1 A grade of 85% shall be considered as satisfactory unless otherwise specified.
- 6.1.2 Failure of any of the examinations listed in paragraph 5.0 (examinations) shall require the examinee to undergo additional training.

6.2 RE-EXAMINATION

- Radiography personnel not considered to be qualified shall be notified upon completion of the examination.
- b. Re-exa nation shall be scheduled after addition. I training at the discretion of the Radiation Protection Officer.

Personnel Qualification and Certification Procedure QC - 5 7.0 CERTIFICATION

- 7.1 Certification of radiography personnel shall be performed by the Radiation Protection Officer.
- 7.2 Certification of radiography personnel shall be based on demonstration of satisfactory qualification as determined by this procedure outlined in paragraph 5.0.
- 7.3 Records of qualification identifying qualified radiography personnel and complete examination records shall be maintained by the Radiation Protection Officer.
- 7.4 Certification of the Radiation Protection Officer shall be in accordance with the NRC approval and his proven ability and past practical experience to maintain this type of program. He must also be a certified radiographer.

8.0 RE-CERTIFICATION

- 8.1 All radiography personnel shall be re-examined and/or re-certified annually.
- 8.2 Radiography personnel may be re-examined and have their certifications extended or revoked anytime at the discretion of the Radiation Protection Officer.

9.0 PERIODIC (REFRESHER) TRAINING

9.1 All radiographic personnel shall complete a two hour refresher course at least every 12 months.

Personnel Qualification and Certification Procedure QC - 6 9.2 The course shall consist of a review of operating and emergency procedures and the latest NRC requirements.

10.0 TERMINATION

- 10.1 All certifications shall be automatically terminated when a change of employer occurs.
- 10.2 Failure to satisfactorily complete the re-qualification requirements.
- 10.3 Sub-standard work and/or failure to follow safe operating conditions.

11.0 EXAMINATION PROCEDURE

11.1 The examination shall be changed at periodic intervals not to exceed 2 years. Personnel Training Procedures QC Sup A - 1 SCOPE- This supplement contains the minimum requirements for the training of Radiographers with no prior training.

- I. Classroom training shall be conducted by the Radiation Protection Officer, or by an accredited organized training course (ie. Amersham Tech/Ops). Classroom training shall include, but shall not be limited to the following subjects for the minimum specified time.
 - A. Fundamentals of Radiation Safety 6 hrs. minimum
 - 1. Characteristics of Gamma radiation.
 - Units of Radiation, dose and quantity of radioactivity.
 - 3. Hazards of excessive exposure. ALARA
 - 4. Levels of radiation from licensed material
 - Methods of controlling radiation dose (Time, Distance, Shielding)
 - B. Radiation Detection Instrumentation to be used 6 hrs. minimum
 - 1. Use of Radiation Survey Instruments
 - 2. Oberatron Limitations Calibrations
 - 3. Survey Techniques.
 - Use of Personnel monitoring equipment (film badges, thermoluminescent dosimeters and pocket dosimeters)

Personnel Training Procedures

- C. Radiographic Equipment to be used 8 hrs. minimum
 - 1. Remote handling equipment
 - 2. Radiographic exposure devices
 - 3. Storage containers.
- D. Inspection and maintenance performed by the radiographers 2 hrs. minimum
- E. Review of Case Histories of Radiography Accidents -2 hrs. minimum
- F. Operating and Emergency Procedures 16 hrs. minimum
 - 1. Requirements of Rules and Regulations.
 - 2. Title 10 Parts; 19,20,21,30,34.
 - 3. DOT Rules and Regulations.
- II. In addition to the classroom training:
 - A. The candidate must demonstrate competence to use the licensee's radiographic exposure devices, sealed sources, related hand tools, and survey instruments. The candidate must demonstrate understanding of the instructions in the forementioned training.
 - B. The candidate must successfully complete a field examination, or simulated field examination, recorded

Personnel Training Procedures

QC Sup A - 3

on Forms #108 and #105 by the RPO, and pass the required written and oral examinations of subjects covered.

C. For an individual to be designated as a radiographer, the candidate shall have completed a minimum of 3 months, or 520 hrs of full time equivalent, performing radiography and associated operations as a radiographer's assistant.

SCOPE - This supplement contains the minimum requirements for the training of Assistant Radiographers.

- I. Minimum Requirements for the Training of Assistant Radiographers.
 - A. Instruction on the operating and Emergency Procedures 4-6 hrs. minimum
 - B. Instruction on the radiographic exposure device; sealed sources, Radiation Survey Instrument, Surveying Techniques, and Radiation Safety - 4-6 hrs.minimum
 - C. Before an Individual can be qualified as a radiographer's Assistant, the candidate must

Personnel Training Procedures QC Sup A - 4 demonstrate complete competence to use, under the personal supervision of the radiographer, the radiographic exposure device, sealed sources, related handling tools, and radiation survey instruments, that the assistant may use.

D. Candidates of Radiographer's Assistants shall be required to pass the written and oral examinations.

SCOPE - This supplement contains the minimum requirements for new employees with previous radiographic experience.

- I. Minimum Requirements for new employees with previous radiographic experience.
 - A. New radiographic employees shall have an 8 hr. indoctrination period on the company's Operating and Emergency Procedures, operation of equipment, care and maintenance of equipment, and safety procedures.
 - B. The candidate shall be required to pass the written and oral examinations of a Radiographer.
 - C. A comprehensive or simulated field operation consisting

Personnel Training Procedures

QC Sup A - 5 of all aspects of radiographic operations and safety procedures shall be performed before a new employee is

GENERAL DESCRIPTION - FIELD PRACTICAL - The practical examination

evaluates the individual's competence to act as a radiographer.

- The prospective radiographer shall be required to perform a I. field or simulated field operation consisting of the following points:
 - A. Check of radiographic equipment

qualified as a Radiographer.

- Check of personnel monitoring equipment. Β.
- Removal of the exposure device from storage С.
- The transport of exposure device. D.
- E. The establishment of prescribed High Radiation Area and Radiation Areas.
- The proper procedure for setting up the exposure device F.

Personnel Training Procedures

QC Sup A - 6

- G. The operation of performing an exposure
- H. Survey the perimeter and surveillance of the areas
- I. The proper procedure for the completion of an exposure
- J. Check of proper surveying before, during, and after the exposure
- K. An oral interrogation of emergency procedures
- L. The return transport and storage of equipment and exposure device
- M. Check of all required written records.

| QSL, Writ Radi | NDE ten Exam <u>ographer</u> |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME | DATE |
| SCOR | EEXAMINER |
| 1. | Cobalt 60, used in Non Destructive Testing, emits |
| * | A. Alpha Particles B. Neutrons C. Gamma Rays D. X-Rays |
| ••• | The time required for one-half of the atoms in a particular sample of radioactive material to disintegrate is called |
| * | A. the inverse square law B. the curie C. a half-life D. the exposure time |
| з. | The most widely used unit of measurement for measuring the rate of the output of a Gamma Ray source. |
| * | A. Curie B. Roentgen C. Half life D. Mev |
| 4. | Exposure to X-rays or Gamma rays |
| * | A. may have a cumulative effect which must be considered when monitoring for maximum permissable dose. B. will be beneficial since it can build up an immunity to radiation poisoning. C. will have no effect on human beings. D. will have only a short term effect on human tissues. |
| 5. | Which dose would be dangerous, if not fatal, if applied to the entire body within a short period of time? |
| | A. 1.5 (a) 15 R B. 25 to 70 R C. 200 to 800 R D. All the above doses would most likely be fatal. |

6. Cobalt 60 source has a half-life of

| Α. | 1.2 years |
|----|-----------|
| Β. | 6 months |
| С. | 75 days |
| D. | 5.3 years |

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- Any of the body tissues may be injured by excessive exposure to Gamma rays but particularly sensitive are: 7.
 - Α. Blood
 - Β. Lens of the eye
 - C. internal organs
 - D. All of the above
- A general rule used to define the amount of radiation exposure that is excessive is: 8.
 - 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. Any dose over 5 R per week is excessive. Α. Β.
 - Any dose which causes a mid-range reading on a geiger C. counter is excessive.
 - D. Any unnecessary exposure to radiation is excessive.
- If a sheet of 1/4" thick lead is placed in the path of a beam of radiation emitting from Iridium 192, it will reduce 9. the dose rate of a given location by _____
 - Α. one third
 - one quarter one half B.C.

 - D. A little more than one half
- If an exposure time of 60 seconds was necessary using a 4 10. foot source-to-film distance for a particular exposure, what time would be necessary if a 2 foot source-to-film distance is used and all other variables remain the same?
 - 120 seconds A. 30 seconds
 - B.C. 15 seconds
 - D. 240 seconds

| 11. | The radiation quality of a Gamma ray source is |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * | A. determined by the size of the focal spot B. determined by the isotope involved C. can be varied by the operator D. is greater in Iridium 192 than in Cobalt 60 |
| 12. | A curie is the equivalent of |
| * | A. U.001 millicuries B. 1000 millicuries C. 1000 megacuries D. 100 megacuries |
| 13. | The Gamma ray absorption of a specimen depends on |
| | A. The thickness and density of the material B. the atomic number of the material C. both "A" and "B" above D. Neither "A" nor "B" |
| 14. | The roentgen is defined as: |
| * | A. The amount of radiation emitted by one curie of Iridium 192 at a distance of one meter. B. The amount of X- or Gamma radiation of one erg of energy in one gram of dry air at standard temperature and pressure. C. The amount of X- or Gamma radiation that will produce one electrostatic unit of charge in one cubic centimeter of dry air at standard temperature ard pressure. D. The amount of X- or Gamma radiation absorbed by one cubic centimeter of water at zero degrees Cent., and 760mm of mercury. |
| 15. | The rad (radiation absorbed dose) is defined as: |
| | A. The amount of radiation energy absorbed by one cubic centimeter of material. B. The amount of radiation energy absorbed by one gram of material. |

- The amount of radiation energy representing the absorption of 100 ergs of energy per cubic centimeter of material. The amount of radiation energy representing the absorption of 100 ergs of energy per gram of material. С.
- D. *

- 16. The greatest problem which arises in the routine use of a pocket dosimeter is:
 - Α. Its relatively flat response to radiation of different energies.
 - Β.
 - Its inherently inconsistent sensitivity. Electrical leakage which tends to discharge the electrometer and give false high readings. Negative drift caused by changes in atmospheric conditions (temperature, humidity, etc.). С. D.
- A radiation level of 100 mR/hr is noted at the perimeter of 17. your posted high radiation area. This perimeter is 10 feet from the exposed source. Approximately how far away from the source should the radiation area signs be posted for the 2 mR/hr line?

| Α. | 40 feet |
|----|----------|
| Β. | 100 feet |
| С. | 70 feet |
| D. | 125 feet |

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- Which one of the following is not a characteristic to be given major consideration in selecting a radiographic survey 18. instrument?
 - Α. Window thickness-radiation detected.
 - Β. Dose rate range(s)
 - С. Time constant
 - D. Battery supply
- With appropriate controls, the allowable radiation limits in unrestricted areas should not exceed_____. 19.
 - Α. 0.500 rem per calender year Β. 2 millirems in any one hour ċ. 100 millirems in seven consecutive days All of the above D.
- 20. A "leaking" source of radioactive material is considered a potentially hazardous situation. At what removable activity level is a sealed radiography source, by regulation, considered to be leaking?
 - Α. 0.0500 microcuries 0.5000 microcuries 0.005 microcuries 0.0005 microcuries Β. С. D.

Sources of radioactive material used for radiography are required by regulation to be leak tested at intervals not to 21. exceed ____

| Α. | 6 months |
|----|-----------|
| Β. | 3 months |
| С. | 12 months |
| D | 24 months |

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- A tenth value thickness for a specific Gamma source is one inch of lead. The radiation intensity is 500 R/hr at 24 inches from the source. How many inches of lead would be required to reduce the intensity to 5 mR/hr at 24 inches? 22.
 - 2 inches 5 inches Α. Β. С. 10 inches
 - D. 4 inches
- Permissible personnel radiation exposure rates are based upon which of the following? 23.
 - Radiation equivalent man Α.
 - Β. Banking concept Physical attributes
 - С.
 - D. Dose absorption rate
- Radioisotope radiographic exposure devices, measuring less than four inches from the sealed source storage position to any exterior surface, shall have a dose rate at 6 inches from the surface of no greater than _____. 24.

| | A. | 2 mR/hr |
|---|----|-----------|
| * | Β. | 50 mR/hr |
| | С. | 10 mR/hr |
| | D. | 200 mR/hr |

- Survey instruments used to monitor Gamma radiation must be capable of measuring radiation in the range of _____. 25.
 - 0 2000 mR/hr Α.
 - Β. 2 mR/hr - 10,000 mR/hr 0 - 200 mR/hr 2 mR/hr - 1000 mR/hr
 - С. D.

- 26. A radiation area refers to any area accessible to personnel in which radiation exists such that an individual could receive in any one hour a dose exceeding _____.
 - 2 millirems 100 millirems 5 millirems 500 millirems Α.
 - Β.
 - C. D.
- 27. 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 20 minutes. Five months from now, what exposure time would be required for the same radiographic density, under similar exposure conditions?
 - 10 minutes Α.
 - Β. 20 minutes
 - 1 hour and 20 minutes С. D. 6 hours
- If a radiographer has twelve (12) exposures of 15 seconds each, what could be the maximum reading at the 2 mR/hr isodose line. 28.

| Α. | 80 mR/hr |
|----|-----------|
| В. | 40 mR/hr |
| С. | 20 mR/hr |
| D. | 160 mR/hr |

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If a one hour exposure was to be taken using 100 Curies of Iridium 192 at what distance from the source would be the 29. radiation area perimeter?

| Α. | 550 | Ft. | |
|----|-----|-----|--|
| В. | 575 | Ft. | |
| С. | 525 | Ft. | |
| D. | 500 | Ft. | |

- In accordance with QSL's OEP, what should the radiographer 30. do in the case of an un-retractable source?
 - A. Maintain restricted areas and call the RPO.

| 31. | On which form is the "Time of Storage Survey" recorded? |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * | A. Form #104, Source Receipt B. Form #106, Utilization Log C. Form #101, Radiographer's worksheet D. None of the above |
| 32. | 85 Curies of Iridium 192 emits R/hr at one foot. A. 501.5 |
| 33. | What is the title of 10 CFR Part 20? |
| | A. Licenses For Radiography and Radiation Safety B. Reporting of Defects and Noncompliance C. Rules of General Applicability to Domestic Licensing of By-product Material. D. Standards for Protection Against Radiation. |
| 34. | What is the title of 10 CFR Part 34? |
| * | A. "A" from above B. "B" from above C. "C" from above D. "D" from above |
| 35. | The best method(s) for controlling radiation dose? |
| * | A. Time B. Distance C. Shielding D. All of the above |
| 36. | You should not use a survey meter if |
| * | A. it only reads 2 mR/hr - 1000 mR/hr. B. if it has not been calibrated within the past 90 days. C. it does not work. D. Both "B" and "C". |
| 37. | You should always after an exposure? |
| | A. Look at your dosimeter. B. Change the film and make another exposure. C. Survey the perimeter. D. Survey the exposure device and lock it. |

- 38. If the source changer received has a surface reading in excess of 200 mR/hr, what should you do next?
 - Do nothing; 200 mR/hr or higher is common at the A.
 - surface of a source changer. Notify the RPO, who will call the NRC, the last carrier, and Tech/Ops. Β.

С. Check that the shipping papers are in order. Look at the Transportation Index. D.

- 39. At what location on the exposure device is the recorded survey taken from?
 - The handle of the exposure device. Α.
 - Β. At the locking mechanism.
 - At the exit port. None of the above. С.
 - D.
- In review of case histories of radiography accidents, what is the primary cause for over exposure to radiographic personnel? 40.
 - Α. Faulty equipment.
 - Β. Component malfunction.
 - C. Insufficiently trained personnel.
 - D. Improper survey, or no survey taken.
- Two half value layers of concrete would reduce the radiation by a factor of _____. 41.
 - Α. 75% Β. 50% C.D. 100%

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42. The purpose for carrying a pocket dosimeter is _____

Α. Because the NRC says you have to.

- Β. it keeps a monthly record of exposure.
 - С. it is small and convenient.
- it gives a visual response to radiation received. * D.

At what distance from the shipping container is the 43. Transportation Index reading taken?

| Α. | One foot |
|----|-----------|
| Β. | 3 feet |
| С. | 36 inches |
| D | One meter |

A radiographer has six (6) exposures of 30 seconds each. At what distance from the source would the 2 mR/hr Isodose line be? (Utilizing 75 Curie of Iridium 192) 44.

| | Α. | 1,106 feet |
|---|----|------------|
| * | Β. | 110 feet |
| | С. | 106 feet |
| | D. | 100 feet |

- An acute dose of 25 R can be detectable by a blood count. 45.
 - () True () False *
- The allowable exposure per calender guarter is 1,250 46. roentgens.

() True () False *

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47. Lead is frequently employed in shield against radiation from gamma ray sources because of its _____.

Α.

- Β.
- С.
- extremely low cost ability to emit electrons when irradiated ability to diffract alpha particles high absorption for given thickness and weight D.
- 48. After an exposure, the radiographer observes indicating 80 mR/nr. What is the next step taken? a meter
 - Α.
 - Β.
 - Survey the exposure device Survey the source tube for the source Look at your dosimeter and see if it has moved Check the crank handle to see if the source has been C. D. fully retracted.

- 49. With the exposure device secured in the transportation vehicle, what is the maximum permissible radiation level outside the vehicle?
 - Α.
 - 2 mR/hr in any one hour 100 millirems in any seven consecutive days Both "A" and "B" None of the above
 - CBCD.

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- 50. What does ALARA stand for?
 - * A. As Low As is Reasonably Achievable

AR.ST - 1

| Assi NAME | stant Radiographer DATE |
|--------------|------------------------------------------------------------------------------------------------------------------------------|
| SCOR | E EXAMINER |
| 1. | Who is responsible for the control of radiation exposure? a. The radiographer |
| 2. | What is the purpose of the pocket dosimeter? a. Immediate response to radiation received. |
| з. | Define Radiation Area. a. Area in excess of 2 mR/hr. |
| 4. | What is a survey instrument used for in industrial radiography? a. To detect radiation. |
| 5. | If the survey instrument used showed a reading of 8 on the 10 scale, what would this reading be in mR/hr? a. 80 mR/hr. |
| 6. | What is the maximum allowable radiation intensity of the exposure device in the shielded position? a. 200 mR/hr |
| 7. | If you surveyed a condition in excess of the amount in question (6), what would you do? |
| | a. Retreat back and notify the supervising radiographer. |

AR.ST - 2

- 8. What kind of radiation is emitted from Iridium 192?
 a. Gamma
- What are the 3 methods of controlling radiation dose?
 a. Time, Distance, Shielding
- Name three materials commonly used for shielding.
 a. Lead, concrete, steel
- What is the purpose of a collimator?
 a. To reduce the radiation intensity.
- 12. How often is the reading recorded from your dosimeter?a. Once, at the end of the shift.
- How often is your dosimeter zeroed?
 a. Once, at the beginning of the work day.
- 14. Why is it important to set the odometer on OOO before making an exposure?

a. So source position can be known at all times.

- 15. Name two general p. perties of Gamma Rays.
 - a. Cannot be detected by human senses; travel in straight lines.
- 16. How is the set-up of the barrier rope determined?
 - a. The calculated intensity of radiation anticipated before the radiation survey.

AR.ST - 3

17. What happens to a beam of Gamma Ray as it passes through steel or concrete?

a. It is absorbed, depending on the thickness.

18. Why do you survey after an exposure?

a. To determine if the source has been returned to its shielded position.

19. If an exposure was to be taken for one hour, what would be the maximum allowable meter reading at the Radiation Area Perimeter?

a. 2 mR/hr

.

20. When is the last survey to be taken?

a. Prior to the exposure device being placed into storage.

21. On what form is this survey recorded?

a. On the Utilization Form #106.

22. What should you do if you find or suspect a malfunction in the equipment?

a. Immediately notify the radiographer, who is to notify the Assistant RPO, or RPO.

- 23. Why shouldn't a person carry the exposure device long distances?a. To prevent undue exposure.
- 24. Define High Radiation Area.
 - a. An area where radiation exists at levels of 100 mR/hr or more.
AR.ST - 4

- 25. What is the inverse square law used for?
 - a. It is used to compute radiation intensities from one given distance and intensity to that of another distance and intensity.
- 26. What are the conventional radiation colors?
 - a. Magenta or purple on yellow.
- 27. Why should you use a collimator whenever possible?
 - a. To reduce the radiation intensity to the surrounding area and exposure to radiographic personnel.
- 28. What is the maximum allowable radiation reading outside the transportation vehicle?
 - a. 2 mR/hr

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- 29. After an exposure, you have completed the survey, what is the next thing you should do?
 - a. Lock the exposure device.
- 30. When connecting or disconnecting the exposure device, you should have in your presence _____.
 - a. Survey Meter

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Radiation Safety; Operating and Emergency Procedures

> Vol. II April 12, 1988

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OPERATING, AND EMERGENCY PROCEDURES

QSL-OEP

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OPERATING, AND EMERGENCY PROCEDURES

1.0 Authority

- 1.1 The responsibility for the overall radiation protection program shall rest with the radiography department of Quality Systems NDE, Ltd., under the direction of the Radiation Protection Officer.
- 1.2 Each radiographer and assistant radiographer employed in radiographic operations shall be audited at an interval not to exceed (3) three months to ensure compliance with NRC Regulations and these procedures. Audits shall be performed in accordance with the QSL internal inspection check list Form #105.
- 1.3 All qualified radiographers shall have the authority to use, and supervise the use, while in constant attendance at the site, the sealed sources for which the company is licensed.
- 1.4 Other personnel in the radiography department, after training and qualifying as required by the provisions of the company's training manual, may be designated as "radiographer's assistants" and may operate the exposure equipment under the supervision of a qualified radiographer.

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- 1.5 As personnel become qualified as "radiographers" and "radiographer's assistants", their names and records of qualification shall be kept on file.
- 1.6 The retention of inspection records on the performance of radiographer's assistants is no less than three years.
- 1.7 The company is licensed to use only the sealed sources and devices designated on its license.
- 1.8 Instructions for the safe use of these devices are stated in Section 4.

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2.0 <u>Security of Sealed Sources in Radiographic Devices and</u> <u>Storage Conta: lers and Source Changers.</u>

- 2.1 The exposure device or its container shall be kept locked when it is not under the direct surveillance of a radiographer or a radiographer's assistant. During radicgraphic operations, the source assembly shall be secured each time the source is returned to the shielded position.
- 2.2 The storage containers and source changers shall be kept locked when containing sealed sources, except when under the direct surveillance of a radiographer or a radiographer's assistant.
- 2.3 Each sealed source storage container and source changer shall have a lock, or an outer lock, to prevent the accidental unauthorized removal of the sealed source from its shielded position.
- 2.4 Locked exposure devices and st rage containers shall be physically secured to prevent tampering or removal by unauthorized personnel.
- 2.5 Storage areas shall be properly posted using the warning signs which contain the words "CAUTION - RADIOACTIVE MATERIAL" and the radiation symbol.

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- 2.6 Each device containing a sealed source is to be clearly labeled with the radiation caution symbol and the words "CAUTION RADIOACTIVE MATERIAL". Also, each device shall carry a label or tag plainly stating the type of radioactive material contained in the device, together with the quantities there of and the date of the measurement of those quantities.
- 2.7 The permanent storage facility is located at 2727 Philmont Avenue, Huntingdon Valley, PA 19006. The vault is constructed of 8" concrete masonry unit walls; 3 ft. wide X 4 ft. long X 3 ft. high. It has a hinged steel plate lid secured by a padlock. The vault is located in a room 7 ft. X 11.5 ft. X 8.3 ft. high with wall thicknesses of 2 ft. to 3.25 ft., constructed of high density concrete blocks.
- 2.8 Storage areas are to be considered as an unrestricted area. Radiation levels outside the vault should not exceed 2 mr/hr or 100 millirems in any seven consecutive days. All precautions shall be made to prevent the unauthorized removal of the source.
- 2.9 The transporting vehicle may be used as a temporary storage area, provided it meets the requirements of an unrestricted area. The exposure device is to be locked and secured inside the locked storage container, in the locked vehicle.

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"Caution Radioactive Material" placards will have to be posted on the door of the vehicle.

- 2.10 All precautions shall be taken to prevent the unauthorized removal of the vehicle or its contents.
- 2.11 Radiographic personnel shall be the only personnel with access to the storage areas, and the radiographic devices.

3.0 Equipment Check

- 3.1 A daily equipment inspection, of the following items, must be performed by the radiographer, prior to the use of any source or device, on any particular day, to ensure overall safety during radiographic operations. The daily inspection is recorded on Form #101.
 - a. Check the operation of the lock on the shielded container.
 - b. Check for proper operation of the crank mechanism.
 - c. Check accuracy of the source position indicator.
 - d. Check the source tube and the drive cable for wear or damage.
 - e. Check for any damage to the device which may impair it's operation.
 - f. Check for proper labeling.
 - g. Check the meter reading of the camera before work.
 - h. Check the meter reading of the camera after work.
- 3.2 If all items check satisfactorily, so indicate by checking the "equipment satisfactory" section of the radiation report Form #101. If the check is unsatisfactory, correct the situation before beginning operations by returning the device and or equipment for corrections, or replacement. This shall be noted on the radiation report under the

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section entitled "remarks". Notify the Radiation Protection Officer or, the Assistant Radiation Protection Officer of the complaint or malfunction, as soon as possible.

- 3.3 Each radiographic device shall be surveyed with a calibrated and operable radiation survey meter before it is put into operation or moved. This is to ensure the radiographer that the source is in the device and in its shielded position. The intensity reading observed at the exit port is recorded on Form #101.
 - a. No radiographic device shall be moved unless it is locked with the caps and plugs inserted into position, when applicable.
- 3.4 The Utilization Log & Inventory Record Form #106 will be posted in the home office storage room and the following information will be kept up to date by the radiographers each time a source is taken out or brought into the storage room:
 - a. The type of source, the serial number and the model number of the source device.
 - b. The recorded time in and time out.
 - c. The date and location where used.

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- d. The name of the radiographer using the device.
- e. The time of storage survey reading.
- A time of storage survey is taken at the exit port of the exposure device before being placed into storage.
 f. The inventory record.
 - A quarterly inventory will be taken for all sources and recorded on this form.
- 3.5 The Radiation Survey Report Form #101, must be fille out daily by each radiographer. It must contain the radiographer's and radiographer's assistant's names, the date, the shift, the radiation doses (taken from their dosimeters), the source(s) used, the camera number, the maximum radiation level at the perimeter of the restricted area, including the points of measurements, and a record of the radiation survey made of the device at the end of the shift.

4.0 Operation of Exposure Device.

- 4.1 A gamma radiography system may be operated only by a qualified radiographer or radiographer's assistant. If the system is to be operated by a radiographer's assistant, the radiographer must be physically present and watching the assistant.
- 4.2 Each radiographer and radiographer's assistant must be weiring a direct reading pocket dosimeter and film badge. Additionally, each should have a properly calibrated and operable survey instrument, capable of detecting radiation levels between 2 mr/hr and 1 R/hr.
 - a. Prior to beginning radiographic operations, survey the exposure device on all sides. This will verify that the source is in the proper storage position, and that the survey instrument is working properly, and will provide a baseline radiation intensity in the vicinity of the exposure device for comparison with following surveys. Before beginning operations, the radiographer should check for obvious defects and damage in the exposure equipment. Record exposure device movements on the utilization log Form #106. Determine, establish, and post the Restricted and High Radiation Areas, as specified in Section 10.

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- b. From the exposure device, position and straighten the control cable, placing the hand crank in position as far as possible from the exposure position. The bend radius of the control housing should not be less than thirty six inches.
- 4.3 The location of the exposure device and path of the guide tube(s) should be chosen to afford as much shielding as possible to the radiographer. It also should not greatly hamper the radiographer's field of view in field conditions.
 - a. At the exposure device, unlock the device, turn the control cable connector to "Connect", remove the plug exposing the pigtail, make the connection with the control cable and inspect physically that the connection is secure. Next, connect the housing cable of the control cable to the exposure device and turn control connector to the "Lock" position.
- 4.4 All available natural shielding and lead or other artificial shielding should be utilized. A collimator should be used whenever possible. These factors will cut down radiation and the size of the restricted area.
 - a. Remove the safety plug and connect the source tube,

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keeping it as straight as possible. The bend radius should not be less than twenty inches.

- b. Check to assure that no unauthorized personnel are inside the restricted area. Thoroughly check the bend radius and the service stop location. Unlock the exposure device and set it in the "Operate" position.
- Adjust the odometer knob to obtain a "000" reading. C. Unlock the control crank, observing the survey meter, rapidly rotate the crank in the "Expose" direction. When the source emerges from the exposure device there should be a rapid increase in the radiation intensity. The intensity should gradually decrease as the source moves toward the source stop. As the source enters the collimator there should be a significant drop in radiation intensity. Never exert more than 5 ft/lbs. of torgue on the hand crank. The odometer will indicate the total distance the source has traveled. Set the brake to "On" to prevent the movement of the source during the exposure. Retreat to the boundary of the restricted area, and maintain surveillance of that area, to assure that no unauthorized personnel enter.
- c. Survey the boundary of the restricted area to assure that radiation levels do not exceed a 2 mr/hr isodose line as specified. Record this survey.
- d. When exposure time has lapsed, rapidly rotate the handcrank in the retract direction. As the source

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leaves the collimator, there should be a significant increase in the radiation intensity. The intensity should gradually increase as the source moves toward the exposure device. As the source enters the exposure device, the radiation intensity should rapidly decrease to background levels.

- e. The odometer should read "000"; lock the crank handle. Approach the exposure device while watching the survey meter. Survey the device on all sides paying particular attention to the exit port area. The radiation intensities should be approximately the same as was measured in the initial survey. Common intensities with the source in the shielded position are from J mr/hr to 200 mr/hr at the surface of the device. Survey along the guide tube to the source stop. The radiation. intensities should rapidly decrease as the survey meter is moved away from the exposure device. Lock the exposure device by turning the selector ring from "Operate" to "Lock".
- 4.5 If the selector ring cannot be rotated to the "Lock" position the source has not been fully retracted. Check the control unit odometer reading, it should read "000". If not, unlock the control crank and turn the crank to the full clockwise (retract) direction. Lock and resurvey in the same manner as above.

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- 4.6 If for any reason the exposure device cannot be locked, the condition shall be handled as an emergency situation. Follow the emergency procedures outlined in Section 9.
- 4.7 If a device is not able to be returned to the locked storage area, or otherwise physically secured, assign a radiographer or a radiographer's assistant to establish a safe area around the device and to keep unauthorized personnel from that area.
- 4.8 Summary of Instructions
 - a. Radiographers are responsible for keeping the equipment in their possession properly labeled, and in good condition.
 - b. Survey the area during an exposure using survey instruments to confirm that the restricted area limits are as specified. Do not allow anyone into this area.
 - c. If unauthorized personnel cannot be prevented from entering the area, the source should be immediately returned to its shielded position.
 - d. After every exposure, survey the device to ensure that the source is back in a safe position.
 - e. Put safety plugs in the device as soon as possible after an exposure. Do not move the device unless the safety plugs are in the proper positions and the device

is locked.

f. If the source should, for any reason, fail to return to its shielded position in the device, or if any emergency arises, immediately follow the emergency plan outlined in these procedures, Section 9.

5.0 Physical Radiation Surveys.

- 5.1 An operable and calibrated survey meter, capable of detecting radiation levels between 2 mR/hr and 1 R/hr, must be maintained at each job site where radiography is being performed.
- 5.2 All radiation surveys are to be conducted in accordance with the following procedures:
 - Survey the entire circumference of the exposure device.
 Pay particular attention to exit port. Use this survey as the basis of other like surveys.
 - b. Determine an area larger than necessary for an actual exposure, from calculations or charts of the source strength and distance.
 - c. Rope off and post this area.
 - d. Expose the source as outlined in Section 3 of these procedures. Utilize the exposure survey from that section.
 - e. Survey the boundaries determined in Para. b. above, using a survey meter. It is not necessary, nor desirable for a physical survey to be made to confirm the radiation level at the boundary of the High Radiation Area. Such a survey could lead to an unnecessary exposure to personnel.

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- f. Make adjustments to the boundary, as necessary to maintain a 2 mR/hr or less isodose line.
- g. A record of these surveys shall be maintained and shall contain sketches and instrument readings, and explanatory notes if the area was restricted to other than the 2 mR/hr isodose line. This information shall be recorded on Form \$101.
- h. If more than one exposure is taken in the same area, and there is to be no change in the restricting of that area, it is not necessary to survey the limits of the restricted area again. Surveillance of the restricted area must be maintained at all times.

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6.0 Procedure for Survey After Completion of Exposure.

- 6.1 Following each individual exposure, return the source to the device; the odometer on the control cable registers "000"; lock the crank cable.
- 6.2 Approach the exposure device using a survey meter, physically survey the device and the guide tube(s) on all sides, paying particular attention to the exit port area. The radiation intensities should be approximately the same as measured in the initial survey.
- 6.3 After determining, from the meter reading that the source is in a safe condition, lock the device.
- 6.4 Survey readings may vary from 5 mR/hr to 200 mR/hr. A reading outside of this range, either high or low may be an indication that the source is not contained in the device, and the situation should be treated as an emergency. Refer to Section 9.

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7.0 Procedure for Securing the Exposure Device When No Additional Exposures are Required.

- 7.1 Following the final exposure, perform a physical radiation survey of the device to ensure the source is in a safe position. Unthread the source tube and insert the safety plug.
- 7.2 Unlock the exposure device and rotate the selector ring from "Lock" to "Connect". The control unit connector will partially disengage.
- 7.3 Disconnect the pigtail from the control cable and install the protective plug. Rotate the selector to "Lock" and remove. Repress the plunger.
- 7.4 Survey the entire circumference of the exposure device with the survey meter to ensure that the source is properly secured. The intensity reading observed at the exit port is recorded on Form #101.
- 7.5 Return and secure the device in the transporting vehicle, for temporary storage, if applicable.
- 7.6 Survey the entire circumference of the exposure device with the survey meter to ensure that the source is still

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properly secured.

7.7 Lock the device in the temporary storage area.

8.0 Procedure for Time of Storage Survey.

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8.1 The physical radiation survey of the exposure device, prior to the placement in final storage, this survey is the last one performed in the work day. The entire circumference of the device must be surveyed using a survey meter. The meter reading from the exit port shall be recorded on Form #106.

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9.0 Emergency Procedures for Radiographic Personnel.

- 9.1 In the event of an emergency (such as a fire), in an area adjacent to a radiographic device:
 - a. Return the source to its shielded position in the device.
 - b. Perform a physical radiation survey of the device to assure that the source is in the shielded position.
 - c. Remove the source and the control cables and insert the safety plugs.
 - d. Remove the device from the danger area, and if possible, return to the storage building.
 - e. Notify your Radiation Protection Officer.
 - f. If a radiographic device cannot be removed from a danger area:
 - Set up a restricted area around the device as specified previously.
 - 2. Notify the Radiation Protection Officer.
 - The Radiation Protection Officer shall determine any further course of action.
- 9.2 In the event of an accident to the source or device, such as a falling object hitting the device:
 - a. Return the source to its shielded position in the

device if possible. Conduct a physical radiation survey, to assure that the source is fully shielded, and lock the device.

- b. Notify the Radiation Protection Officer.
- c. Do not use the device again until the Radiation Protection Officer has made an inspection of the device and the personnel monitoring equipment and grants approval for its use.
- d. In the event that the source cannot be returned to the device:
 - Set up and post a Restricted Area as specified in Section 10.3, using a survey instrument to determine the perimeter of the area.
 - Do not allow non-monitored personnel to enter this area.
 - 3. Notify your supervisor.
 - Notify the Radiation Protection Officer at (215) 947-2991 (office#) or (215) 453-9385 (home#).
- 9.3 In the event of an accident involving the exposure of nonmonitored personnel to radiation:
 - a. After setting up the restricted areas, using a survey instrument to determine the perimeter of the area, record the names and telephone numbers of all non monitored personnel involved.

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b. Notify the Radiation Protection Officer.

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- c. The Radiation Protection Officer shall determine the course of action and shall notify the NRC in accordance with 10 CFR Part 20.403 and Part 20.405 , as necessary.
- 9.4 In the event of a source disconnect (the source cannot be cranked back into the exposure device):
 - a. Notify the Radiation Protection Officer, immediately.
 - b. Maintain security and surveillance of the restricted area until the Radiation Protection Officer arrives.
- 9.4.1 The following shall be performed by the Radiation Protection Officer:
 - a. The RPO shall evaluate the situation and determine the course of action, by consulting with the technicians involved and surveying the situation. The information learned by following the proper survey practices will help in deciding the course of action to be taken. If it is necessary to obtain outside assistance; Notify Tech/Ops at 1-800-225-1383.
 - b. The RPO is to make a plan for the source retrieval, determine the time required to accomplish each step of the operation, and compute the expected

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exposure to any technicians involved.

- c. Modify the plan, if possible, to minimize the exposure to personnel.
- d. Determine if any additional shielding may be used to minimize the expected exposure. The emergency site may provide the necessary shielding. It may be possible to drag the source guide so that the exposed source can be moved behind some shielding. It may be advisable to place shielding material over the source or between the source and the operator. Shielding material should never be thrown onto the source, this may cause further damage.
- e. The RPO must maximize the distance between himself and the source, if at all possible. For example:
 A pole can be used for simple poking operations, a simple pick up tool can be fabricated by wiring pliers to a pole.
- f. The RPO should attempt to get the source into the exposure device. If this cannot be accomplished, steps will be taken to reduce the radioactive intensities and maintain a restricted area until gualified cutside assistance can be obtained.
- g. Notify the NRC in accordance with 10 CFR Part 20.403 and Part 20.405, as necessary.
- h. Check non-monitored personnel and notify the NRC in

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accordance with 10 CFR Part 20.403 and Part 20.405.

- 9.5 In the event of a vehicular accident involving by-product material:
 - A restricted area must be established as specified previously in this procedure.
 - b. If the survey meter is operable, use it to establish the perimeter of the restricted area. Notify the home office, the RPO, and the local civil authorities.
 - c. If the survey meter is inoperable, use calculations to establish the perimeter of the restricted area assuming that the source is in the exposed position inside the vehicle. Notify the parties as in (B) above.
 - d. In the case of a minor accident where it can be visually determined that the source is safely stored in its container, no restriction of area is required.
 - e. If the survey meter is operable, and no radiation hazard exists, continue to the destination and call the RPO.
- 9.6 The Notification and Reporting of Incidents, Theft, or Loss of Licensed Material.
 - a. The RPO shall notify the NRC by telephone or telegraph, in accordance with 10 CFR Part 20.402 for theft or loss

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of licensed material, and in accordance with 10 CFR Part 20.403 regarding incidents.

b. The RPO shall notify the NRC in writing within (30) thirty days, in accordance with 10 CFR Part 20.402 regarding theft or loss of licensed metrial, and in accordance with 10 CFR Part 20.405 regarding incidents.

10.0 Restricted Areas for Radiography.

- 10.1 Post all "Restricted Areas" as specified in these procedures with warning signs, provided by the company. These signs contain the words "Caution - Radiation Area" and the standard three bladed radiation symbol. The signs are magenta or purple on a yellow background.
- 10.2 Post all "High Radiation Areas" as specified in these procedures with warning signs containing the words: "Caution - High Radiation Area", and the radiation symbol.
- 10.3 Posting the Restricted Area
 - a. A Restricted Area is that area to which the radiographer must control access for purposes of radiation safety. This restriction must be extended to include those areas containing radiation levels such that a person continuously present in the area could receive an exposure in excess of 2 millirem in any one hour. The perimeter of the restricted area would be at the 2 mR/hr isodose line. For exposures of short duration, calculations and charts may be used to determine how many exposures may be taken without exceeding the 2 mR/hr

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- b. All Restricted Areas must be kept under constant surveillance by the radiographer or the radiographer's assistant. Rope and radiation signs shall be used to designate the perimeter of the restricted area.
- c. Personnel who have no need to enter a Restricted Area, or who are not adequately monitored or aware of the radiation field, must not be allowed to enter a Restricted Area. If any unauthorized personnel cannot be prevented from entering the Restricted Area, the source should be immediately returned to its shielded position.

10.4 Posting the High Radiation Areas

a. "High Radiation Areas" are those areas which contain radiation levels such that a person continuously present in the area could receive an exposure in excess of 100 mR in any (1) one hour. The limits of this area must be posted with the signs bearing the radiation symbol and the words "Caution - High Radiation Area". These signs should be posted at the 100mR/hr isodo line, during the exposure period.

10.5 Posting the Radiation Areas

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a. "Radiation Areas" are those areas which contain radiation levels such that a person continuously present in the area could receive an exposure in excess of 5 millirem in any (1) one hour. Radiation Areas must be posted with signs bearing the radiation caution symbol and the words "Caution - Radiation Area". Our policy is to use these signs to mark the perimeter of the Restricted Area and to guard the boundaries of the Restricted Area, therefore, no action concerning the perimeter of the Radiation Area need be taken.

11.0 PERSONNEL MONITORING

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- 11.1 Pocket dosimeters and radiation film badges are to be issued to each member of the radiographic department.
- 11.2 Dosimeters and film badges must be worn at all times by radiographic personnel during working hours.
- 11.3 Personnel monitoring devices, when not in use, shall be placed in their respective holding fixtures to ensure proper storage and care. Respective holding fixtures are located in the supervisor's office.
 - a. When extended (overnight) field work applies, all personnel monitoring devices will become the responsibility of the radiographer in charge. Storage of such devices will be at the discretion of the radiographer, but under no circumstances will they be stored in the same area as the radioactive source
- 11.4 Pocket dosimeters, Victoreen Model 541R, and Dosimeter Corp's Model 862, or equal are furnished. The pocket dosimeters shall have a range from 0 to at least 200 milliroentgens.
 - a. Dosimeters are delicate instruments, and should be

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treated as such. Excessive humidity, jarring or dropping the instrument, may cause a high reading. If damage to your pocket dosimeter is suspected, notify your Radiation Protection Officer immediately.

- b. If a dosimeter should go off scale (over 200 mR), an emergency situation shall be considered to exist, stop work and notify the Radiation Protection Officer immediately.
 - 1. Paragraph 34.33 (b) of 10 CFR, Part 34, requires that if a dosimeter becomes fully discharged, the film badge shall be processed immediately to determine if any overexposure has taken place. Such a film badge must be sent to the Radiation Protection Officer; from there it will be sent to the film badge supplier for immediate processing. Having followed this procedure, immediately recharge the dosimeter and leave it in an area free of any type of radiation for a period of approximately (1) one hour. After this time lapse, recheck the dosimeter; if it is again discharged, totally or partially, in all probability you have not been exposed to an overdose of radiation. This would indicate that the dosimeter is probably faulty. Having determined this, inform your Radiation Protection Officer. Only ar Radiation Protection Officer may decide whether a not you may

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return to radiation work after he has carefully evaluated the situation.

- c. All dosimeters shall be charged daily, at the start of each shift, by the radiographer. The radiographer shall read the dosimeter several times during the course of the work shift and record the actual reading at the end of each shift.
- 11.5 All dosimeters are to be calibrated annually by Quality Systems NDE, Ltd., 2727 Philmont Avenue, Huntingdon Valley, PA 19006. The results will be filed with the equipment log in accordance with 10 CFR 34, paragraph 34.33. Nuclear Associates Multi-Dosimeter Calibrator Model 06-201 is furnished.
 - a. Dosimeters shall be calibrated on an annual basis, or at any time the dosimeter is suspected of being out of calibration.
 - b. The annual calibration is performed by the Radiation Protection Officer, the Assistant Radiation Protection Officer.
 - c. Radiographers are encouraged to perform the procedure as a check of suspected malfunctioning dosimeters. Any malfunction in dosimetry shall be reported to the Radiation Protection Officer or the Assistant Radiation

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Protection Officer.

d. Procedure

- 1. The dosimeters shall be zeroed out and placed in the dosimeter calibrator for a period of 24 hours.
- At the end of 24 hours, the dosimeter should read 100 mR/hr. Deviation shall not be more than 30% (plus or minus) of the 100 mR/hr reading.
- 3. All dosimeters determined to be within acceptable limits shall be properly tagged as to the calibration status. The tag shall identify: the date calibrated, the person performing the calibration and the due date of the next calibration.
- 4. Dosimeters which are not reading within acceptable limits shall be tagged as defective, removed from use, and returned to the Radiation Protection Officer or Assistant Radiation Protection Officer.
- 5. An historical log shall be maintained to indicate the calibration status of the dosimeters, previously or currently, utilized by Quality Systems NDE, Ltd., and will be kept on file for a period not less than two years.
- 11.5 Dosimeters are to be read as often as necessary to determine if an abnormal dose of radiation has been
received.

- 11.7 Each radiographer is responsible for recording both his and his assistant's dose, at the end of the work day, on the Radiation Survey Report Form #101.
- 11.8 Dosimeters are to be charged each work day at the start of each shift and the initial reading is to be recorded by the radiographers.
- 11.9 Operating Instructions for Dosimeter Chargers
 - a. Insert the dosimeter into the charging socket.
 - b. Hold the dosimeter in contact (pressure is required against the spring).
 - c. Turn the large knob to adjust the dosimeter to zero.
 - d. Remove the dosimeter from the charger and check the hairline position by looking through the dosimeter at a source of light.

11.10 Procedures of Issuance and Processing of Film Badges

- Film badges shall be worn by all radiography personnel during working hours.
- b. Radiographic personnel shall not report to a job without their film badge.

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- c. Each film badge has each person's name and a number.
- d. Film badges will be changed monthly by the Radiation Protection Officer or radiographer.
- e. New films will be obtained from the film supplier and used. Films will be turned in promptly by the Radiation Protection Officer for processing.
- f. Control badges are not to be worn by radiographic personnel. Control badges are periodically developed to insure that areas are free of radiation.
- g. All contacts with the film badge supplier shall be through the Radiation Protection Officer. The Radiation Protection Officer shall return all used film to the supplier and receive all the reports of film badge results from the supplier.
- h. The Radiation Protection Officer will review all film badge reports received. Individuals involved will be informed on a monthly basis of the reports.
- i. The Radiation Protection Officer will be responsible for the maintenance of a central and complete file on all film badge results received. The film results must be maintained or form NRC-5 which is obtained from the commission's field office.
 - The film badge schedule provides a change of film on a monthly basis. During this period, badges are not to be interchanged with other employees. The film

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supplier shall be:

R.S. Landauer, Jr. & Company Division of Tech/Ops, Inc. Glenwood Science Park Glenwood, IL 60425

12.0 Survey Meters

- 12.1 Each radiation survey instrument shall be calibrated at intervals not to exceed three months, and after each servicing. A record shall be maintained of the results for each instrument calibration, including the date, and shall be kept on file for no less than two years after the date of calibration.
- 12.2 Manufactured for the purpose of detecting radiation, the instrument shall have a range such that at least two milliroentgens per hour to one roentgen per hour can be measured.
- 12.3 Meters will be calibrated by:
 - a. Camberra (RMC) 3508 Market Street P.O. Box 7940 Philadelphia, PA 19101
 - b. Universal Testing
 Woodlawn Ave. & North Street
 Collingdale, PA 19023
 - c. Gamma Industries 2255 Dunham Ave. Baton Rouge, LA 70802

Page - 38 12.4 Other sources for calibration may be used if they can provide expertise equal to the fore-mentioned companies.

- 12.5 The small tag attached to the survey meter provides the date of it's latest calibration. This tag should be inspected frequently to ensure that the instrument has been calibrated within 90 days. If the instrument has not been so calibrated, or seems not to be operating properly, it is not to be used, but should be forwarded to the Radiation Protection Officer, or Assistant Radiation Protection Officer
- 12.6 Survey meters are delicate instruments. It is essential that reasonable care be taken in their use to assure reliability.
- 12.7 Should the survey meter become inoperable for any reason. immediately cease work and make arrangements to replace it with a calibrated meter. Surveillance of the area must be maintained until a replacement meter arrives.
- 12.8 Any inoperable survey meter must be tagged "Do Not Use". Notify management whenever there is a malfunction or a defect in the equipment.

12.9 Survey meters, when transported in company vehicles,

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should be placed in the drivers compartment. Adequate support of the instrument to prevent damage during transit is necessary.

13.0 Movement of Radiographic Devices

- 13.1 The NRC has authorized our use of radiography sources at temporary field sites away from our plant. Use of this material at these locations must be approved by the Radiation Protection Officer.
- 13.2 Transportation to field sites and to any in-plant areas must be in accordance with the instructions of the following section. Before departing for a field site, all the equipment specified in this section must be secured in the vehicle and checked by the radiographer.
- 13.3 Transportation of Radiographic Devices
- 13.3.1 Devices shall be surveyed, using a survey meter, by a radiographer prior to its smoval from any storage area.
- 13.3.2 A radiographer or radiographer's assistant shall be in constant attendance during the movement.
- 13.3.3 No device shall be moved unless it is locked, and all the safety plugs are inserted.
- 13.3.4 In-plant transportation can be accomplished by the use

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of handcarts or company vehicles. Portable exposure devices are not to be hand carried over long distances. Relatively high radiation levels often exist at the surfaces of these devices. Physical handling could result in unnecessary exposure to personnel.

- 13.3.5 Transportation to field sites or other plant sites must be accomplished with the exposure device firmly secured inside the vehicle so as to avoid bouncing or other individual movement.
- 13.3.6 The outer surface of a transporting vehicle must be treated as an unrestricted area when the vehicle is outside of our plant area. After the exposure device has been secured in the vehicle, a physical radiation survey of the vehicle must be made to assure that radiation levels outside the vehicle, and inside the passenger compartment, do not exceed 2 mR/hr. A record of this survey should be made on the Radioactive Material Transportation Record, Form #107.
- 13.3.7 If radiation levels in excess of 2 mR/hr are found, the exposure device must be repositioned in the vehicle or further shielding must be used. Lead or concrete shielding should be added, when necessary, to reduce the radiation to that level. The shielding must be

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secured in the vehicle so as to avoid individual movement.

- 13.3.8 The radioactive material must never be transported outside QSL's plant property unless it is accompanied by a radiographer or a radiographer's assistant.
- 13.3.9 The radiographer is required to fill out the Radioactive Material Transportation Record Form #107, identifying the radioactive material, the date, origination, destination, survey readings, and the transportation index.
- 13.3.10 The following equipment must be packed in the transporting vehicle prior to departing for a field exposure site:
 - a. Survey meter calibrated within 90 days.
 - b. At least one 250 coil foot of rope.
 - c. At least six "Caution Radiation Area" signs.
 - d. At least three "Caution High Radiation Area" signs.
 - e. Report Form #101 (for length of time in field).
 - f. The exposure device and all the related cables.
 - g. Road flares.
 - h. A copy of the Operating, and Emergency Frocedures

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manual.

- The Radiation Material Transportation record, Form #107
- 13.4 Shipping Radioactive Sources
- 13.4.1 The shipping container shall be labeled in accordance with Section 172.403 of 49CFR172 of DOT's Regulations.
- 13.4.2 QSL will, primarily, ship containers that require a Radioactive Yellow ^{TT}, with a maximum radiation level at the surface being 50 mr/hr and 1.0 mr/hr at one meter. Transportation Index of (1).
- 13.4.3 If the package being transported requires a Radioactive Yellow III, the vehicle will have to be placarded as specified in 49CFR Part 172.
- 13.4.4 No package is to be shipped with surface radiation levels above 200 mr/hr, or 10 mr/hr at one meter. Contact the RPO immediately, if such radiation levels are found.
- 13.4.5 The shipping container must have a placard affixed, "Caution Radioactive Material".

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13.5 Receipt and Disposal of Sources

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- 13.5.1 When a source is received from the supplier; transferred from one camera to another; or disposed of by returning to the supplier, the information required on Form # 104 will be filled out.
- 13.5.2 Upon receipt, survey the source changer on all sides to assure that the source is in its proper storage position, record this survey on Form #104. Radiation levels should be less than 200 mr/hr at the surface of the container and less than 10 mr/hr at one meter from the surface. If either of these radiation levels are exceeded, place the source changer in a restricted area and notify the RPO, the NRC, the final delivering carrier and Amersham Tech/Ops. Radiation Protection Dept.
- 13.5.3 The disposal of any sources will be done by returning them to the supplier.
- 13.5.4 When the sources are returned to the supplier, all applicable records will show the action taken. These records will be kept on file along with the daily charts and receipts of the sources from the suppliers.

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14.0 Inspection and Maintenance of the Radiographic Devices.

- 14.1 Inspections shall be made by the RPO, the Assistant RPO, or the manufacturer, at intervals not to exceed three (3) months, or earlier if determined necessary.
- 14.2 General Instructions Drive Cable
 - a. The cable should be lubricated by disconnecting it from the source cable and carefully winding it out completely, withdrawing it from the protective conduit.
 - b. The full length of the cable should rest only on a dirt-free, lint-free surface to minimize residue pickup on the spiral drive surfaces.
 - c. The spiral drive should be cleaned with a soft, lintfree cloth saturated with a petroleum solvent and thoroughly dried.
 - d. A thin film of lubricant should be applied by dusting with lint-free cloth dusted with Texaco's "Uni-Temp" per the manufacturer's recommendation, "Molykote" or equal may also be used.
 - e. The cable may then be hand fed back into the protective conduit to engage with the gear drive system of the source position indicator handle, then driven back for the balance of its length using the handle.

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f. Using a model 550 No-Go gauge, check the male connector of the drive cable. If the ball of the connector fits through the gauge hole or the ball shank fits into the slot in the gauge, the connector is worn and the cable must be replaced. Wipe the guide tubes and the control housing with a cloth soaked with solvent and flex them to check for internal damage. Damage is evidenced by crunchy feelings when the housing or the tube is bent. While doing this, feel for dents, cut, flattened, or burnt control housings and guide tubes. ^cuch damaged control housings and guide tubes should be repaired or replaced.

14.3 Crank Assembly

- a. Disassemble the crank assembly and clean all the control box parts in solvent, dry them thoroughly with compressed dry air (15 psi. Max.). Replace any parts that are damaged or show signs of excessive wear. Replace any defective parts. Lightly grease all moving parts and their contact surfaces.
- b. Check the odometer uni for proper operation. The unit should turn freely, without excessive play. Clean the unit with the solvent and lightly grease. Replace the assembly, if it is defective.
- c. After complete reassembly, check for proper operation

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by turning the crank, it should spin freely. Run the drive cable through the control box and turn the crank, it should turn easily with no snags. Set the brake to "ON" and attempt to turn the crank. It should not turn, using moderate pressure. Do not apply excessive pressure to the crank, as this may cause damage. If the box fails this test, disassemble, check the parts for damage and proper alignment, then reassemble and check for proper operation again.

14.4 Model 660 Exposure Device

 To service the exposure device, remove the source following the source changing procedures.
 Note: Before removing the source, check the female

drive cable connector with the 550 No-Go gauge. If the gauge width can fit into the female slot, the connector is worn and the source must be replaced.

b. After the source has been removed, service the exposure device by performing the manufacturer's inspection and maintenance procedure. It is our policy to have Amersham/Tech/Ops. Inc. ship a 650 Source Changer, for the purpose of performing the required maintenance at intervals not to exceed 90 days, or as needed. Records of each servicing shall be kept on Management Inspection Form #102.

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14.5 Leak Testing

14.5.1 Leak testing of all sealed sources is performed using the leak test kit, Model 518, supplied by Tech/Ops Inc., Burlington, MA. Tests will be performed at intervals not to exceed six (6) months by the Radiation Frotection Officer.

14.5.2 Procedure:

- a. Be sure the source is fully retracted into the projector. (Use a survey meter to be sure that the radiation levels are normal.)
- Remove the source tube from the face shield and remove the shipping plug.
- c. Wet the swab with EDTA solution. Shake off any excess and insert the swab into the hole in the shield. Wipe the interior of the hole thoroughly by rotating the swab holder.
- d. Withdraw the swab and place into the plastic envelope.
- e. The swab should now be monitored by turning the survey meter to its most sensitive range. Place the meter in a low background area and move the swab, still in it's plastic envelope, to the meter, not the meter to the swab.

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- f. If there is no indication on the meter, or if the indication is <u>no more</u> than 0.2 mr/hr above the background, put the plastic envelope with the swab into the mailing box and mail it to Technical Operations, Inc., Burlington, MA. <u>Be sure to fill out and return the identification sheet</u>, with the swab.
- g. If the swab should show more than 0.2 mR/hr, <u>do not</u> <u>mail</u>. Contact Tech/Ops for specific instructions.
- Note: If the survey meter available does not have the capability of detecting as little as 0.2 mR/hr, ship the wipe test swab to Tech/Ops, Inc., via express. Do not ship if the radiation from the swab exceeds 2 mR/hr and contact Tech/Ops, Inc., for specific instructions. The wipe test swab will be subjected to a precise radio assay when it is received, and a leak test certificate will be mailed promptly. The NRC requires that these certificates be kept with our records and that they be available for inspection.

14.6 Management Inspection (Radiation Survey Form #102)

14.6.1 QSL will perform detailed, periodic inspections at intervals not to exceed (3) three months, or whenever a device appears to be impaired through abuse or wear. Inspections will be performed by the RPO, the Assistant RPO, or the Manufacturer.

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- 14.6.2 Preventive maintenance checks will be made on all of the above mentioned operational items.
- 14.6.3 Corrective maintenance will be performed on any operational items found to be unsafe; such items will be disconnected until a repair or replacement part can be obtained.
- 14.6.4 QSL will perform inspections on the items listed below to ensure proper operation:
 - a. Any change in the operational characteristics.
 - b. The proper operation of the source indicator and the crank mechanism.
 - c. The operation of the locking device
 - d. Any damaged or worn parts.
 - e. Any rust, dirt or sludge build-up in the source tube.
 - f. The proper connection of all the mating components.
 - g. All of the gear drives.
 - h. Proper labeling.

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15.0 Operating Instructions - Source Changer 650

- 15.1 The model 650 is a duel chamber container to permit interchange of Iridium 192 Sources. The inner shield consists of depleted uranium casting. The total shipping weight of 70 lbs. The compact design of the container results in a light weight, rugged structurally sound package, capable of withstanding severe abuse encountered during shipping and field use. The model 650 Source Changer has been subjected to Hypothetical Accident Test Conditions, (sequential drop, puncture, fire, etc.), and has been approved as a type "B" package for the transporting of sealed sources of Iridium 192, up to a maximum of 240 curies. The package meets the requirements of the following agencies:
 - a. Nuclear Regulatory Commission, Transportation Branch
 - b. U.S. Departments of Transportation (DOT)
 - c. International Atomic Energy Agency Vienna, Austria
- 15.2 This package is licensed under U.S. Nuclear Regulatory Commission License Number 20-00277-03, Amendment Number 33, issued to Tech/Ops, Inc. This package has been assigned the following Package Identification Number, USA/9032/B (U), which is permanently engraved on the outer shell casement.

15.3 Source Change Operations

- 15.3.1 Source change operations are to be performed by Amersham Tech/Ops Inc., the RPO, the Assistant RPO, or other personnel specifically trained to perform the operation.
 - a. Upon receipt of a source changer, survey the source changer on all sides to assure that the source is in its proper storage position. Radiation levels should be less than 200 milliroentgens per hour at the surface of the container and less than 10 milliroentgens per hour at one meter from surface.
 - b. If either of these radiation levels are exceeded, place the source changer in a restricted area and notify the Radiation Safety Officer. The Radiation Safety Officer should notify the U.S. Nuclear Regulatory Commission, the final delivering carrier of the device, and Amersham Tech/Ops Inc. Radiation Protection Department.
 - c. If the radiation levels are found to be acceptable, visually inspect the source changer for signs of damage, and assure that the seal wire has not been tampered with. Complete the Notification of Receipt form and mail to Amersham Tech/Ops Inc. Radiation Protection Department.

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d. Place the source changer and the radiographic exposure device in a restricted area. Arrange them so that one length of guide tube will fit between them without any sharp bends or kinks in the tube. The bend radius of the source guide tube during source changing operations should be greater than 24 inches.

NOTE: THE SOURCE CHANGER MUST REMAIN UPRIGHT AT ALL TIMES. DO NOT LAY THE SOURCE CHANGER ON IT'S SIDE.

- e. Place the control housing as far away as possible from the exposure device and the source changer and, preferably, behind any available radiation shielding.
- f. Remove the cover from the source changer by unlocking the padlock and breaking the seal wire and removing the bolts.
- g. Remove the source holddown cap that covers the source, by breaking the seal wire and unbolting it. Remove the identification plate from the new source. NOTE: WHEN THE SOURCE HOLDDOWN CAP IS REMOVED, THE SOURCE CONNECTOR IS EXPOSED. CARE MUST BE TAKEN TO ASSURE THAT THE SOURCE IS NOT DISLODGED WHEN HANDLING THE CHANGER.
- h. Set the radiographic exposure device as if for an exposure.
- i. Connect one end of the guide tube extension to the exposure device and the other end to the fitting

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above the empty chamber of the source changer.

- j. Close and latch the source guides. Assure that no unauthorized personnel are in the restricted area and all access points are secured.
- k. Position the survey meter close to the operation control point so as to continuously monitor the dose rate to which the operator is exposed.
- 1. At the exposure device controls, crank the source rapidly from the exposure device to the source changer. The radiation intensity should greatly increase as the source is first exposed, decrease slightly as the source is being cranked out from the exposure device to the source changer and then drop to background levels when the source is in the source changer.
- m. Approach the exposure device with a survey meter; survey the exposure device on all sides, survey the guide tube, and survey the source changer on all sides to assure that the source has been properly transferred and stored. The maximum radiation level should be less than 200 mR/hr at the surface of the source changer and less than 10 mR/hr at one meter away from the surface of the source changer.
- n. Open the source guides; disconnect the drive cable from the source assembly by moving the lock pin of the source connector down towards the source. Slide

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the drive cable out through the keyway.

- o. When the disconnect of the source connector and the drive cable is complete, remove the guide tube from the source changer. Connect the guide tube to the fitting above the chamber containing the new source.
- p. Couple the drive cable to the source by depressing the lock pin, sliding the drive cable connector into the keyway and releasing the lock pin. Assure that the connection is secure before continuing.
- q. Close and latch the source guides above the new source. Assure that no unauthorized personnel are in the restricted area.
- r. At the exposure device controls, crank the new source from the source changer to its storage position in the exposure device. Observe the survey meter during this operation. The radiation intensity should increase as the source exits the source changer. The radiation intensity should steadily increase as the source travels to the exposure device and then drop to background when the source is properly stored in the exposure device.
- s. Approach the exposure device with the survey meter, survey the exposure device on all sides, survey the length of the guide tube, and survey the source changer on all sides to a sure that the source has been properly transferred to its storage position in

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the exposure device. Radiation levels should be less than 200 mR/hr at the surface and less than 10 mR/hr at one meter away from the surface.

- t. When the source has been determined to be properly stored, lock the exposure device and remove the guide tube and controls. Disconnect the guide tube from the source changer.
- u. Place the source holddown cap over the old spent source in the source changer. Attach the identification plate of the old source to the holddown cap.
- V. BOLT THE SOURCE HOLDDOWN CAP IN PLACE AND SEAL THE WIRE. ASSURE THAT THE SOURCE HOLDDOWN CAP IS BOLTED DOWN FIRMLY OVER THE SOURCE CONNECTOR(S).
- w. Affix the identification plate of the new source to the exposure device.
- x. Solt the source changer cover in place and seal the wire. Lock the padlock in place. If the source changer is to be shipped inside an outer packaging or barrel, mark the outside package "INSIDE PACKAGE COMPLIES WITH PRESCRIBED SPECIFICATIONS USA/9032/B(U) Type B."

If an outer barrel is used as an over pack, it must be fastened with a seal wire.

y. Survey all exterior surfaces of the package to assure that the radiation level does not exceed 200 mR/hr at

the surface.

z. Affix two DOT style shipping labels. The blank spaces should be filled in as follows: Principle Radioactive Content

Iridium 192

(not abr. IR 192)

Activity of Contents..... (Number of Curies)

Transportation Index.....(by Radiation SurveymR/hr at one meter)

aa. Return the source changer, freight prepaid, to Tech/Ops Inc., 40 North Avenue, Burlington, MA 01803, for disposal.

| | | . | • | | | | • | | Page - | 58 |
|--------------|-------------------------------|-----|------|-------|------|-------|------|------|-------------|---------------|
| | Asst Name | | | | | | | | | |
| | ding Asst | | | | | | | | 1 | |
| | Dosimeter Rea Radiographer | | | | | | | | se Side | |
| HRU | MR/HR Camera Secured | | | | | | | | on Rever | |
| F | MR/HR Camera | | | | | | | | heck List | |
| | MR/HR at Boundary | | | | | | | | liographer- | |
| OF | Exp. Time | | | | | | | | Rad | |
| WEEK | No. of Exp. | | | | | | | | | |
| : | сі. | | | | | | | | | LTB |
| THORT | 89 | | | | | | | | | DE, |
| VET RI | IR 192 | | | | | | | | | N SW |
| AND SUR | Model # | | | | | | | | | SYSTE |
| WORK SHEET | Camera S/N | | | | | | | | | UALITY |
| DIOGRAPHER'S | Location | | | | | | | | emarks: | 100 |
| 5 | | Sun | Mon. | Tues. | Wed. | Thur. | Fri. | Sat. | N N | |

12727 Philmont Averue * Huntington Valley, PA 19006

MANAGEMENT INSPECTION

OPERATIONAL CHECK LIST

| COMPONENTS | Damaged or Worn Parts | Rust,Dirt or Sludge | Proper Labeling | Operational | Unsatis- factory |
|-----------------------------------------------------------------------------------|--------------------------|------------------------|--------------------|----------------|---------------------|
| 1. Crank Mechanism a. SN# b. SN# | | | | | |
| <pre>2. Source Indicator a. SN# b. SN#</pre> | | | | | |
| <pre>3. Locking Devices a. SN# b. SN#</pre> | | | | | |
| 4. Camera a. SN# b. SN# | | | | | |
| 5. Source Tubes a. eg. 5' Lg. b. eg. 4' Lg. | | | | | |
| 6. Mating Corponents | | | | | |
| 7. Gear Drives | | | | | |
| 8. Proper Connections of Mating Parts | | | | | |
| REMARKS: | | | | | |
| | In | spector: | | Date: | |
| Form 102 ***NOTE: | EQUIPMENT TO | BE CHECK EVE | RY (3) MONT | HS OR WHENEVER | NECESSARYI |

| . • | • | Page - 60 Form #103 | |
|------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| QUALITY SYSTEM | S NDE, LTD. | Sheet of | |
| QSL 2727 Philmont Avenue • | Huntingdon Valley, PA 19006 | Rev. | |
| Phone: (215) 947-2991 | | Date: | |
| NDE PERSONNEL O | UALIFICATION AND CERTIFICATION | | |
| PRACTICAL SAFETY EXA | MINATION - RADIOGRAPHIC TEST MET | НОД | |
| NAME : | NDT Le | vel | |
| DATE: LOCATION OF | F EXAM: | | |
| 1. Calibrated survey meter used | | | |
| battery check | 18. Retract source quick1 | y & steadily | |
| 2. Dosimeter (on Zero) and current Film Badge | 19. Survey exposure devic | e (R) | |
| 3. Survey of storage location(R)* | 19.1 From rear, lock exp | osure device | |
| 4. Inspect exposure device (R) | 19.2 In front | an an in the first of the second s | |
| 5. I a truck is used to trans- port the source | 19.3 Full length of sour | ce del. tube | |
| 5.1 Survey outside of truck (R) | 20. Read dosimeter | | |
| 5.2 Survey cab (R) | 21. Disconnect control ca | ble & store | |
| 5.3 Placard truck 4 sides | 22. Disconnect del. tube and store properly | | |
| 5.4 Emergency kit available | 23. Replace shipping plug | | |
| 5.5 Survey meter in cab | 24. Replace caps | | |
| Establish estimated restricted area at 2 mR/hr | 25. Remove signs and bari | cades | |
| 6.1 Radiation barrier rope | source, recheck step | 5. | |
| 6.2 Red flasher lights available | 27. Before store, survey device (R) | exposure | |
| 7. Post high radiation area | 28. Store exposure device | and survey | |
| 8. Lay out control cable straight | 29. Lock storage area | | |
| 9. Con::ect control cable, pull to test connection | 30. Post storage area | | |
| 10. Lock the exposure device | 31. Neat records and proc | edures | |
| 11. Attach source delivery tube, lay out straight | 32. Evaluation of Candida test. Comments: | ates attitude toward | |
| 12. Use appropriate collimator | | and a second | |
| 13. Clear restricted area | | | |
| 14. Expose source quickly and steadily | | | |
| 15. Rad Tad working & worn | | | |
| 16. Survey boundary of restricted area & record (R) | | | |
| 17. Adjust boundaries if necessary | RFO Signature: | | |
| Business and a second | | | |

* (R) indicates record made on appropriate form

0

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SOURCE RECEIPT/TRANSFER/DISPOSAL LEAK TEST REPORT

| ource | Matreial | Capsule Number |
|----------|---------------------------------|-----------------------|
| | Received From | |
| | Curies | Changer Number |
| TAIB | Installed in Camera: Model | Serial Number |
| RECI | NOTE: Complete leak test report | data as shown below. |
| | Ву | Date |
| | Source Changer Surface mR: | |
| | From Location | To Location |
| TRANSFER | From Camera: Model | Serial Number |
| | To Camera: Mod =1 | Serial Number |
| | Changer Number | Curies |
| | Ву | Date |
| | Sent To: | |
| AL | Changer Number | Curies |
| DISPOS | Ву | Date |
| | Type of Test: Dry | WaterSolvent |
| ē | Test Kit Used: | Number of Swabs Used: |
| TEST | Location Wiped: | |
| EAK | Camera: Model | Serial Number |
| Г | By: | Date |

COMMENTS ON REAR OF FOPM

0

QUALITY SYSTEMS, Ltd., ENGINEERS AND CONSULTANTS

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Field Radiography

Internal Inspection Checklist

| Red | lographic Location | - | _Date | Time | | | |
|-----------------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------------------------|----------------|----|--|--|
| Rad | lographer | Inspector | | | | | |
| RadioisotopsCuriesSerial No | | | | | | | |
| Pro. | Sector Serial No | Pr | rojector Node | 1 No | | | |
| Sur | vey Keter Model No | Serial No | Calibra | tion Due Date_ | | | |
| | | | | | | | |
| | | | | Yes | No | | |
| 1. | Was the radiographer wea dosimeter? | aring a film bady | ge and | | | | |
| 2. | Were other individuals w area wearing film badges | working within the and dosimeters | he restricted | | | | |
| 3. | Was the restricted area DANGER) RADIATION AREA* | posted with "CAL signs? | JTION (or | | | | |
| 4. | Was the restricted area unauthorized entry? | he restricted area properly controlled to prevent horized entry? | | | | | |
| 5. | Was the high radiation a DANGER) HIGH RADIATION A | area posted with WEA" signs? | "CAUTION (or | • | | | |
| 6. | Did the radiographer has operating survey meter? | ve a calibrated a | and properly | | | | |
| 7. | Was the utilization log | properly filled | out? | | | | |
| 8. | Did the radiographer has safety rules? (Ascertat | ve sufficient kni ined by oral que | owledge of stions.) | | | | |
| 9. | Was the radiographer won equipment? | rking with defec | tive | | | | |
| 10. | Did the radiographer pro projector and source tub reading 1 foot (0.3 m) following the radiograph | operly survey the be and take a ra- in front of the hic exposure? | e source diation . source | | | | |
| 11. | Were radioactive isotope locked to prevent unaut | es stored proper horized removal? | ly and kept | | | | |
| | | | | | | | |

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EXHIBIT 1, continued

- Yes
- 12. Was the storage area posted with "CAUTION (or DANGER) RADIOACTIVE MATERIAL" signs?
- 13. Did the radiographer possess a copy of the applicant's operating and emergency procedures and, as applicable, State or NRC rules and regulations for protection against radiation?
- 14. Were there any items of noncompliance other than those listed on this form? (If any, explain in remarks.)

Remarks

No

• FOR'I - 100'

Page - 64 UTILIZATION LOG & INVENTORY RECORD

| | | | | | Source Mate | erial | | Capsule _ | |
|---|-----------------------|---|----|---|------------------|-----------------|-----------------|------------|--------------|
| | | | | | Camera: M | odel | | Serial No. | |
| • | itory | | | | Date/Time out | Date/Time in | MR at Camera | Location | Radiographer |
| | Inven By | | | | | | | | |
| | Last Leak Test | | | | | | | | |
| | tion | | | | | | _ | | |
| | Loca | | | | | | | | |
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IRIDIUM 192 CHART

| Strength | Exposure Time in any one hour (minutes) | Distance from Perimeter of Restricted Area (feet) | mR/hr Level |
|-----------|-----------------------------------------------|------------------------------------------------------------|----------------|
| 20 Curies | 60 | 245 | 2 |
| | 30 | 170 | 4 |
| | 10 | 100 | 12 |
| | 5 | 70 | 24 |
| | 1 | 30 | 120 |
| 30 Curies | 60 | 300 | 2 |
| | 30 | 210 | 4 |
| | 10 | 120 | 12 |
| | 5 | 85 | 24 |
| | 1 | 40 | 120 |
| 40 Curies | 60 | 345 | 2 |
| | 30 | 245 | 4 |
| | 10 | 140 | 12 |
| | 5 | 100 | 24 |
| | 1 | 45 | 120 |
| 50 Curies | 60 | 385 | 2 |
| | 30 | 275 | 4 |
| | 10 | 160 | 12 |
| | 5 | 110 | 24 |
| | 1 | 50 | 120 |
| 60 Curies | 60 | 420 | 2 |
| | 30 | 300 | 4 |
| | 10 | 175 | 12 |
| | 5 | 125 | 24 |
| | 1 | 55 | 120 |
| 70 Curies | 60 | 455 | 2 |
| | 30 | 325 | 4 |
| | 10 | 185 | 12 |
| | 5 | 135 | 24 |
| | 1 | 60 | 120 |

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| Strength | Exposure Time in any one hour (minutes) | Distance from Perimeter of Restricted Area (feet) | mR/hr Level |
|------------|-----------------------------------------------|------------------------------------------------------------|----------------|
| 80 Curies | 60 | 485 | 2 |
| | 30 | 345 | 4 |
| | 10 | 200 | 12 |
| | 5 | 140 | 24 |
| | 1 | 65 | 120 |
| 90 Curies | 60 | 515 | 2 |
| | 30 | 365 | 4 |
| | 10 | 210 | 12 |
| | 5 | 150 | 24 |
| | 1 | 70 | 120 |
| 100 Curies | 60 | 545 | 2 |
| | 30 | 385 | 4 |
| | 10 | 225 | 12 |
| | 5 | 160 | 24 |
| | 1 | 70 | 120 |

Attenuation Factor of Tech/Ops Model 799 Tungsten Collimator for Ir 192 = 5.0 x 10^{-2}

| | Halr Val | lue Layers | |
|----------|----------|------------|----------|
| | Lead | Iron | Concrete |
| Ir - 192 | 0.2 | 0.5 | 1.7 |
| Co - 60 | 0.5 | 0.8 | 2.4 |

Inverse Square Law ... $I_1(D_1)^2 = I_2(D_2)^2$

I₁ = first Intensity I₂ = second Intensity D₁ = first Distance D₂ = second Distance

"OFFICIAL RECORD COHY"

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TIME DATE CONVERSATION RECORD TYPE ROUTING VISIT CONFERENCE TELEPHONE NAME/SYMBOL INT INCOMING OUTGOING Location of Visit/Conference: NAME OF PERSON(S) CONTACTED OR IN CONTACT ORGANIZATION (Office, dept., bureau, TELEPHONE NO WITH YOU 947-Quality System NDE 2991 Mike Large SUBJECT August 17, 1987 Re: Application Sted SUMMARY Met with M. Large & Andy Scraphin to discuss application Topics covered 1) Storage Area - will camera be returned each night Training of 2) Rabinguphen. - Yohr come, OJT Perfrance Ass't foliographen - 4-6 hr come us start Rad a provins Training 3) Instruments (2-1000 miller Qt Internal Inspection Program 4) (34.32 5 topus to be Evened Q+ Maintenance HRA signs posted 6) Loching & Seeing Cameron (34.23) 7 Transportation 8 (Sauce disconnect = Roda Emergeny Temp job Site 10) ACTION REQUIRED Submit NEW Agilinting Moul, 1987 NAME OF PERSON DOCUMENTING CONVERSATION SIGNATURE 9/21/87 JACK PAUS Jah, ACTION TAKEN Extent date tourd of DEC 1987 MLIO SIGNATURE TITLE "OFFICIAL RECORD COPY" OPTIONAL FORM 271 (12-76) DEPARIMENT OF DEFENSE CONVERSATION RECORD 50271-101 DU.S. G.P.O. 1983-381-526/8346