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030-21231

NRC FORM 313
(1-84)
10 CFR 30, 32, 33, 34,
35 and 40

REGULATORY COMMISSION
APPROVED BY OMB
3150-0120
Expires 5-31-87

FROM

VECTOR CORPORATION

3700 Butler Street

Pittsburgh, PA 15201

SEND TWO COPIES

INSTRUCTIONS: SEE THE
OF THE ENTIRE COMPLETE

FEDERAL AGENCIES FILE APP

U.S. NUCLEAR REGULATORY
DIVISION OF FUEL CYCLE
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APP
LOCATED IN:

CONNECTICUT, DELAWARE, NEW
MASSACHUSETTS, NEW JERSEY
OR VERMONT, SEND APPLICATION

U.S. NUCLEAR REGULATORY
COMMISSION
NUCLEAR MATERIAL SECTION
631 PARK AVENUE
KING OF PRUSSIA, PA 19406

TO

U.S. Nuclear Regulatory Commission,
Region I Attn: John E. Glenn Ph.D.

Nuclear Materials & Safeguards Branch

King of Prussia, PA 19406

HIO, OR

IA, NEBRASKA,
TEXAS, UTAH,

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA,
PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR
WEST VIRGINIA, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION II
MATERIAL RADIATION PROTECTION SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON,
AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS
TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
MATERIAL RADIATION PROTECTION SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL
IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTION.

1. THIS IS AN APPLICATION FOR (Check appropriate item)

- ☒ A. NEW LICENSE
☐ B. AMENDMENT TO LICENSE NUMBER _____
☐ C. RENEWAL OF LICENSE NUMBER _____

2. NAME AND MAILING ADDRESS OF APPLICANT (Include Zip Code)

Technical Services Division
of Vector Corporation
3700 Butler Street
Pittsburgh, Penna. 15201

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

- 1) Temporary job sites throughout United States
- 2) Storage vault (storage only) 3700 Butler Street, Pittsburgh, Pa 15201
- 3) Shielded room at Vector Corporation 493 Nixon Road, Cheswick, PA 15024
when constructed - completion date approximately October 1985

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Edward Handrahan

TELEPHONE NUMBER

(412)687-7100

SUBMIT ITEMS 5 THROUGH 11 ON 8 1/2 x 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
a. Element and mass number, b. chemical and/or physical form, and c. maximum amount
which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR
TRAINING AND EXPERIENCE

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.

9. FACILITIES:

8507260272 850624
REG1 LIC30
37-20827-01 PDR

10. RADIATION SAFETY PROGRAM.

11. WASTE MANAGEMENT.

12. LICENSEE FEES (See 10 CFR 170 and Section 170.31)

FEE CATEGORY 3 (0)

AMOUNT
ENCLOSED \$ 700.00

13. CERTIFICATION. (Must be completed by applicant) THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE
BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS
PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN,
IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948, 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION
TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

SIGNATURE - CERTIFYING OFFICER

D.E. Zappa

TYPED/PRINTED NAME

D.E. Zappa

TITLE

President

DATE

3/21/85

14. VOLUNTARY ECONOMIC DATA

a. ANNUAL REVENUE

< \$250K	\$1M - 3.5M
\$250K - 500K	\$3.5M - 7M
\$500K - 750K	\$7M - 10M
\$750K - 1M	> \$10M

b. NUMBER OF EMPLOYEES (Total for
entire facility excluding outside contractors)

c. NUMBER OF BEDS

d. WOULD YOU BE WILLING TO FURNISH COST INFORMATION (Dollar and/or staff hours)
ON THE ECONOMIC IMPACT OF CURRENT NRC REGULATIONS OR ANY FUTURE
PROPOSED NRC REGULATIONS THAT MAY AFFECT YOU? (NRC regulations permit
it to protect confidential commercial or financial - proprietary - information furnished to
the agency in confidence)

YES

☒

NO

FOR NRC USE ONLY

TYPE OF FEE

FEE LOG

FEE CATEGORY

COMMENTS

GPPL March 15th 30

"OFFICIAL RECORD COPY"

APPROVED BY

Frances Brown

AMOUNT RECEIVED

CHECK NUMBER

\$700

1394

ML10

03574

DATE

3/28/85

PRIVACY ACT STATEMENT ON THE REVEALED

MAR 25 1985

PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552a(e)(3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on NRC Form 313. This information is maintained in a system of records designated as NRC-3 and described at 40 Federal Register 45334 (October 1, 1975).

1. **AUTHORITY:** Sections 81 and 161(b) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2111 and 2201(b)).
2. **PRINCIPAL PURPOSE(S):** The information is evaluated by the NRC staff pursuant to the criteria set forth in 10 CFR Parts 30, 32, 33, 34, 35 and 40 to determine whether the application meets the requirements of the Atomic Energy Act of 1954, as amended, and the Commission's regulations, for the issuance of a radioactive material license or amendment thereof.
3. **ROUTINE USES:** The information may be (a) provided to State health departments for their information and use; and (b) provided to Federal, State, and local health officials and other persons in the event of incident or exposure, for their information, investigation, and protection of the public health and safety. The information may also be disclosed to appropriate Federal, State, and local agencies in the event that the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding. In addition, this information may be transferred to an appropriate Federal, State, or local agency to the extent relevant and necessary for an NRC decision or to an appropriate Federal agency to the extent relevant and necessary for that agency's decision about you.
4. **WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION:** Disclosure of the requested information is voluntary. If the requested information is not furnished, however, the application for radioactive material license, or amendment thereof, will not be processed. A request that information be held from public inspection must be in accordance with the provisions of 10 CFR 2.790. Withholding from public inspection shall not affect the right, if any, of persons properly and directly concerned need to inspect the document.
5. **SYSTEM MANAGER(S) AND ADDRESS:** U.S. Nuclear Regulatory Commission
Director, Division of Fuel Cycle and Material Safety
Office of Nuclear Material Safety and Safeguards
Washington, D.C. 20555

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
FOR USE OF SEALED SOURCES IN RADIOGRAPHY

TECHNICAL SERVICES
Division of
VECTOR CORPORATION

Prepared by
Edward Handrahan
Radiation Safety Officer

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Item 10.4	Radiographic Personnel Operating and Emergency Procedures Manual
Item 10.5	Leak Test Procedure
Item 11	Waste Management

ITEM 5

Radioactive Material

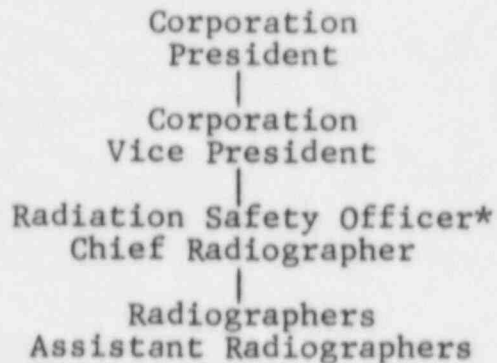
	Element and Mass Number	Source Model Number	Name of Manufacturer	Maximum Activity per source	Number of Sources	Exposure Device Model Number	Name of Mfg.	Source Changer Model No	Name of Mfg.
A	Iridium 192	A2A	Gamma Industries	100 Curies	1	Gamma Century SA	Gamma Industries	Model C-10	Gamma Industries
B	Iridium 192	A424-9	Technical Operations	100 Curies	1	Model 660	Technical Operations	Model 650	Technical Operations
C	Cobalt 60	A-8-A	Gamma Industries	100 Curies	1	Gammatron 100A	Gamma Industries	Model C-8	Gamma Industries
D	Cobalt 60	A-424-14	Technical Operations	100 Curies	1	Model 680	Technical Operations	Model 488 Model 771	Technical Operations

ITEM 6

- 1) Radiographic Exposure Devices listed in Item 5 will be used for performance of Industrial Radiography.
- 2) Source changes listed in Item 5 will be used for source exchange.

ITEM 7

ORGANIZATIONAL STRUCTURE



*Person directly assigned to maintain an active management control of the radiation program and radiographic operations.

NAME AND ADDRESS:

Edward P. Handrahan
12 McClure Road
Cheswick, PA 15024

DATE OF BIRTH:

June 7, 1939

MARITAL STATUS:

Married

EDUCATION:

Grade School-High School (Graduated)
Penn State University - Unaccredited
course in Industrial Radiography and
Radiation Safety.

EXPERIENCE IN RADIATION:

Three years as Inspector-Radiographer with
Power Piping Corp., during which time I used
X-Ray, Iridium and Cobalt Isotopes for the
purpose of weld inspection.

For 15 years, I was Chief Radiographer and
Radiation Safety Officer with Industrial
Testing Laboratory Services Corporation,
responsible for their Radiographic Facility
and the training of radiographic personnel.

Presently hold Examiner Card for Radiography
to NAVSHIPS 250-1500-1 and SNT-TC-1A, Level
III, in Radiography.

For the last three years, I have been Chief
Radiographer and Radiation Safety Officer
for Technical Services Division of Vector
Corporation. I have been responsible for
their Radiographic Facility and the train-
ing of corporate radiographic personnel.

ITEM 8

TRAINING MANUAL

OF

Technical Services Division
of Vector Corporation

Prepared by
Edward Handrahan
Radiation Safety Officer

TABLE OF CONTENTS

- I. Introduction
- II. Description of Training Program
- III. Training Procedures
- IV. Initial Training
- V. Periodic Training
- VI. On the Job Training

Appendix A - Radiographic Personnel Training and Job Designation Record.

Appendix B - Previous Radiological Safety Training.

Appendix C - Assistant Radiographer's Examination.

Appendix D - Answers to Assistant Radiographer's Examination.

Appendix E - Radiographer's Safety Examination.

Appendix F - Answers to Radiographer's Safety Examination

TRAINING MANUAL

of

Technical Services Division
of Vector Corporation

I. Introduction

Industrial radiography has become an important method of non-destructive testing of vital importance in safeguarding against the devastation which might occur as a result of an undetected flaw. The work we do as industrial radiographers must conform to rigid test specifications -- our customers and the public rely on a radiographer's training, ability and integrity to know and faithfully apply these test specifications in our work.

To perform radiographic testing, we must use potentially lethal sources of radiation. How safely these sources are used must also conform to a rigid set of specifications, which are just as essential to our work as the test specification. In fact, these safety standards and the regulations of federal and state agencies which permit us to use these potentially hazardous radiation devices are an extremely important part of every radiography job. We are relied upon to perform our work safely and this requires that we know and adhere to certain regulations. In addition, we must understand the basis for these radiation safety requirements. Many of these safety requirements are so vital to our own health as well as for protection of others that they have become law. We cannot rely on any law to make anything safe -- the regulations contain only minimum requirements for safety. To be safe we must rely on training and constant application of safety practices. To our families and friends, we are sometimes looked to as "radiation experts" and we all realize how difficult it is to be an expert in anything. While we all cannot become experts, all who work in the field of industrial radiography are required to have a basic understanding of the nature of the radioactive materials and equipment used and its hazards.

The purpose of this Training Manual is to provide you with an outline of our company's training program. This is your Training Manual -- a starting book for the training received by you, to be added to by you as additional training is received either on your own, or through formal lectures by others, or on-the-job training. Consider this manual as a start of your own set of training materials to be used in training others. Remember radiation safety training is a continuous thing -- it's never enough...never over with the last exam. Each time your work involves radiation -- your radiation safety training is being tested. Don't risk working with radiation if you're not sure you know enough to do the routine radiation job safely and know what to do in an emergency involving radiation. Your life, reputation and the safety of others depends on your training and ability to use it.

II. Description of Training Program

The training program for Technical Services Division of Vector Corp is under the technical guidance of the radiation safety officer and the administrative direction of the corporation Vice President. Our training program consists of three categories: (1) initial training (2) periodic and (3) on-the-job training. Each of these categories are described in subsequent sections of this manual along with typical outlines of various topics that are covered in these courses. Regardless of prior training and/or experience, all newly hired radiographers and assistant radiographers will receive a minimum of 18 hours of basic radiological safety orientation in the subjects listed in Appendix A of Title 10-CFR-34 "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations". A copy of Appendix A may be found on the next page. Each man will be tested to demonstrate his comprehension of these subjects. Documentation and testing of prior radiological safety training will be obtained and retained on file for each radiographer and assistant radiographer.

The basic minimum training requirement which radiography personnel must meet are set forth in 10-CFR-34.31 as follows:

34.31 "Limitations". (a) The licensee shall not permit any person to act as a radiographer until such person:

- 1) Has been instructed in the subjects outlined in Appendix A of this part and shall have demonstrated understanding thereof;
- 2) Has received copies of an instruction in the regulations contained in this part and the applicable sections of Parts 19 and 20 of this chapter, NRC license(s), and the licensee's operating and emergency procedures, and shall have demonstrated understanding thereof; and
- 3) Has demonstrated competence to use the radiographic exposure devices, sealed sources, related handling tools and survey instruments which will be employed in his assignment.

(b) The licensee shall not permit any personnel to act as a radiographer's assistant until such person:

- 1) Has received copies of and instructions in the licensee's operating and emergency procedures, and shall have demonstrated understanding thereof; and
- 2) Has demonstrated competence to use under the personal supervision of the radiographer, the radiographic exposure devices, sealed sources, related handling tools and radiation survey instruments which will be employed in his assignment.

APPENDIX A of 10-CFR-34

Subjects to be included in the initial training of all radiography personnel.

- I. Fundamentals of radiation safety
 - A. Characteristics of gamma radiation
 - B. Units of radiation dose (mrem) and quantity of radioactivity (curie)
 - C. Hazards of excessive exposure to radiation
 - D. Levels of radiation from licensed material
 - E. Methods of controlling radiation dose
 1. Working time
 2. Working distances
 3. Shielding
- II. Radiation detection instrumentation to be used
 - A. Use of radiation survey instruments
 1. Operation
 2. Calibration
 3. Limitations
 - B. Survey techniques
 - C. Use of personnel monitoring equipment
 1. Film badges
 2. Pocket dosimeters
 3. Pocket chambers
- III. Radiographic equipment to be used
 - A. Remote handling equipment
 - B. Radiographic exposure devices
 - C. Storage containers
- IV. The requirements of pertinent Federal Regulations
- V. The licensee's written operating and emergency procedures.

Basic Text and Reference Materials

The basic text books used in this training program are as follows:

NUREG/BR-0024 "Working Safely in Gamma Radiography"-U.S. Nuclear Regulatory Commission

Title 10 CFR 19 "Notices, Instructions and Reports to Workers; Inspections"

Title 10 CFR 20 "Standards for Protection Against Radiation"

Title 10 CFR 34 "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations"

Pennsylvania Health Dept. Title 25
Article V

Formal lectures and practical demonstrations will utilize the text book "Working Safely in Gamma Radiography". Students will be assigned reading of the text book listed above, plus such other reference materials as may be required by the instructor. Examination questions will be based on both the information contained in these texts as well as that presented by the instructor in lecture, demonstration or practical training exercises.

III. Training Procedures

A. Purpose

The purpose of this section of the manual is to set forth the requirements and procedures for training and qualification of the various radiographic personnel of Technical Services Division of Vector Corporation.

B. Personnel Classifications and Qualifications

1. Radiation Safety Officer (RSO)

The RSO is that person, designated by company management, who by reason of training, knowledge, and experience in industrial radiography and radioactive materials safety precautions and procedures, has direct responsibility and authority for conducting the company's radiological safety program and radiographic operations. Qualification requirements for the RSO are as follows:

The RSO shall:

- a) be a high school graduate and meet the company's medical and personnel requirements.
- b) be a qualified radiographer with at least two years experience as a fully qualified radiographer without any violation of radiation safety procedures or regulation requirements.
- c) have provided all necessary documentation of previous occupational radiation exposures.
- d) demonstrate by written and oral examination, as well as by practical demonstration, his knowledge of all subjects required in this manual.

2. Radiographer

A radiographer is any individual who performs or who, in attendance at the site where radioisotopes and X-ray equipment are being used, personally supervises radiographic operations and who is responsible to the licensee for insuring compliance with the requirements of 10-CFR-19, 10-CFR-20 and 10-CFR-34 and Pennsylvania Title 25 and the conditions of our license. Qualifications for radiographers are as follows:

III.

A radiographer shall:

- a) be at least 18 years of age
- b) have completed form NRC 4
- c) have at least three months experience as a radiographer's assistant without any violation of radiation safety procedures
- d) have completed all training required for radiographer's assistant set forth in Section IV and demonstrate his proficiency in the subject matter by written and oral examinations as well as practical demonstration of routine and emergency radiological safety procedures. Examinations for proficiency in radiographic techniques will be conducted by the RSO. Examinations in radiological safety will be conducted by the RSO.
- e) be designated as a radiographer in a probationary status for 6 months. Upon completion of 6 months without any violation of radiological safety procedures or license conditions, he shall be designated as a fully qualified radiographer.

3. Radiographer's Assistant

A radiographer's assistant is any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools or survey instruments in radiography. Qualifications for designation as a radiographer's assistant are as follows:

A radiographer's assistant shall:

- a) be at least 18 years of age
- b) have completed form NRC 4
- c) have observed radiographic operations as a trainee for at least one month
- d) have completed the training and proficiency requirements for radiographer's assistant as set forth in Section IV of this manual.

4. Trainee

A trainee is any individual assigned to the radiographic department for training who is not yet qualified as a radiographer's assistant or higher. Requirements for employment as a trainee are:

III.

A trainee shall:

- a) be at least 18 years of age
- b) have completed form NRC 4
- c) completed all training requirements, as set forth in Section 4 for designation as a radiographer's assistant within three months after designation as a trainee.

C. Responsibilities for Training

1. Radiation Safety Officer

- a) Schedule, arrange, conduct or request qualified personnel to present training as required in this manual.
- b) Schedule and conduct:
 - 1. Proficiency examinations in radiographic technique.
- c) Arrange for radiological safety qualifying examinations as required.
- d) Certify qualification and designation of radiographers and radiographer's assistants upon completion of the requirements of this manual.

2. Radiographers

Radiographers shall:

- a) Assist as requested by the RSO in presenting certain demonstrations and discussions as part of the "on the job" training of assistants and trainees toward completion of training requirements.
- b) Assist the RSO in presenting practical training sessions in radiographic technique, preparation of radiation records, and radiological safety practices as directed by the RSO.
- c) Assist in testing and certifying proficiency of trainees and assistants in radiographic technique and procedures as directed by the RSO.
- d) Conduct all radiographic operations in such manner as to exemplify safe radiographic procedure.

III. D. Procedures for Qualification and Designation

1. General Procedures

Each person assigned to the radiographic department shall maintain up-to-date training and proficiency records, reflecting the status of his qualifications. This record shall also be maintained in the RSO's files and removed only to make entries thereon. After completion of a training requirement, the individual concerned shall obtain his record from the RSO and have the requirement certified by the individual designated as responsible for certification.

2. Designation for Higher Classification

When an individual has met all requirements for the next higher classification, the RSO shall conduct the radiological safety examination for that classification, and upon certification of satisfactory performance in the examination, the RSO shall designate the individual as qualified for the higher classification on the form set forth in Appendix A of this manual.

3. Qualifications Completed Prior to Employment

If an individual has qualified as a radiographer with another employer the RSO may, at his discretion, waive such of the formal training requirements as have, in his judgement, been completed previously. The experience requirements and radiological safety examination shall not be waived. Regardless of prior training and/or experience all newly hired radiation personnel will receive a minimum of 18 hours basic radiological safety orientation and attain satisfactory grades in a written examination.

4. Qualification for Use of New Equipment

If, within the license or amendment thereto, the company acquires new radiographic equipment, all radiographers shall be trained in accordance with Section IV of the Training Course prior to using such equipment.

Qualification on new equipment shall be entered on each man's qualification record by the RSO.

IV. INITIAL TRAINING

Initial training of each radiographer or assistant radiographer will be completed and/or documented during the 30 day probationary period following assignment to radiography operations. Each man's training must total a minimum of 40 hours of formal training or proof therefore in those subjects listed in Appendix A of 10-CFR-34.

The RSO will evaluate each radiation worker's radiography experience and documentation of radiation safety training in order to determine which radiation job category (e.g. radiographer, assistant radiographer, or radiography trainee) the individual qualifies for. This decision shall be made in writing specifically stating the job classification and recommending such additional training as may be required to qualify for higher classifications. A copy of the findings along with any written examination, documentation from former employers and copies of radiological safety training certificates shall be made a part of the worker's personnel file to be maintained by the RSO. Appendix A contains a sample form which will be used to document each person's training.

Regardless of prior experience, each radiation worker will receive a minimum of 18 hours of radiological safety orientation before being assigned to work in radiation area. The training shall be given by the Radiation Safety Officer or another qualified individual designated by the RSO.

Each radiation worker must maintain his own procedures manual, a complete copy of this training manual, NRC and applicable state regulations along with a copy of our current NRC License. The RSO will test each radiation worker by written, oral and practical examinations to assure acceptable degrees of understanding of radiation safety and demonstrated ability to comply with applicable NRC and state regulations. Every newly hired employee assigned to radiation work must provide certain details on previous training and experience with radiation. Typical forms used for this information are shown in Appendix B.

TRAINING COURSE

TRAINING REQUIRED TO ADVANCE FROM TRAINEE TO ASSISTANT RADIOGRAPHER

I. Introduction (1 hour)¹

- A. Purpose - Objectives of radiological safety training.
- B. Company's policy concerning safety
 - 1. Management's philosophy and responsibility
 - 2. Commitment to comply with regulations
 - 3. Employee's safety, duties and responsibility
- C. Company's radiological safety program
 - 1. Organization
 - 2. Radiological safety officer (RSO)
 - 3. Operating and emergency procedures manual
 - 4. Regulations and safety standards

II. Fundamentals of Radiation Safety (7 hours)

- A. Atomic and Nuclear Physics
 - 1. Review of Mathematics, Physics, and Biology
 - 2. Fundamentals of Nuclear Physics
 - 3. Interaction of Radiation and Matter
- B. Characteristics of radiation and radioactivity
- C. Radiation units
 - 1. Exposure: Roentgen (R) R/hr; MR/hr
 - 2. Dose (RAD), (REM)
 - 3. Radioactivity: curie (Ci, mCi, uCi)

NOTE 1: Times shown are only approximate; actual time spent on each subject will depend on the background of the class.

II. D. Hazards of excessive radiation exposure

1. Biological effects of radiation exposure
 - a. Summary of effects resulting from whole body exposure to radiation.
 - b. Estimated doses for varying degrees of injury.
 - c. Natural and diagnostic exposures
2. Occupational implications
3. Regulatory control measures

E. Radiation levels from radioactive sources

1. Cobalt 60
2. Iridium 192
3. X-ray

F. Current radiation exposure limits

1. Occupational MPD's whole body and extremities
2. Exposure limits in unrestricted area
3. Accumulated radiation exposure history and MPD's base on 5 (N-18)

G. Methods of controlling radiation dose

1. Working time
2. Working distance
3. Shielding (HVL)

III. Radiation Detection and Measurement (6 hours)

A. Use of radiation survey instruments

1. Principles of radiation detection
2. Radiation measurements and instrumentation
 - a. Operating procedures of all company survey instruments
 - b. Detection of malfunction

- III. A. 2. c. Limitations - of all company survey instruments - Range and response
- d. Calibration
- e. Maintenance
- f. Records
- B. Survey Techniques
 - 1. Types of surveys
 - 2. Exposure devices
 - 3. Storage facilities
 - 4. Working areas, restricted and unrestricted
 - 5. Posting
 - 6. Surveillance
 - 7. Maximum allowable radiation levels
 - 8. Records and Reports
- C. Use of personnel monitoring equipment
 - 1. Film badges
 - a. Type used
 - b. When and how to wear
 - c. Records and reports
 - 2. Self reading pocket dosimeter
 - a. Type used
 - b. Method of changing
 - c. Reading - (when and how)
 - d. Records - daily dosimeter reading log
 - e. Procedure if dosimeter discharges completely
 - 3. Pocket chambers

IV. Radiographic Equipment to be Used (8 hours minimum)

- A. Remote handling equipment
- B. Radiographic exposure devices
Operation of radiographic equipment

NOTE: Four hour instruction and practice on each model exposure device owned by the company to include:

- 1. X-ray machines
 - a. Operation
 - b. Locking and securing
 - c. Radiation and electric hazards
- 2. Remote operating radioisotope device
 - a. Operation
 - b. Labeling
 - c. Locking and securing
 - d. Demonstration of ability to set up an exposure and operate the device under the supervision of a radiographer.

C. Storage containers

V. The Requirements of Pertinent Radiation Safety Standards and Applicable Regulations (4 hours)

- A. Development of radiation safety criteria and standards
 - 1. National Council on Radiation Protection and Measurement (NCRP) and ICRP
- B. Regulations of the U.S. Nuclear Regulatory Commission
 - 1. "Notices, Instructions and Reports to Workers, Inspections" 1--CFR-19
 - 2. "Standards for Protection Against Radiation" 10-CFR-20

- V.
 - B. 3. "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations" 10-CFR-34
 - C. Conditions of company's NRC Licenses
 - D. Registration and Regulation by Pennsylvania
 - 1. Pennsylvania Title 25
 - 2. Other pertinent state regulations
 - E. Other pertinent regulations
 - 1. U.S. Department of Transportation (DOT)
 - 2. Municipalities
 - 3. Turnpike and Port Authorities
- VI. Company's Procedures Manual (7 hours)
 - A. Radiographic Operating Procedures
 - 1. Radiographic equipment
 - a. Radiographic exposure devices
 - b. Storage and shipping containers
 - 2. Conducting a Leak Test
 - a. Steps in taking a Leak Test
 - b. Qualifying to take a Leak Test
 - c. Records
 - 3. Locking, surveying and securing radiographic exposure devices and associated equipment
 - a. Shops
 - b. Field
 - 4. Conducting radiation surveys
 - a. Shop radiographic facilities
 - b. Shop area
 - c. Field

- VI.
 - A. 5. Methods of controlling access to radiation areas
 - a. Surveillance
 - b. Rope-off and post
 - c. Locking
 - d. Alarm systems
 - 6. Records
 - a. Types of records required
 - b. Where records will be kept
 - c. Responsibility for keeping records
 - B. Radiation Emergency Procedures
 - 1. Detecting and evaluating an emergency
 - a. Performing initial radiation survey
 - b. Evacuation, isolation, and security of affected area and equipment
 - c. Evaluation of possible personnel exposure (health, physics and medical)
 - d. Notification RSO and other necessary personnel
 - 2. Development and selection of emergency recovery plan
 - a. Initial and alternate plan
 - b. Selection of personnel and equipment
 - c. Practice run
 - d. Exposure calculation for initial and alternate plans
 - e. Instructions to support personnel, additional help on stand-by

VI. B. 3. Recovery operation

- a. Cautious adherence to plan - know when to abandon it
- b. Selection of alternate plan, or evaluate and obtain additional help
- c. Survey and security of affected area of equipment after recovery

4. Documentations and Notification

- a. Radiation survey and personnel monitoring data
- b. Description of incident (equipment, area, and personnel)
- c. Determination of cause and remedial action necessary to prevent recurrence
- d. Notification (Company officials; NRC; State)

VII. Practical Demonstration of Emergency Procedures (5 hours)

A. Some types of radiation emergencies

- 1. Source disconnect
- 2. Crimped or smashed source tube
- 3. Broken control cable

B. Demonstration of emergency procedures

- 1. Radiation survey
- 2. Calculations of radiation exposure
- 3. Recovery operations
- 4. Critique

VIII. Radiation Records and Reports (2 hours)

A. Preparation of radiation records

- 1. Radiation survey

- VIII.
 - A.
 - 2. Personnel monitoring (dosimeter records and film badge reports)
 - 3. Source utilization
 - 4. Leak tests
 - 5. Radioactive material transfer records
 - 6. Radiation overexposure reports
 - 7. Radiation equipment inspection reports
- IX. Inspection and Maintenance Performed by the Radiographers (2.0 hours)
 - A. Daily maintenance check of radiography device
 - 1. Daily check list on equipment
 - 2. Reporting damage
 - 3. Recording results of examination
 - 4. Maintenance to be performed on equipment daily
 - B. Quarterly inspection and maintenance on radiography device
 - 1. Inspection procedure device
 - 2. Inspection of source tube
 - a. Maintenance to be performed on source tube
 - 3. Inspection of control cables
 - a. Maintenance to be performed on control cables
 - b. Lubrication of control cable
 - 4. Records of quarterly inspection
- X. Case Histories of Radiography Accidents(2.0 hours)
 - A. Review of case histories
 - B. Discussion of how accident could have been prevented

XI. Examination and critique

NOTE: Appendicies C, D, E and F are representative of the examinations given to radiographic personnel for advancement to Assistant Radiographer and Radiographer positions. The tests and related answer sheets are not included in the copy of the Training Manual given to Radiographic Personnel.

V. PERIODIC TRAINING

The RSO shall present a minimum of 18 hours per year of radiation safety training to every radiation worker. This training will include instruction in radiation safety practices and procedures; changes or amendment of the company's licenses, regulations, revisions of safety manuals or changes in routine or emergency procedures; review of the use of radiation instrumentation, personnel monitoring devices, radiography equipment currently assigned to radiography personnel; radiation records and reports required by these procedures and current regulations. The number of lecture hours of periodic or refresher training shall be documented and maintained in each worker's personnel file, along with copies of all examinations. A typical course outline is included in the next few pages.

PERIODIC TRAINING COURSE IN RADIATION SAFETY (16-18 hours)

I. Introduction (1 hour)¹

- A. Purpose - objectives of radiological safety training
- B. Company's policy concerning safety
 - 1. Management's philosophy and responsibility
 - 2. Commitment to comply with regulations
 - 3. Employee's safety, duties, and responsibilities
- C. Company's radiological safety program
 - 1. Organization
 - 2. Radiation safety officer (RSO)
 - 3. Operating and emergency procedures manual
 - 4. Regulations and safety standards
 - 5. Recent or anticipated changes in the above

II. Fundamentals of Radiological Safety(3 hours)

- A. Characteristics of gamma radiation
- B. Radiation units
 - 1. Exposure (R) Roentgen
 - 2. Dose (RAD), (REM)
 - 3. Radioactivity (C) curie
- C. Hazards of excessive radiation exposure
 - 1. Biological effects of radiation
 - 2. Occupational implications
 - 3. Regulatory control measures
- D. Radiation levels from radioactive sources
- E. Current radiation exposure limits
 - 1. Occupational MPD's whole body and extremities
 - 2. Exposure limits in unrestricted areas
 - 3. Accumulated radiation exposure history and MPD's based on 5 (N-18)
- F. Methods of controlling radiation dose
 - 1. Working time
 - 2. Working distance
 - 3. Shielding (HVL)

NOTE 1: Times shown are only approximate; actual time spent on each subject will depend on the background of the class.

III. Radiation Detection and Measurement (2 hours)

- A. New instrumentation
- B. Use of radiation survey instruments
 - 1. Operation
 - 2. Calibration
 - 3. Limitations
- C. Survey techniques
 - 1. Check potential "trouble spots"
 - 2. Meter malfunctions - what to do
- D. Use of personnel monitoring equipment
 - 1. Film badges
 - 2. Pocket dosimeters

IV. Radiographic equipment to be used (2 hours)

- A. Recent or anticipated changes or modifications of equipment of procedures
- B. Remote handling equipment
- C. Storage containers

V. The requirements of pertinent Radiation Safety Standards and applicable regulations (2 hours)

- A. Regulations of the U.S. Nuclear Regulatory Commission
 - 1. "Standards for Protection Against Radiation" 10-CFR-20
 - 2. "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations" 10-CFR-34
 - 3. "Notices, Instructions and Reports to Workers; Inspections" 10-CFR-19
- B. Conditions of the company's NRC License
- C. Licensing and regulation by NRC Agreement States
- D. Other pertinent regulations
 - 1. Occupational Safety and Health Administration
- E. Recent or anticipated changes in the above

VI. The company's Procedures Manual (2 hours)

- A. Radiographic operating and emergency procedures
- B. Modifications, additions, changes in the above

VII. Radiation records and reports (1 hour)

- A. New or modifications in records, systems or reports.
- B. Preparation of radiation records
 - 1. Radiation survey
 - 2. Personnel monitoring (dosimeter records)
 - 3. Source utilization
 - 4. Leak Tests
 - 5. Radiation overexposure reports
 - 6. Radiographic equipment inspection reports.

VIII. Radiation emergency procedures (3 hours)

- A. Detecting and evaluating an emergency
 - 1. Performing initial radiation on survey
 - 2. Evacuation, isolation, and security of affected area and equipment
 - 3. Notification RSO and other necessary personnel
- B. Documentations and Notification
 - 1. Radiation survey and personnel monitoring data
 - 2. Description of incident (equipment, area, and personnel)

IX. Practical demonstration of emergency procedures (2 hours)

- A. Some types of radiation emergencies
 - 1. Source disconnect
 - 2. Crimped or smashed source tube
 - 3. Broken control cable
- B. Demonstration of emergency procedures
 - 1. Radiation survey
 - 2. Calculations of radiation exposure risks
 - 3. Recovery/operations
 - 4. Critique

X. Examination and critique

VI. ON THE JOB TRAINING

The RSO or person delegated by him, shall provide on-the-job training for company personnel to familiarize them with the routing and emergency procedures. Supervisory personnel will also participate in this training. The main purpose of this type of training is to provide sufficient individual instruction, of a practical nature, to acquire the necessary competency in the handling, inspection and use of radiographic exposure devices; collimators and source recovery tools; preparation of radiation records; and use of radiation survey instruments. Both routine and emergency situations will be covered in this phase of training. The results of written and oral exams including practical demonstrations will be documented for each individual on a form similar to that shown in Appendix A.

Some of the typical subjects to be included in our on-the-job training are informal lectures and practical demonstrations in the following:

1. Inspection and maintenance of radiographic equipment
 - a. Use and maintenance of current equipment
 - b. What trouble symptoms to look for
 - c. What to do about these before a potentially serious incident occurs
 - d. How to document the daily inspection of cameras
 - e. Performing a leak test
2. Evaluation of radioisotope storage practices and problems
3. Routine radiography operations
 - a. Initial calculation of radiation zones
 - b. Setting up for a radiographic exposure
 - c. Making the exposure
 - d. Survey and documentation and surveillance
 - e. Post exposure survey and documentation
4. Practice in detecting and controlling radiation emergencies
 - a. Evaluation and notification
 - b. Controlling situation until help arrives
 - c. Recovery
 - d. Documentation
5. Radiation survey meters
 - a. Current model - use and limitations
 - b. New instruments - use maintenance, etc.
6. New radiographic equipment and techniques
 - a. Use of collimators
 - b. Special shields
7. Changes in safety regulations, procedures
 - a. Reemphasis upon recent problems

APPENDIX A

RADIOGRAPHIC PERSONNEL TRAINING AND JOB DESIGNATION RECORD

Name: _____ Social Security Number _____
 Date of Birth: _____ Job Application _____
 Date _____
 Date Employed: _____

TRAINING RECORD

Subject	Hours	Date
Fundamentals of Radiation Safety	_____	_____
Radiation Detection and Measurement	_____	_____
Radiographic Equipment	_____	_____
Safety Regulations	_____	_____
Operating and Emergency Procedures	_____	_____
Radiation Records	_____	_____
Radiation Emergency Procedures	_____	_____
Practical Demonstration of Emergency Procedures	_____	_____

WRITTEN EXAMINATION RESULTS: Grade _____ Passing Score _____

Designated as Assistant Radiographer on _____ 19 ____.

Signed _____ RSO

Written examination results: Grade _____ Passing Score _____

Designed as a Radiographer, probationary status, on _____ 19 ____.

Equipment covered by this qualification includes: _____

By _____
 (Signature of RSO)

Designated as a full Radiographer on _____ 19 ____

By _____
 (Signature of RSO)

APPENDIX A (Cont.)

SUPPLEMENTAL QUALIFICATION RECORD:

<u>Equipment</u>	<u>Date Qualified</u>	<u>RSO Signature</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

PREVIOUS RADIOLOGICAL SAFETY TRAINING

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APPENDIX C

WRITTEN FINAL GRADE _____ %

FIELD EXAM. FINAL GRADE _____ %

PASSING SCORE 80%

ASSISTANT RADIOGRAPHER'S EXAMINATION

Name _____ Social Security Number _____

Date of Birth _____ Present Classification _____

Date Assigned to Radiography _____

Date Examination Completed _____

EXPERIENCE

I. Fundamentals of Radiation Safety (3 points per Question)

1.

A. Name the fundamental principles involved in controlling radiation exposures and explain why they control the exposure.

B. What is the overall effect on exposure rate and exposure of these controls?

2. What are the half-life periods for the following:

Iridium - 192 _____

Cobalt - 60 _____

3. What are the gamma dose rates unshielded for the following isotopes at one (1) meter and at one (1) foot?

Iridium - 192 _____ at 1 meter _____ at 1 foot

Cobalt -60 _____ at 1 meter _____ at 1 foot

4. Define the inverse square law.

5. A. How many milliroentgens in one (1) roentgen?

B. 5000 mR = _____ R

17600 mR = _____ R

0.082 R = _____ mR

2.065 R = _____ mR

6. Name three (3) types of the most common materials used to reduce radiation intensities.

1)

2)

3)

7. What is the dose rate at 10 feet from an Iridium-192 source of 100 curies?

8. What is the dose rate at 50 feet from a 50 curie Iridium-192 source?

9. If you have a reading of 160 $\frac{\text{mR}}{\text{Hr}}$ at 10 feet, what will your reading be at 40 feet?

II. Operation and Emergency Procedures

(3 points each except
where noted)

1. What is the Assistant Radiographer's job assignment when a source is jammed in the source tube?
2. Describe exactly what you would do if your dosimeter pencil went beyond range during radiographic operations.
3. What would you do if you dropped your film badge near the exposure device while performing industrial radiography?
4. List the name and phone number of your Radiation Safety Officer:
Radiation Safety Officer _____
Plant Phone Number _____
5. When performing radiography in the shielded room facility, is an area radiation monitor permitted to be used in place of the survey meter? (Give reasons for your answer)
6. Describe the operations performed before using a survey meter.
Step 1)
Step 2)
Step 3)
Step 4)
7. How often must a survey meter receive the following:
 - a. Leak Testing (if meter has a check source)
 - b. Calibration

8. If your survey meter becomes inoperable during a field project, would you continue to use your exposure device? Give reason.
9. Why do we utilize survey meters in industrial radiography?
10. Match the following: (10 points)
- | | |
|--|----------------------------|
| _____ 1. A dosimeter pencil measures | a. 3 months |
| _____ 2. An exposure device must be leak tested every | b. greater than 2 mR/hr. |
| _____ 3. The range of your survey meter for industrial radiography | c. 9 months |
| _____ 4. A survey meter must be calibrated every | d. greater than 5 mR/hr. |
| _____ 5. Survey meter measures | e. exposure rate |
| _____ 6. If a survey meter has a check source it must be leak tested every | f. less than 2 mR/hr. |
| _____ 7. Radiation area | g. 30 days |
| _____ 8. Restricted area | h. greater than 100 mR/hr. |
| _____ 9. Unrestricted area | i. radiation received |
| _____ 10. High radiation area | j. 1 mR to 1 R |
| | k. 0.5 mR to 5 R |
| | l. greater than 100 R/hr. |
| | m. 6 months |
11. What responsibilities does the assistant radiographer have in performing industrial radiography?

12. Is the assistant radiographer permitted to make any change in the operating and emergency procedures used by this company?
13. What personnel monitoring equipment is required to be used by the assistant radiographer?
14. How long are film badges to be worn?
15. The worker may exchange a film badge with another person under what conditions?
16. How often must a dosimeter pencil be charged?
17. When must the radiographic exposure device be locked?
18. Describe in detail how to use a radiographic exposure device.
(12 Points)

Appendix C

ASSISTANT RADIOGRAPHER'S FIELD EXAMINATION

1. Show how to properly inspect a survey meter prior to use.
2. Set up a gamma century SA Camera, survey site and post-required signs and ropes.
3. Show steps to be taken after last shot of the day.
4. Your dosimeter is off scale. Show steps to be taken.
5. Show your duties if a source is disconnected in the guide tube.

APPENDIX D

ANSWERS TO ASSISTANT RADIOGRAPHER'S EXAMINATION

I. Fundamentals of Radiation Safety.

1. A. (a) Time-the less time you are near the source, the less radiation you will receive.
(b) Distance-the further away the less radiation you will receive.
(c) Shielding-the more you are shielded from the source, the less radiation you will receive.
B. Reduces exposure rate and thus the possible exposure that an individual might receive.
2. Iridium-192 - 75 days
Cobalt-60 - 5.25 years
3. Iridium-192 - $\frac{0.55 \text{ R/hr. per Ci}}{\text{at 1 foot}}$ at 1 meter $\frac{5.9 \text{ R/hr per Ci}}{\text{at 1 foot}}$
Cobalt-60 - $\frac{1.35 \text{ R/hr. per Ci}}{\text{at 1 foot}}$ at 1 meter $\frac{14.5 \text{ R/hr. per Ci}}{\text{at 1 foot}}$
4. Exposure rate varies inversely with the square of the distance from the source.
5. A. 1000 mR per R
B. $5000 \text{ mR} = 5 \text{ R}$
 $17600 \text{ mR} = 17.6 \text{ R}$
 $0.082 \text{ R} = 82 \text{ mR}$
 $2.065 \text{ R} = 2065 \text{ mR}$
6. 1) Lead
2) Steel
3) Concrete
7. $(100 \text{ Ci}) (5.9 \text{ R/hr. per Ci at 1 ft.}) = 590 \text{ R/hr. at 1 ft.}$
 $\frac{590 \text{ R/hr. at 1 ft}}{100} = 5.9 \text{ R/hr. at 10 ft.}$
8. $\frac{(50 \text{ Ci}) (5.9 \text{ R/hr. per Ci at 1 foot})}{2500} = 0.118 \text{ R/hr.} = 118 \text{ mR at 50 feet}$
9. Going from 10 ft. to 40 ft. so 1/16 the exposure
 $\frac{160 \text{ mR/hr.}}{16} = 10 \text{ mR/hr. at 40 ft.}$

II. Operating and Emergency Procedures

1. Survey area and make adjustments and barricades if necessary. He should secure area while Radiographer calls for instructions. Keep area under constant surveillance.
2.
 - 1) Survey the area to be sure source is in safe position.
 - 2) Notify Radiation Safety Officer.
 - 3) Turn your film badge in and do not work with radioactive material until your film badge has been processed and results are received.
3.
 - 1) Note reading on dosimeter pencil.
 - 2) Contact Radiation Safety Officer giving him full details.
 - 3) Cease operation until a new film badge is obtained.
4. Radiation Safety Officer - Edward P. Handrahan
Plant Phone Number - 412
5. No, a monitor is only a supplementary device not to be used in place of the survey meter.

The detector may be too far away or in an unfavorable position relative to the radioactive source to detect a hazard.
6.
 - 1) Check sticker on side of instrument to see if meter has been calibrated.
 - 2) Turn to "Zero" position and adjust needle to 0.
 - 3) Turn to lowest range selector position and make certain needle returns to zero.
 - 4) Turn selector to another rate range and make certain needle returns to zero.
7.
 - a. Every 6 months
 - b. Every 3 months
8. No. Because you have no way of knowing if your source has been returned to the shielded position.
9. To insure safe working conditions by making sure the sealed source has been retracted properly to the shielded position.
10. Matching:

1. i	5. e	9. f
2. m	6. m	10. h
3. j	7. d	
4. a	8. b	
11.
 - 1) Assist the radiographer in his work.
 - 2) Demonstrate an understanding of the operating and emergency procedures as contained in the manual.

11. 3. Exhibiting the competence to use radiographic equipment survey meters and safety devices under the direct supervision of the radiographer.
12. No changes or modifications are to be made in any part of this manual or in any operating or emergency procedure until the proposed revision has been submitted to the RSO in writing and approved by him.
13. Film badge and dosimeter pencil
14. One (1) month
15. E. Under no conditions may one person exchange a film badge with another person.
16. F. Daily
17. G. After every exposure
18. Operation
 - 1) Have an operating survey meter on hand always and use it.
 - 2) Remove the protector cap from the lock box, thereby exposing the pigtail connector.
 - 3) Crank the control cable to a length of approximately six (6) inches.
 - 4) Connect the control cable and source pigtail.
 - 5) Crank control cable in so that male connecting thread can be screwed into lock box.
 - 6) Screw control cable into lock box.
 - 7) Remove safety plug from protruding nipple approximately 1" from top of unit. Connect source tube.
 - 8) Place free end of source tube in desired position trying to keep in a straight line without kinks.
 - 9) Stretch control cable away from exposure device in as straight a line as possible. (Radiographer should take advantage of local shielding when possible to limit the amount of radiation he receives.)
 - 10) Clear all personnel from the area and post appropriate radiation warning signs at the approximate distances from the source relative to the amount of radioactivity used.

- 11) Unlock the unit. Note: On the Gamma "Century SA", the unit is unlocked by turning the control crank handle back (counterclockwise) which will permit the key to be turned.
- 12) Crank source out as smoothly as possible. When you feel that source is approaching end of source tube, slow turning speed so that pigtail does not strike the end of the source tube with undue force.
- 13) Survey the area and check the locations of radiation warning signs.
- 14) Maintain continuous surveillance of high radiation except if the area is equipped with a radiation control device or an alarm system, or where the radiation area is kept locked to prevent any accidental or unauthorized entrance.
- 15) At end of exposure, retract source into unit. To positively determine that the sources are in the safe position, all radiographers shall make a radiographic survey of the source shield after each exposure to confirm that the source is in the shielded position. With the source in the shielded position, the radiation levels at the surface of the source shield may vary from 10 mR to 200 mR/hr. Note: A zero radiation level could indicate that the source did not return to the storage position. If this should happen, the radiation emergency procedures shall be followed.
- 16) Depress lock plunger. Note: On the Gamma "Century SA" unit, turn crank handle back (counterclockwise) and depress lock plunger.
- 17) Disconnect control cable.
- 18) Screw safety cap into place.
- 19) Remove the film and disconnect the source tube and replace the plug over the opening.
- 20) Return the exposure device and equipment to the radioisotope storage area.
- 21) Lock the radioisotope storage area.

APPENDIX D

ASSISTANT RADIOGRAPHER'S FIELD EXAMINATION CHECK LIST

1. (a) Calibration date
 (b) Meter response
 (c) Battery condition or zero
2. (a) Camera survey and record
 (b) Daily check list and record
 (c) Leak Test
 (d) Survey meter calibration
 (e) Control cable assembly
 (f) Position source tube
 (g) Rope off and post signs at proper points.
 (h) Attach source tube, unlock and expose.
 (i) Readjust barrier if needed.
 (j) Retract source, check with meter, lock and survey -
 including guide tube.
3. (a) Remove key from lock.
 (b) Properly position safety plugs.
 (c) Survey device record results
 (d) Return to storage area - lock area.
4. (a) Survey area.
 (b) Notify R.S.O.
 (c) Turn in film badge - cease operations.
5. (a) Survey area - adjust barrier.
 (b) Help secure area - keep under surveillance.

APPENDIX E

RADIOGRAPHER'S SAFETY EXAMINATION

FINAL GRADE: _____%

PASSING SCORE: 80%

NAME _____ SOC. SEC. NO. _____

DATE OF BIRTH _____ PRESENT CLASSIFICATION _____

DATE ASSIGNED TO RADIOGRAPHY _____

DATE EXAMINATION COMPLETED _____

EXPERIENCE

I. FUNDAMENTALS OF RADIATION SAFETY

1. There are three (3) fundamental principles involved when controlling exposure to radiation. List the three (3) and give brief description of how they protect you from receiving radiation.
 - (a)
 - (b)
 - (c)
2. Define the following terms:
 - (a) "half-life" -
 - (b) Curie -
 - (c) Roentgen -
 - (d) Dose -
 - (e) Dose Rate -
 - (f) Restricted Area -
 - (g) Inverse Square Law -

3. Matching

- | | |
|--|---------------------------|
| _____ 1. Half life period for ⁶⁰ Co | A. 3 months |
| _____ 2. The gamma dose rate of 100 Ci of ¹⁹² Ir at 2 feet is | B. greater than 2 mR/hr. |
| _____ 3. half life period for ¹⁹² Ir | C. greater than 5 R/hr. |
| _____ 4. a dosimeter pencil measures | D. 9 months |
| _____ 5. an exposure device must be leak tested every | E. 14.5 R/hr. |
| _____ 6. the range of your survey meter for industrial radiography | F. greater than 5 mR/hr. |
| _____ 7. the gamma dose rate of 1 Ci of ⁶⁰ Co at 1 foot is | G. dose rate |
| _____ 8. a survey meter must be calibrated every | H. 5.9 R/hr. |
| _____ 9. survey meter measures | I. 148 R/hr. |
| _____ 10. if a survey meter has a check source, it must be leak tested every | J. less than 2 mR/hr. |
| _____ 11. a milliroentgen is how much of a roentgen? | K. 75 days |
| _____ 12. radiation area | L. 30 days |
| _____ 13. restricted area | M. greater than 100 mR/hr |
| _____ 14. unrestricted area | N. 1.25 years |
| _____ 15. high radiation area | O. 1/10,000 |
| | P. radiation received |
| | Q. 1 mR to 1 R |
| | R. 0.5 mR to 5 R |
| | S. 2.7 inches |
| | T. 5.25 years |
| | U. greater than 100 R/hr. |
| | V. 6 months |
| | W. 1/1,000 |

4. What is the purpose of a Strontium 90 source in a survey meter?
5. What would you do if during radiographic operations on a field project, you discovered your survey meter was not working?
6. Describe exactly at what intervals you utilize your survey meter after arriving at a radiographic assignment.
7. When a survey meter is removed for radiographic operations, how do you know that the instrument has been calibrated within the required limits?
8. What are the required range limits per AEC Regulations that your survey meter must be able to detect radiation?
9. Describe in detail, exactly what steps must be taken after your exposure time has elapsed when using a remote exposure device.
10. Describe how you would make an exposure with a Gamma Century exposure device.
11. Why is it necessary to survey the front (source tube side of unit) after each exposure" Explain in detail.
12. How often must a radioisotope be leak tested and what are the required limits of contamination?

13. How do you secure an exposure device on a field radiographic project when going to lunch?
14. How do you know the activity of your radioisotope in your exposure device?
15. Vehicles hauling radioactive materials:
 - (a) What type warning signs are required?
 - (b) Where should they be placed?
 - (c) What is the maximum allowable radiation outside your vehicle?
16. What would you do if you dropped your film badge near a source while your exposure was in the "ON" position and what must you do in the event that you do not discover it until the exposure has been completed?
17. What action would you take if you knew your source was loose in the source tube?
18. What would you do if your dosimeter pencil went off-scale during radiographic operations and you were 200 miles away from your home office?
19. What is the range of your dosimeter pencil and where must it be worn?
20. Do your procedures permit you to leave a restricted area unattended during an exposure?

APPENDIX F

ANSWERS TO RADIOGRAPHER'S SAFETY EXAMINATION:

1.
 - (a) Distance - the further away the less radiation you will receive.
 - (b) Time - the less time you are near the source, the less radiation you will receive.
 - (c) Shielding - the more you are shielded from the source, the less radiation you will receive.
2.
 - (a) "half-life" - the period of time in which a given quantity of a specific radioactive isotope will decay to an activity equal to one-half ($1/2$) of the original activity.
 - (b) Curie - the unit of activity for measuring the quantity of a radioactive material.
 - (c) Roentgen - the unit of measure of radioactive material received.
 - (d) Dose - amount of radiation received.
 - (e) Dose Rate - amount of radiation received per hour.
 - (f) Restricted Area - any area greater than 2 mR/hr.
 - (g) Inverse Square Law - as the distance is doubled, the radiation is reduced to $1/4$ the original level.
3. Matching:

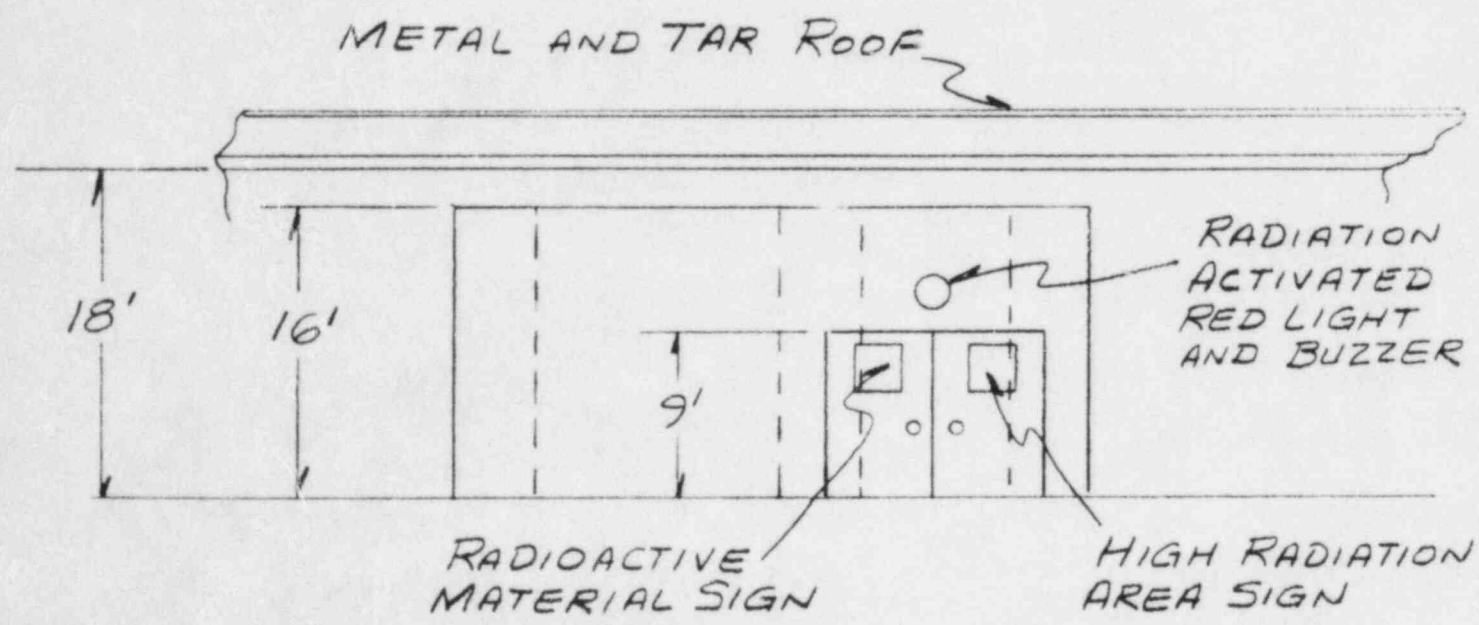
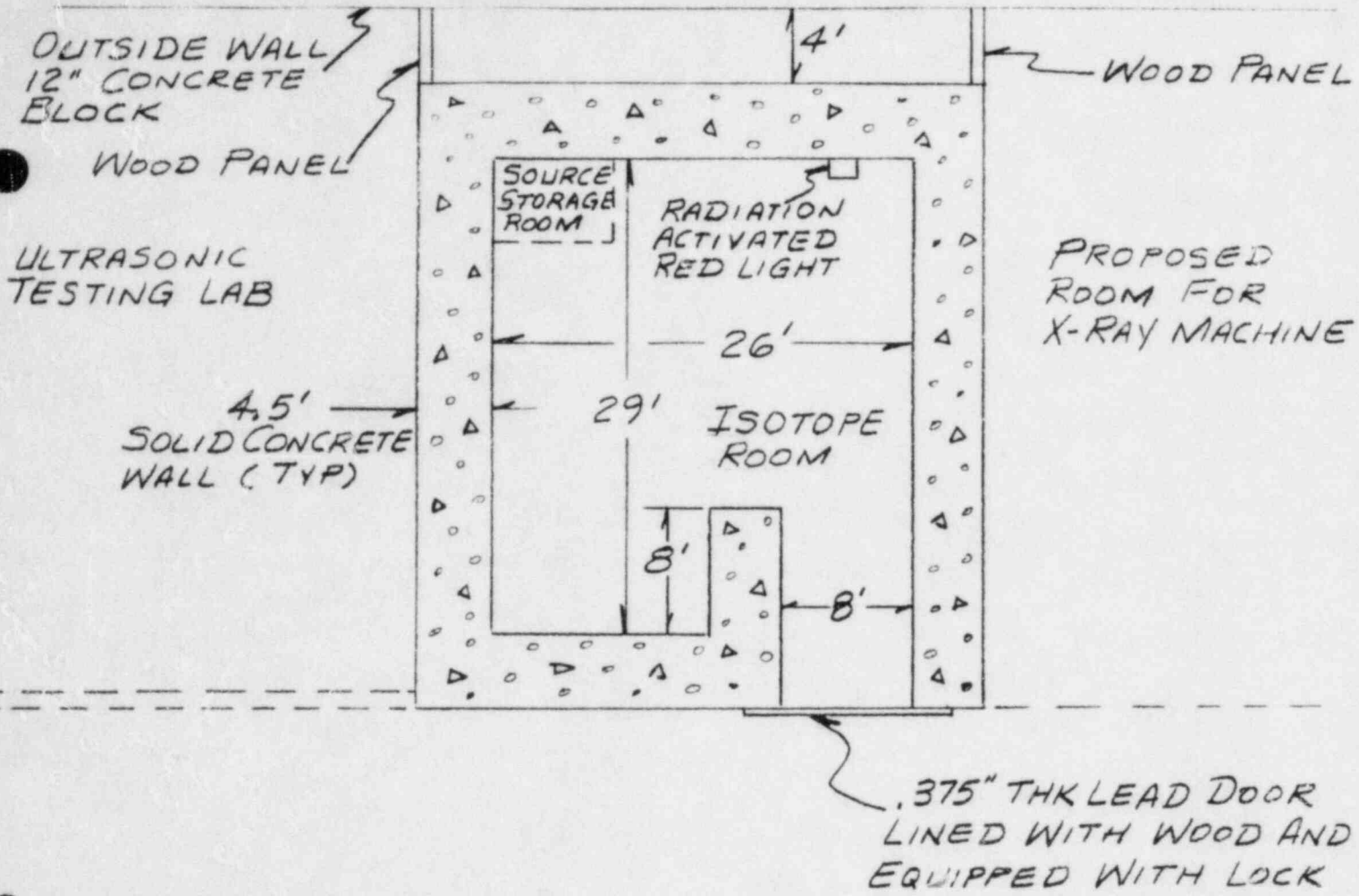
1. T	6. Q	11. W
2. I	7. E	12. F
3. K	8. A	13. B
4. P	9. G	14. J
5. V	10. V	15. M
4. Strontium 90 is used as a check source to determine if meter is capable of detecting ionizing radiation.
5. Stop all operations.
Check dosimeter pencil for radiation exposure.
Make sure survey meter is not working.
Notify RSO for replacement meter.

6. Prior to operations.
After each exposure.
Assignment is completed, therefore, survey vehicle.
7. The survey meter should have a sticker on it indicating last calibration date and the calibration due date.
8. 2 mR/hr. to 1 R/hr.
9. Turn crank counter-clockwise until the source is returned to the camera. Survey exposure device. Survey the entire tube. Lock camera.
10. Makeing an exposure with a Gamma Century exposure device:
 - (a) remove safety plug from lock box.
 - (b) pull out pigtail 1/2 inch and connect control cable to pigtail.
 - (c) thread control cable to lock box.
 - (d) remove safety plug from source tube side of unit and thread on source tube.
 - (e) unlock unit and crank clockwise to expose source.
 - (f) After exposure time has elapsed, crank source back in counter-clockwise and lock source in position.
 - (g) survey unit and source tube.
11. The source may not be fully retracted into the unit.
12. Every six (6) months. 0.005 microcuries.
13. Lock the source in the camera and lock the camera inside the vehicle. Chain it to a steel beam and post warning signs around source.
14. Decay curve or 75 day half-life.
15. Vehicle hauling radioactive materials:
 - (a) signs required: Caution - - Radioactive Material or Radioactive
 - (b) placement: outside the vehicle on both sides and rear
 - (c) macimum allowable radiation outside vehicle: 2mR/hr.

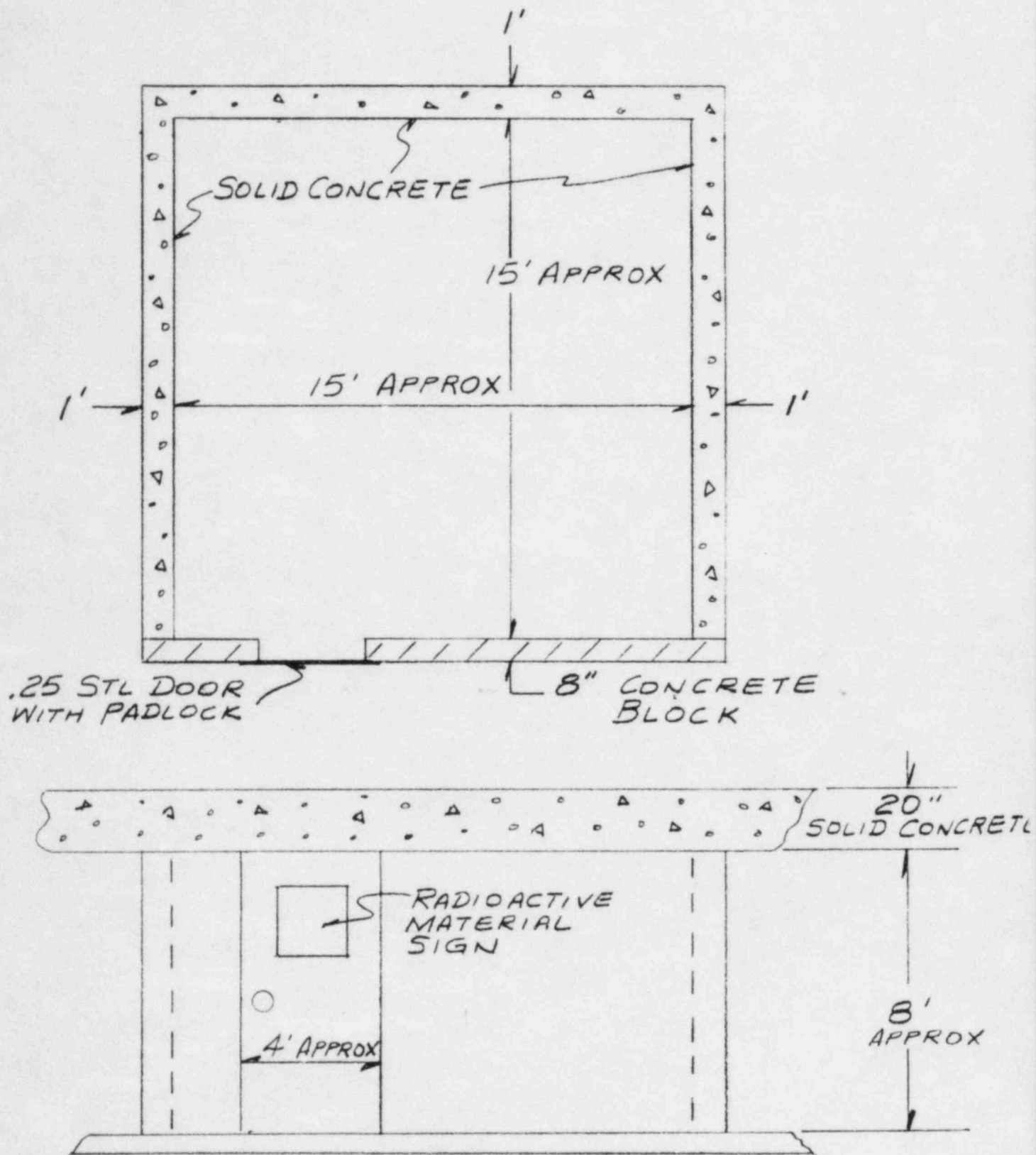
16. Stop operations immediately, contact RSO, and send film badge in for immediate processing. Get new badge and make a statement of facts.
17. Return to the control cable and turn the hand crank clockwise and counter-clockwise trying to bring the pigtail back into the unit. If this is not successful, then the area should be secured and posted as a Restricted Area, and the RSO should be called.
18. Notify RSO immediately.
19. 0 to 200 mR. It must be worn where it will pick up the maximum amount of radiation while you are working on job assignment.
20. 100.

ITEM 9

Sketch of
Facility and
Safety Equipment



RADIOGRAPHIC EXPOSURE ROOM
(RADIO ISOTOPES)
 493 NIXON ROAD
 CHESWICK, PA 15024



TEMPORARY
RADIOISOTOPE STORAGE VAULT
 3700 BUTLER ST
 PGH PA 15201

ITEM 9

Technical Services, a division of Vector Corporation, proposes to use a vault at our current facility at 3700 Butler Street, Pittsburgh, Pennsylvania 15201 to store radiographic sources until our shielded room is constructed at our new facility at 493 Nixon Road, Cheswick, Pennsylvania 15024. The sources will be used at various field sites throughout the United States.

When the exposure room is completed the sources will be stored and operated in the exposure room as well as field sites.

The N.R.C. will be advised when the move is made so they may inspect the operations at the new facility.

The vault at 3700 Butler Street is a safe and secure storage facility to store radiographic sources and will be under the direct daily control of the radiation safety officer with access limited to him or radiographers designated by him.

The vault will be secured with a padlock at all times sources are not being removed or placed into the vault for storage.

ITEM 10.1

Personnel monitoring equipment:

Film badges will be supplied on a monthly basis by:

Radiation Detection Co.
162 Wolfe Road
Sunnyvale, CA 94086

All radiographic personnel are supplied with pocket dosimeters in addition to their film badges.

ITEM 10.2

Instrument Types - Make & Model No.....Victoreen 492
Number Available.....2
Radiation Detected.....Gamma & X-Ray
Sensitivity Range (mR/hr).....0-1000 mR/hr
Use (Monitor, Survey, Meas.).....Survey

Instrument calibration procedures:

Radiation survey meters will be calibrated every three (3)
months and after each instrument servicing by:

Applied Health Physics, Inc.
2986 Industrial Boulevard
P. O. Box 197
Bethel Park, PA 15102

ITEM 10.3

INTERNAL INSPECTION AND AUDITING SYSTEM

ITEM 10.3

INTERNAL INSPECTION AND AUDITING SYSTEM

The company official who signed the application for Technical Services Division of Vector Corporation current NRC License has delegated the responsibility and authority of operation of our Radiography Safety Program to the Radiation Safety Officer. The company official is legally accountable to regulatory agencies for any loss or injury resulting from the use of radiation sources by the company. No changes or modification will be made in the Internal Inspection and Auditing System or the Radiographic Personnel Operating and Emergency Procedures Manual until the proposed revision has been approved by the RSO. The proposed changes will then be transmitted to the appropriate regulatory agencies for their review and comments. Upon approval by the official agencies, changes will be made in the appropriate procedures.

DUTIES OF THE RADIATION SAFETY OFFICER

- 1) Monitor all activities of the Radiation Safety Program monthly to ensure compliance with NRC regulations:

10-CFR-19-Notices, Instructions and Reports to
Workers; Inspections

The following will be posted in accordance with Part 19:

- 1) Part 19 Notice to Employees (FIGURE 1)
NRC 3 (FIGURE 2)
Pennsylvania Notice to Employees (FIGURE 3)
- 10-CFR-20 - Standards for Protection Against Radiation
- 10-CFR-30 - Rules of General Applicability to Licensing of Byproduct Material
- 10-CFR-34 - Licenses for Radiography and Radiation Safety Requirements for Radiography Operations
- 2) Monitor all activities of the Radiography program to ensure their compliance with the company's operating and emergency procedures.
- 3) Handle all contact with Federal, State, and Local regulatory agencies relative to the licensing and use of radiation either directly or through his superiors.
- 4) Control the procurement, use, storage, transfer, and disposal of all radioactive materials and radiation producing equipment including documentation. (FIGURES 4 and 5)
- 5) Supervise the personnel monitoring program including issuance of film badges on a monthly basis and dosimeters and keeping film badge records and dosimeter pencil reports.
 - a) Under no circumstances shall any individual be permitted to work with radiation equipment or radioactive materials unless he is wearing the personnel monitoring devices assigned to him for such work.

- 5) b) It is the responsibility of the Radiation Safety Officer to issue each radiation worker an operable dosimeter pencil and film badge, and then issue a new film badge at the beginning of each month.
- c) Film badges will be received from Radiation Detection Co. in bulk on a monthly basis. Each batch of film will be appropriately identified by date, name, and serial number for insertion in the film badge holder worn by each worker for the specific period of time. A film should not be worn longer than the prescribed monitoring period indicated on the badge; unless the film badge supplier is specifically informed in writing of the dates and circumstances involved.
- d) The Radiation Safety Officer will return all used and unused film to the supplier. He will receive the reports of the film badge exposures from the supplier and will keep each individual informed of any high exposure. The Radiation Safety Officer will investigate any overexposure and will report to all individual concerned per Parts 10-CFR 19 and 20.

Film badge records will serve as the permanent exposure record, unless otherwise specified for unusual circumstances.

- 5) e) Check dosimeters for leakage on a quarterly basis and radiation response on an annual basis. Dosimeter pencil reading should not change more than 2% of full scale in 24 hours when zeroed and left in an area away from X or gamma radiation. Dosimeters should read within $\pm 30\%$ of radiation output of calibrator in accordance with procedure outlined in Para. 2.5 of the Operating and Emergency Procedures Manual. If a dosimeter pencil indicates a change in scale position of greater than 2% of full scale under the above conditions, it will be removed from use and a new dosimeter pencil will be issued.
- f) No employee will be permitted to continue routine work with radiation after his dosimeter has gone off-scale due to radiation exposure. In the event of an off-scale exposure of an employee's dosimeter pencil, his film badge will be sent without delay to Radiation Detection Company for immediate processing along with instructions for prompt notification of results. The individual will not be permitted to work with radiation until the nature of the exposure has been evaluated and the magnitude of his radiation dosage determined.
- g) Radiation exposure reports will be supplied on a form similar to FIGURE 6 and FIGURE 7.
- h) NRC 4 (FIGURE 8) will be filled out by all radiographic personnel and kept in their personal folders.

- 5)
 - i) The personal monitoring records will be reviewed on a monthly basis (except in incident situations) for conformance to exposure limits set forth in 10-CFR-20.
 - j) Current NRC 5 will be kept on file (FIGURE 9).
- 6) Maintain adequate radiation survey instruments capable of detecting 2 mR/hr to 1 R/hr, and see that each instrument is calibrated every 90 days (FIGURES 10 and 11).
 - a) No radiography will be permitted unless a calibrated and operable survey meter capable of detecting 2 mR/hr through 1 R/hr of X or gamma radiation is available.
 - b) The Radiation Safety Officer has the responsibility of keeping each radiation survey instrument calibrated at intervals not to exceed three (3) months, and after each instrument servicing. To facilitate compliance with NRC and State regulations, each survey meter shall have a label attached which indicates the date calibrated, recalibration due date and instrument serial number.
 - c) The Radiation Safety Officer is to see that surveys are conducted as described in the Radiographic Personnel Operating and Emergency Procedures Manual. The RSO will weekly review and maintain Radiation Survey and Utilization reports of all radiographic operations.
- 7) Establish and conduct the training program for all radiography personnel.
- 8) Examine and determine competency of radiographic personnel to advance to Radiographer and Assistant Radiographer positions.

- 8) Examination will cover operating and emergency procedures, NRC regulations and state regulations.
- 9) Maintain up-to-date operating and emergency procedures and see that these procedures are understood and observed by all personnel.
- 10) Maintain radiographic equipment in safe operating condition.
- 11) Supervise sealed source replacement and six-month leak tests of all sealed radioisotope sources. Maintain records of inventory and leak tests and see that leak test certificate sticker is applied to proper unit. (FIGURES 12 and 1e)
- 12) Conduct quarterly inventories of radioactive materials (FIGURE 14).
- 13) Establish and maintain a radiological safety inspection system.
 - a) Quarterly inspection of Radiographic equipment and maintenance procedure, see Radiographic Personnel Operating and Emergency Procedures Manual.
 - b) Unannounced inspection will be conducted during actual radiographic exposure to determine compliance with standard procedures and regulations (FIGURE 15). Each Radiographer and Assistant Radiographer will be inspected at least once per calendar quarter.
 - c) It is the responsibility of the Radiation Safety Officer to see that restricted areas are established on all sides of the radiographic operations during the exposure. The Radiation Safety Officer is to inspect radiographers to make certain that maximum attention is paid to controlling access into the radiation area during radiographic exposures.

- 14) Promptly investigate cause of any unusual radiation incident and take necessary preventative action.
- 15) Notify official agencies promptly of any accidents involving radioactive materials and provide reports when required.
- 16) Maintain adequate supply of radiation warning signs and enforce their use as required. An adequate supply of radiation warning signs (metal or cardboard) will be kept in stock so that they may be conspicuously posted by the radiographer around all restricted areas to control access to that particular area. The signs must include the radiation symbol (magenta on yellow background) and one of the following warnings:

"CAUTION - - RADIATION AREA"

"CAUTION - - HIGH RADIATION AREA"

"CAUTION - - RADIOACTIVE MATERIAL"

- 17) Assume control and institute corrective action in emergency situations.
- 18) In the event of an emergency involving radiation, the Radiation Safety Officer must assume full responsibility for:
 - a) Developing effective radiation emergency plans to:
 1. Promptly and accurately evaluate any unusual incident.
 2. Limit the extent of damage.
 3. See that personnel receive competent medical attention.
 4. Manage all necessary accident repair and recovery operations.
 5. Institute remedial action to prevent recurrence.

- 18)
 - b) Instruct all radiation personnel in what action they must take in an emergency.
 - c) Providing ample emergency equipment, instruments and protective devices.
 - d) Knowing who to contact for medical, radiological, fire and police assistance.
 - e) Notifying proper personnel in the official agencies within the prescribed period of time after discovery of the incident.
 - f) Documenting the facts concerning the incident.
 - g) Preparing the prescribed reports to official agencies, management and insurance carriers.
- 19) Review records kept by Radiographers weekly; inspected records will be initialed and dated (See RPO & EP Manual for records that must be kept by Radiographers.)
- 20) Prepare and maintain radioactive material shipment/receipt report (FIGURE 16) on all radioactive material received by Technical Services, Division of Vector Corporation or shipped to Gamma Industries or Technical Operations for disposal.

FIGURE 1

NOTICE TO EMPLOYEES

10 CFR 19

Effective:

Part 19--Notices, Instructions and Reports to Workers: Inspections

In accordance with 19.11 the documents listed below are available to any person who is working at a) Technical Services Division of Vector Corporation. and b) within the conditions of a Technical Services Division of Vector Corporation held NRC license. They may be examined during normal working hours at:

Technical Services Division of Vector Corporation
3700 Butler Street
Pittsburgh, Pennsylvania 15201

- I. 10 CFR 19 Notices, Instructions and Reports to Workers; Inspections.
- II. 10 CFR 20 Standard for Protection Against Radiation
- III. NRC Licenses, license conditions, amendments and associated correspondence for Technical Services Division of Vector Corporation By-product Material License
- IV. Technical Services Division of Vector Corporation Procedures Manual -- RADIOGRAPHIC PERSONNEL OPERATIONS AND EMERGENCY PROCEDURES MANUAL.
- V. Any notice of Violation of Regulations and associated response from licensee.



FIGURE 2

UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, D.C. 20555

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION (PART 20); NOTICES, INSTRUCTIONS AND
REPORTS TO WORKERS; INSPECTIONS (PART 19); EMPLOYEE PROTECTION

WHAT IS THE NUCLEAR REGULATORY COMMISSION?

The Nuclear Regulatory Commission is an independent Federal regulatory agency responsible for licensing and inspecting nuclear power plants and other commercial uses of radioactive materials.

WHAT DOES THE NRC DO?

The NRC's primary responsibility is to ensure that workers and the public are protected from unnecessary or excessive exposure to radiation and that nuclear facilities including power plants are constructed to high quality standards and operated in a safe manner. The NRC does this by establishing requirements in Title 10 of the Code of Federal Regulations (10 CFR) and in licenses issued to nuclear users.

WHAT RESPONSIBILITY DOES MY EMPLOYER HAVE?

Any company that conducts activities licensed by the NRC must comply with the NRC's requirements. If a company violates NRC requirements, it can be fined or have its license modified, suspended or revoked.

Your employer must tell you which NRC radiation requirements apply to your work and must post NRC Notices of Violation involving radiological working conditions.

WHAT IS MY RESPONSIBILITY?

For your own protection and the protection of your co-workers, you should know how NRC requirements relate to your work and should obey them. If you observe violations of the requirements, you should report them.

HOW DO I REPORT VIOLATIONS?

If you believe that violations of NRC rules or of the terms of the license have occurred, you should report them immediately to your supervisor. If you believe that adequate corrective action is not being taken, you may report this to an NRC inspector or the nearest NRC Regional Office.

WHAT IF I WORK IN A RADIATION AREA?

If you work with radioactive materials or in a radiation (controlled) area, the amount of radiation exposure that you may legally receive is limited by the NRC. The limits on your exposure are contained in sections 20.101, 20.103, and 20.104 of Title 10 of the Code of Federal Regulations (10 CFR 20). While those are the maximum allowable limits, your employer should also keep your radiation exposure as far below those limits as is "reasonably achievable."

MAY I GET A RECORD OF MY RADIATION EXPOSURE?

Yes. Your employer is required to tell you, in writing, if you receive any radiation exposure above the limits set in the NRC regulations or your employer's license. In addition, if your job involves radiation, you may request from your employer a record of your annual radiation exposures and a written report of your total exposure when you leave your job.

HOW ARE VIOLATIONS OF NRC REQUIREMENTS IDENTIFIED?

NRC conducts regular inspections at licensed facilities to assure compliance with NRC requirements. In addition, your employer and site contractors conduct their own inspections to assure compliance. All inspectors are protected by Federal law. Interference with them may result in criminal prosecution for a Federal offense.

MAY I TALK WITH AN NRC INSPECTOR?

Yes. Your employer may not prevent you from talking with an NRC inspector and you may talk privately with an inspector and request that your identity remain confidential.

MAY I REQUEST AN INSPECTION?

If you believe that your employer has not corrected violations involving radiological

working conditions, you may request an inspection. Your request should be addressed to the nearest NRC Regional Office and must describe the alleged violation in detail. It must be signed by you or your representative.

HOW DO I CONTACT THE NRC?

Notify an NRC inspector on-site or call the nearest NRC Regional office collect. NRC inspectors want to talk to you if you are worried about radiation safety or other aspects of licensed activities, such as the quality of construction or operations at your plant.

CAN I BE FIRED FOR TALKING TO THE NRC?

No. Federal law prohibits an employer from firing or otherwise discriminating against a worker for bringing safety concerns to the attention of the NRC. You may not be fired or discriminated against because you:

- ask the NRC to enforce its rules against your employer;
- testify in an NRC proceeding;
- provide information or are about to provide information to the NRC about violations of requirements;
- are about to ask for or testify, help, or take part in an NRC proceeding.

WHAT FORMS OF DISCRIMINATION ARE PROHIBITED?

No employer may fire you or discriminate against you with respect to pay, benefits, or working conditions because you help the NRC.

HOW AM I PROTECTED FROM DISCRIMINATION?

If you believe that you have been discriminated against for bringing safety concerns to the NRC, you may file a complaint with the U.S. Department of Labor. Your complaint must describe the firing or discrimination and must be filed within 30 days of the occurrence.

Send complaints to:

Office of the Administrator
Wage and Hour Division
Employment Standards Administration
U.S. Department of Labor
Room 53502
200 Constitution Avenue, N.W.
Washington, D.C. 20210

or any local office of the Department of Labor, Wage and Hour Division. Check your telephone directory under U.S. Government listings.

WHAT CAN THE LABOR DEPARTMENT DO?

The Department of Labor will notify the employer that a complaint has been filed and will investigate the case.

If the Department of Labor finds that your employer has unlawfully discriminated against you, it may order you to be reinstated, receive back pay, or be compensated for any injury suffered as a result of the discrimination.

WHAT WILL THE NRC DO?

The NRC may assist the Department of Labor in its investigation. NRC may conduct its own investigation where necessary to determine whether unlawful discrimination has prevented the free flow of information to the Commission. Also, if the NRC or Department of Labor finds that unlawful discrimination has occurred, the NRC may issue a Notice of Violation to your employer, impose a fine, or suspend, modify, or revoke your employer's NRC license.

UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICE LOCATIONS

A representative of the Nuclear Regulatory Commission can be contacted at the following addresses and telephone numbers. The Regional Office will accept collect telephone calls from employees who wish to register complaints or concerns about radiological working conditions or other matters regarding compliance with Commission rules and regulations.

Regional Offices

REGION	ADDRESS	TELEPHONE
I	U.S. Nuclear Regulatory Commission Region I 831 Park Avenue King of Prussia, PA 19406	215 337-5000
II	U.S. Nuclear Regulatory Commission Region II 101 Marietta St., N.W., Suite 2900 Atlanta, GA 30323	404 221-4503
III	U.S. Nuclear Regulatory Commission Region III 799 Roosevelt Road Glen Ellyn, IL 60137	312 790-5500
IV	U.S. Nuclear Regulatory Commission Region IV 611 Ryan Plaza Drive, Suite 1000 Arlington, TX 76011	817 860-8100
V	U.S. Nuclear Regulatory Commission Region V 1450 Marie Lane, Suite 210 Walnut Creek, CA 94596	415 943-3700



NOTICE TO EMPLOYEES

Standards for Protection Against Radiation

In Article 433 of its Rules and Regulations, the Pennsylvania Department of Health has established standards for your protection against radiation hazards.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to -

1. Apply these Department of Health regulations and any conditions of his radioactive materials license to all work involving radiation sources.
2. Post or otherwise make available to you a copy of the regulations, licenses, and operating procedures which apply to work you are engaged in, and explain their provisions to you.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with these provisions of the regulations and operating procedures which apply to the work you are engaged in. You should observe their provisions for your own protection and protection of your co-workers.

WHAT IS COVERED BY THESE REGULATIONS

1. Limits on exposure to radiation and radioactive materials in restricted and unrestricted areas;
2. Measures to be taken after accidental exposure;
3. Personnel monitoring, surveys and equipment;
4. Caution signs, labels, and safety interlock equipment;
5. Exposure records and reports; and
6. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Department of Health regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or the license. The basic limits for exposure to employees are set forth in Sections D.3, D.4, and D.5 of the regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air.
2. If you work where personnel monitoring is required pursuant to Section D.9:
 - (a) Your employer must give you a written report of your radiation exposure upon the termination of your employment if you request it, and
 - (b) Your employer must advise you annually of your exposure if you request it.

INSPECTIONS

All activities involving radiation are subject to inspection by representatives of the Pennsylvania Department of Health.

INQUIRIES

Inquiries dealing with matters outlined above can be sent to the Office of Radiological Health, Pennsylvania Department of Health, P. O. Box 90, Harrisburg, Pennsylvania 17120. Telephone 717-787-3720.

POSTING REQUIREMENT

Copies of this notice must be posted in a sufficient number of places in every establishment where activities covered by the regulations are conducted to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

FIGURE 4

Date _____

RADIOACTIVE MATERIAL TRANSFER REPORT

TRANSFERRED TO: (Receiver's Name and Address)

SHIPPER: (Name and Address)

Telephone No. _____

REASON FOR TRANSFER:

DESCRIPTION OF SHIPMENT:

MAKE OF EXPOSURE DEVICE OR SOURCE CHANGER _____

MODEL NO. _____ SERIAL NO. _____

RADIOISOTOPE _____ STRENGTH _____ CAPSULE SERIAL NO. _____

TO BE SHIPPED VIA _____ DATE _____ BILL OF LADING _____

☐ RAIL ☐ RWY EXPRESS ☐ TRUCK ☐ AIR CARGO ☐ AIR PASSENGER

VALUATION \$ _____

SURVEY AT SURFACE OF SHIPPING CONTAINER _____ MR/HR

AT ONE METER _____ MR/HR Maximum

LEAK TEST DATE _____ LEAK TEST DUE DATE _____

DATE OF SURVEY _____ SURVEY METER USED _____

SURVEY BY _____

APPROVED BY _____ PERSON PREPARING SHIPMENT _____
Signature Signature

CONDITION OF EQUIPMENT _____
Note any physical or operating discrepancy

REMARKS: _____

THE ABOVE MATERIAL WAS RECEIVED

DATE: _____ BY: _____
Signature

CONDITION _____
Note any physical or operating discrepancy

SURVEY _____ AT SURFACE CONTAINER _____ AT 1 METER _____

FIGURE 5

SHIPPER'S CERTIFICATION FOR RADIOACTIVE MATERIALS

This is to certify that the contents of this consignment are properly described by name and are packed, marked and labeled and are in proper condition for transportation according to all applicable regulations of the Department of Transportation. This consignment is within the limitations prescribed for cargo-carrying aircraft.

Name and Address of Shipper:

Date: _____

Edward Handrahan

Name and Address of Recipient:

Date: _____

(Signature)

The following information is included here for each package of the consignments:

Radionuclide:

Activity: Curies:

Class: Radioactive material nos. Special Form

Leak Test Date: Less than .005 microcuries

Label: Radioactive yellow

Transport Index:

Physical Form: Metallic/solid

Transport Group III

FIGURE 6

TO: Social Security No. _____
Date of Birth: _____

SUBJECT: Report of Radiation Exposure on Termination of Employment

While employed with
and engaged in Industrial Radiographic work from _____
through/and _____, you received _____
millirems whole-body external radiation exposure. The radiation you
received was taken from our film badge reports.

This report is furnished to you under the provisions of the Nuclear
Regulatory Commission regulations 10 CRF part 19. You should preserve
this report for further reference:

Very truly yours,

Edward Handrahan
Radiation Safety Officer

OCCUPATIONAL RADIATION EXPOSURE

Termination Report

License Number

Social Security Number

Period of Employment (from-to)

Total
mrem

Figures 18C-4
(6-17)
(10 CFR 20)

Agreement: 100%
 18-180225-14104-1
 E-mail: 4-313-803

See Instructions on the Back

1. NAME (PRINT - LAST, FIRST, AND MIDDLE)	2. SOCIAL SECURITY NO.
3. DATE OF BIRTH (MONTH, DAY, YEAR)	4. AGE IN FULL YEARS (N)

5. PREVIOUS EMPLOYMENTS INVOLVING RADIATION EXPOSURE—LIST NAME AND ADDRESS OF EMPLOYER	6. DATES OF EMPLOYMENT (FROM—TO)	7. PERIODS OF EXPOSURE	8. WHOLE BODY (REM)	9. RECORD OR CALCULATED (INSERT ONE)
10. REMARKS	11. ACCUMULATED OCCUPATIONAL DOSE — TOTAL			

(A) PERMISSIBLE ACCUMULATED DOSE = $5(N-18)$ REM

(B) TOTAL EXPOSURE TO DATE (FROM ITEM 11) REM

(C) UNUSED PART OF PERMISSIBLE ACCUMULATED DOSE (A-B) REM

EMPLOYEE'S SIGNATURE _____ DATE _____

14. NAME OF LICENSEE

INSTRUCTIONS FOR PREPARATION OF NRC FORM 4

This form or a clear and legible record containing all the information required on this form must be prepared by each licensee of the Nuclear Regulatory Commission who, pursuant to Section 20.101, proposes to expose an individual to a radiation dose in excess of the amounts specified in Paragraph 20.101(a) of the regulations in Part 20, "Standards for Protection Against Radiation," 10 CFR. The requirement for completion of this form is contained in Section 20.102 of that regulation. The information contained in this form is used for estimating the external accumulated occupational dose of the individual for whom the form is completed. A separate Form NRC-4 shall be completed for each individual to be exposed to a radiation dose in excess of the limits specified in Paragraph 20.101(a) of Part 20 of the Commission's regulations.* Listed below by item are instructions and additional information directly pertinent to completing this form.

Identification

- Item 1. Self-explanatory.
- Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.
- Item 3. Self-explanatory.
- Item 4. Enter the age in full years. This is called "N" when used in calculating the Permissible Dose. N is equal to the number of years of age of the individual on his last birthday.

Occupational Exposure

- Item 5. List the name and address of each previous employer and the address of employment. Start with the most recent employer and work back.

Include only those periods of employment since the eighteenth birthday involving occupational exposure to radiation. For periods of self-employment, insert the word "self-employed."

- Item 6. Give the dates of each employment listed in Item 5.
- Item 7. List periods during which occupational exposure to radiation occurred.
- Item 8. List the dose recorded for each period of exposure from the records of previous occupational exposure

of the individual as calculated under Section 20.102. Dose is to be given in rem.

"Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye.

- Item 9. After each entry in Item 8 indicate in Item 9 whether dose is obtained from records or calculated in accordance with Section 20.102.
- Item 10. Self-explanatory.

Total Accumulated Occupational Dose (Whole Body)

- Item 11. The total for the whole body is obtained by summation of all values in Item 8.

Certification

- Item 12. Upon completion of the report, the employee must certify that the information in Columns 5, 6, and 7 is accurate and complete to the best of his knowledge. The date is the date of his signature.

Calculations

- Item 13. The lifetime accumulated occupational dose for each individual and the permissible dose under Paragraph 20.101(b) are obtained by carrying out the following steps: The value for N should be taken from Item 4. Subtract 18 from N and multiply the difference by 5 rem. (For example, John Smith, age 32; $N = 32$, $PAD = 5(32 - 18) = 70$ rem.) Enter total exposure to date from Item 11. Subtract (b) from (a) and enter the difference under (c). The value in (c) represents the unused part of the permissible accumulated dose. This value for permissible dose is to be carried forward to Form NRC-5, "Current Occupational External Radiation Exposure (Whole Body)."

- Item 14. Self-explanatory.

*This form requires the signature of the employee concerned.

PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552(a) (3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on Form NRC-4. This information is maintained in a system of records designated as NRC-27 and described at 40 Federal Register 45344 (October 1, 1975).

- 1. **AUTHORITY** Sections 53, 63, 65, 81, 103, 104, 161(b), and 161(c) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2073, 2093, 2095, 2111, 2133, 2134, 2201(b), and 2201(c)). The authority for soliciting the social security number is 10 CFR Part 20.
- 2. **PRINCIPAL PURPOSE(S)** The information is used by the NRC in its evaluation of the risk of radiation exposure associated with the licensed activity and in exercising its statutory responsibility to monitor and regulate the safety and health practices of its licensees. The data permits a meaningful comparison of both current and long-term exposure experience among types of licensees and among licensees within each type. Data on your exposure to radiation is available to you upon request.
- 3. **ROUTINE USES** The information may be used to provide data to other Federal and State agencies involved in monitoring and/or evaluating radiation exposure received by individuals employed as radiation workers on a permanent or temporary basis and exposure received by monitored visitors. The information may also be disclosed to an appropriate Federal, State, or local agency in the event the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding.
- 4. **WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION** It is voluntary that you furnish the requested information, including social security number, however, the licensee must have a completed Form NRC-4 on each individual whom the licensee proposes to expose to a radiation dose in excess of the amounts specified in 10 CFR 20.101(a). Failure to obtain the requested information before permitting such exposure may subject the licensee to enforcement action in accordance with 10 CFR 20.601. The social security number is used to assure that NRC has an accurate identifier not subject to the coincidence of similar names or birthdates among the large number of persons on whom data is maintained.

- 5. **SYSTEM MANAGER(S) AND ADDRESS** Director, Office of Management Information and Program Control
U.S. Nuclear Regulatory Commission, Washington, D.C. 20555

CURRENT OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

See Instructions on Back

IDENTIFICATION

1. NAME (PRINT - Last, first, and middle)	2. SOCIAL SECURITY NO.
3. DATE OF BIRTH (Month, day, year)	4. NAME OF LICENSEE

5. DOSE RECORDED FOR (Specify: Whole body; skin of whole body; or hands and forearms, feet and ankles.) <u>whole body</u>	6. WHOLE BODY DOSE STATUS (rem)	7. METHOD OF MONITORING (e.g., Film Badge - FB; Pocket Chamber - PC; Calculations - Calc.) X OR GAMMA <u>FB</u> BETA <u>N/A</u> NEUTRONS <u>N/A</u>
--	---------------------------------	---

8. PERIOD OF EXPOSURE (From - To)	DOSE FOR THE PERIOD (rem)				13. RUNNING TOTAL FOR CALENDAR QUARTER (rem)
	9. X OR GAMMA	10. BETA	11. NEUTRON	12. TOTAL	
Jan. - Dec.					
JANUARY					
FEBRUARY					
MARCH					
Qtr. Total Cumulative					
APRIL					
MAY					
JUNE					
Qtr. Total Cumulative					
JULY					
AUGUST					
SEPTEMBER					
Qtr. Total Cumulative					
OCTOBER					
NOVEMBER					
DECEMBER					
Qtr. Total Cumulative					

LIFETIME ACCUMULATED DOSE

14. PREVIOUS TOTAL (rem)	15. TOTAL QUARTERLY DOSE date rem	16. TOTAL ACCUMULATED DOSE (rem)	17. PERM. ACC. DOSE SIN 181 (rem)	18. UNUSED PART OF PERMISSIBLE ACCUMULATED DOSE (rem)

The preparation and safekeeping of this form or a clear and legible record containing all the information required on this form is required pursuant to Section 20.401 of "Standards for Protection Against Radiation," 10 CFR 20, as a current record of occupational external radiation exposures. Such a record must be maintained for each individual for whom personnel monitoring is required under Section 20.202. Note that a separate Form NRC-5 is to be used for recording external exposure to (1) the whole body; (2) skin of whole body; (3) hands and forearms; or (4) feet and ankles, as provided by Item 5 below.

Listed below by item are instructions and additional information directly pertinent to completing this form.

Identification

- Item 1. Self-explanatory.
- Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.
- Item 3. Self-explanatory.
- Item 4. Self-explanatory.

Occupational Exposure

- Item 5. "Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye. Unless the lenses of the eyes are protected with eye shields, dose recorded as whole body dose should include the dose delivered through a tissue equivalent absorber having a thickness of 300 mg/cm² or less. When the lenses of the eyes are protected with eye shields having a tissue equivalent thickness of at least 700 mg/cm², dose recorded as whole body dose should include the dose delivered through a tissue equivalent absorber having a thickness of 1,000 mg/cm² or less.
Dose recorded as dose to the skin of the whole body, hands and forearms, or feet and ankles should include the dose delivered through a tissue equivalent absorber having a thickness of 7 mg/cm² or less. The dose to the skin of the whole body, hands and forearms, or feet and ankles should be recorded on separate forms unless the dose to those parts of the body has been included as dose to the whole body on a form maintained for recording whole body exposure.
- Item 6. This item need be completed only when the sheet is used to record whole body exposures and the licensee is exposing the individual under the provisions of Paragraph 20.101(b) which allows up to 3 rems per quarter to the whole body. Enter in this item the unused part of permissible accumulated dose taken from previous records of exposure, i.e., Item 18 of the preceding Form AEC-5 or NRC-5 or Item 13 of Form AEC-4 or NRC-4 if the individual's exposure during employment with the licensee begins with this record.
- Item 7. Indicate the method used for monitoring the individual's exposure to each type of radiation to which he is exposed in the course of his duties. Abbreviations may be used.
- Item 8. Doses received over a period of less than a calendar quarter need not be separately entered on the form provided that the licensee maintains a current record of the doses received by the individual which have not as yet been entered on the form. The period of exposure should specify the day the measurement of that exposure was initiated and the day on which it was terminated. For example, if only quarterly doses are entered, the period of exposure for the first calendar quarter of 1962 might be taken as running from Monday, January 1, 1962, through Friday, March 30, 1962, and would be indicated in this item as Jan. 1, 1962-Mar. 30, 1962. If weekly doses are entered, a film badge issued Monday morning, January 1, 1962, and picked up Friday, January 5, 1962, would be indicated as Jan. 1, 1962-Jan. 5, 1962.

- Items 9, 10 and 11. Self-explanatory. The values are to be given in rem. All measurements are to be interpreted in the best method known and in accordance with Paragraph 20.4(c). Where calculations are made to determine dose, a copy of such calculations is to be maintained in conjunction with this record. In any case where the dose for a calendar quarter is less than 10% of the value specified in Paragraph 20.101(a), the phrase "less than 10%" may be entered in lieu of a numerical value.
- Item 12. Add the values under Items 9, 10 and 11 for each period of exposure and record the total. In calculating the "Total" any entry "less than 10%" may be disregarded.
- Item 13. The running total is to be maintained on the basis of calendar quarters. Paragraph 20.3(a) (4) defines calendar quarter. No entry need be made in this item if only calendar quarter radiation doses are recorded in Items 9, 10, 11 and 12.

Lifetime Accumulated Dose (Whole Body)

NOTE: If the licensee chooses to keep the individual's exposure below that permitted in Paragraph 20.101(a), Items 14 through 18 need not be completed. However, in that case the total whole body dose for each calendar quarter recorded in Item 13 (or Item 12 if quarterly doses are entered in Item 12) should not exceed 1 1/4 rem.

If an individual is exposed under the provisions of Paragraph 20.101(b), complete Items 14 through 18 at the end of each calendar quarter and when the sheet is filled. Values in Item 13, when in the middle of a calendar quarter, and values in Item 18, must be brought forward to next sheet for each individual.

- Item 14. Enter the previous total accumulated dose from previous dose records for the individual (e.g., from Item 16 of Form AEC-5 or NRC-5 or Item 11 of Form AEC-4 or NRC-4). The total occupational radiation dose received by the individual must be entered in this item, including any occupational dose received from sources of radiation not licensed by the Commission. If the individual was exposed to sources of radiation not licensed by the Commission during any calendar quarter after completing Form AEC-4 or NRC-4 and personnel monitoring equipment was not worn by the individual, it should be assumed that the individual received a dose of 1 1/4 rems during each such calendar quarter.
- Item 15. Enter the total calendar quarter dose from Item 13 (or from Item 12 if quarterly doses are entered in Item 12) and the date designating the end of the calendar quarter in which the dose was received (e.g., March 30, 1962).
- Item 16. Add Item 14 and Item 15 and enter that sum.
- Item 17. Obtain the Permissible Accumulated Dose (PAD) in rem for the WHOLE BODY. "N" is equal to the number of years of age of the individual on his last birthday. Subtract 18 from N and multiply the difference by 5 rem (e.g., John Smith, age 32; N = 32; PAD = 5(32-18) = 70 rem.)
- Item 18. Determine the unused part of the PAD by subtracting Item 16 from Item 17. The unused part of the PAD is that portion of the Lifetime Accumulated Dose for the individual remaining at the end of the period covered by this sheet.

PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552(a)(3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on Form NRC-5. This information is maintained in a system of records designated as NRC 27 and described at 40 Federal Register 45344 (October 1, 1975):

1. **AUTHORITY** Sections 53, 63, 65, 81, 103, 104, 161(b), and 161(c) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2073, 2093, 2095, 2111, 2133, 2134, 2201(b), and 2201(c)). The authority for soliciting the social security number is 10 CFR Part 20.
2. **PRINCIPAL PURPOSE(S)** The information is used by the NRC in its evaluation of the risk of radiation exposure associated with the licensed activity and in exercising its statutory responsibility to monitor and regulate the safety and health practices of its licensees. The data permits a meaningful comparison of both current and long term exposure experience among types of licensees and among licensees within each type. Data on your exposure to radiation is available to you upon your request.
3. **ROUTINE USES** The information may be used to provide data to other Federal and State agencies involved in monitoring and/or evaluating radiation exposure received by individuals employed as radiation workers on a permanent or temporary basis and exposure received by monitored visitors. The information may also be disclosed to an appropriate Federal, State, or local agency in the event the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding.
4. **WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION** It is voluntary that you furnish the requested information, including social security number; however, the licensee must complete Form NRC-5 on each individual for whom personnel monitoring is required under 10 CFR 20.202. Failure to do so may subject the licensee to enforcement action in accordance with 10 CFR 20.601. The social security number is used to assure that NRC has an accurate identifier not subject to the coincidence of similar names or birthdates among the large number of persons on whom data is maintained.
5. **SYSTEM MANAGER(S) AND ADDRESS** Director, Office of Management Information and Program Control, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

FIGURE 10

RADIATION INSTRUMENT SERVICE RECORD

MANUFACTURER _____

MODEL NO. _____ SERIAL NO. _____

NOTICE: In accordance with NRC Regulations Title 10-CFR-34 (Paragraph 34.24), this radiation survey instrument shall be recalibrated at intervals not to exceed three (3) months and after each instrument servicing.

CALIBRATED ON	RECALIBRATION DUE	REMARKS

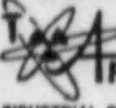
FIGURE 11

INSTRUMENT SERVICE RECORD

Calibrated by _____ on _____

Calibration void after _____

PLEASE RETURN THIS INSTRUMENT
TO APPLIED HEALTH PHYSICS, INC. FOR RE-
CALIBRATION PER NRC REGULATION 10-CFR-34

 **Applied HEALTH PHYSICS** Inc.

2986 INDUSTRIAL BLVD. • BETHEL PARK, PA 15102 • Phone: (412) 563-2242



HEALTH PHYSICS inc.

2986 Industrial Blvd. • Box 197 • Bethel Park, Pa. 15002 • Phone 412 • 563-2242

CERTIFICATE OF LEAK TEST

NO. _____

This is to certify that the source indicated below was leak testing using an approved method. The leak test was performed by _____, on _____.

SOURCE DESCRIPTION:

Radioisotope Activity Model No. Serial No. Manufacturer

INSTALLED IN:

Device Model No. Serial No. Manufacturer

LOCATION:

Company Company Address

Analysis of the leak test specimen, No. _____, By Applied Health Physics, Inc. indicated the presence of _____ microcurie of _____ activity on _____.

Pursuant to the results of this leak test, the following action is recommended:

☐ Analysis indicated 0.005 microcurie or more of radioactivity on the leak test specimen. Immediately withdraw the source from use. Decontaminate and repair it or conduct disposal in accordance with applicable regulations. Also, file a report with the regulatory agency within the time period prescribed - if required.

☐ Analysis indicated less than 0.005 microcurie of radioactivity on the leak test specimen. The sealed source may be used as authorized. This source must be leak tested again, on or before _____ or within any other such time period required by the regulatory agency.

This certificate is an essential record and should be maintained for inspection by the regulatory agency.

APPLIED HEALTH PHYSICS, Inc.

BY: _____

DATE: _____

FIGURE 13

LEAK TEST CERTIFICATE NO.

This source or device was leak tested on _____
_____, and analysis indicated less than
0.005 microcurie of removable contamination.
In compliance with pertinent regulations, leak
testing must be performed again, on or before



Sample
HEALTH PHYSICS Inc.

P. O. BOX 197 • BETHEL PARK, PA. 15102

FIGURE 14

LEAK TEST AND QUARTERLY INVENTORY RECORD

Exposure Device manufactured by_____

Model No. _____ Serial No. _____

Sealed Source Model No. _____ Manufactured by _____

NOTICE: In accordance with NRC Regulation Title 10-CFR-34 (Paragraph 34.25), this sealed source shall be tested for leakage at intervals not to exceed six (6) months. Technical Services, Division of Vector Corporation shall conduct a quarterly physical inventory to account for this sealed source. (Paragraph 34.26)

[illegible]

FIGURE 15

Page 1

Date _____

UNANNOUNCED RADIATION SAFETY INSPECTION REPORT

NRC LICENSE NO. _____

ON _____ an Unannounced Radiation Safety Inspection
was conducted at _____.

The purpose of this inspection was to observe all safety requirements of
NRC Regulations, and Technical Services, Division of Vector Corporation
Operating and Emergency Procedures.

PERSONNEL

Radiographer _____ Film Badge No. _____ Dosimeter
Pencil No. _____

Asst. Radiographer _____ Film Badge No. _____ Dosimeter
Pencil No. _____

Additional Personnel _____

RADIOGRAPHIC EQUIPMENT

_____ X-Ray Machine Make _____ Model _____ Ser. No. _____

_____ Exposure Device Used Make _____ Model _____ Ser. No. _____

Leak Test Date of Exposure Device _____

Survey Meter Number _____ Model Number _____ Calibration Date _____

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(continued on page 2)

FIGURE 15

Page 2

SAFETY REQUIREMENTS

Copy of License & Procedures Available? _____ Copy of Dosimeter Records Available? _____ Barricades Posted Properly? _____ Maximum Reading at Perimeter _____ mR/Hr. Radiation Level at Surface of Exposure Device _____ mR/Hr. at 6" and Dosimeter Pencils Worn at Proper Locations? _____ Exposure Device Surveyed Entire Length of Source Tube? _____ Exposure Device Locked After Each Exposure? _____ "High-Radiation" Sign Posted Near Source? _____ Exposure Device Labeled to Show Kind and Quantity of By-Product Material in Exposure Device? _____ What was the Approximate Isotope Strength? _____ Operator Competent to Handle Radioactive Material _____ Were the Shielded Room Facilities Used Properly? _____

If a negative answer is obtained to any of the above questions, list the corrective action on the reverse side of this form.

AUTHORIZATION: I certify that the Above-mentioned Unannounced Inspection was conducted by me on _____ (date).

Signature of Radiation Safety Officer

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FIGURE 16

Date _____

RADIOACTIVE MATERIAL REPORT

(Shipment) (Receipt)

(SHIPPED TO):

(RECEIVED FROM):

DESCRIPTION OF SHIPMENT:

MAKE OF EXPOSURE DEVICE OR SOURCE CHANGER _____

MODEL NO. _____ SERIAL NO. _____

RADIOISOTOPE _____ STRENGTH _____ CAPSULE SER. NO. _____

SURVEY AT SURFACE OF SHIPPING CONTAINER _____ MR/HR
Maximum

SURVEY AT SURFACE OF EXPOSURE DEVICE OR SOURCE CHANGER _____ MR/HR
Maximum

LEAK TEST DATE _____ LEAK TEST DUE: _____

CONDITION OF EQUIPMENT _____

REMARKS: _____

DATE OF SURVEY: _____ SURVEY BY: _____

FIGURE 17

Page 1

INTERNAL INSPECTION AND AUDITING SYSTEM CHECK LIST

10 CFR 34 (Para. 34-11 (d))

1. Review 10 CFR 19 for changes during quarter.
Review 10 CFR 20 for changes during quarter.
Review 10 CFR 30 for changes during quarter.
Review 10 CFR 34 for changes during quarter.
2. Check posting of Technical Services Notice to Employees
PA Notice to Employees
NRC Form 3
3. Review receipt/shipment forms for radioisotopes shipped or received during quarter.
4. Review dosimeter and film badge reports for quarter.
5. Review calibration records for dosimeters, survey meters.
6. Review training records of radiographers to determine their competency.
7. Review leak test records for radioisotopes.
8. Conduct quarterly inventory, inspection and maintenance on radioisotope equipment.

FIGURE 17

Page 2

9. Review survey and utilization records for compliance with procedures.
10. Review with radiographers and changes in manual or specification.

The above items have been reviewed by me and found to comply with existing procedures and regulations or were corrected as listed above.

Date: _____

Edward Handrahan
Radiation Safety Officer

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ITEM 10.4

RADIOGRAPHIC PERSONNEL
OPERATING AND EMERGENCY
PROCEDURES MANUAL

RADIOGRAPHIC PERSONNEL
OPERATING AND EMERGENCY
PROCEDURES MANUAL

Prepared by

TECHNICAL SERVICES

Division of

VECTOR CORPORATION

Edward Handrahan
Chief Radiographer

RADIOGRAPHIC PERSONNEL
OPERATING AND EMERGENCY
PROCEDURES MANUAL

- 1.0 Introduction
- 2.0 Personnel Monitoring and the Use of Personnel Monitoring Equipment
- 3.0 The Use, Maintenance and Calibration of Radiation Survey Instruments
- 4.0 Security Measures for Industrial Radiography
- 5.0 Use, Inspection and Maintenance of Radiographic Equipment
- 6.0 Methods and Occasions for Locking and Securing Radiographic Exposure Devices and Storage Containers
- 7.0 Transportation of Radiographic Devices
- 8.0 Minimizing Exposures of Persons in the Event of Accidents
- 9.0 Persons to Contact in the Event of an Emergency
- 10.0 Maintenance of Radiation Records and Reports

1.0 INTRODUCTION

1.1 Purpose

This manual was prepared for the purpose of furnishing employees of Technical Services Division of Vector Corporation with practical information that will permit the safe and efficient use of radioactive sources. The procedures contained in this document are essential to compliance with Federal, State and local regulations governing the use of radiation and radioisotopes, as well as the terms and conditions of our company's licenses for these materials. Understanding of and adherence to the procedures set forth in this manual are prerequisites for our use of radiation. The radiation safety control procedures set forth in this manual were designed to protect not only the radiographic personnel, who, by the nature of their work may be exposed to radiation, but to ensure that all personnel will be protected from the hazards of radiation exposure.

1.2 Scope

All personnel engaged in operations involving radioisotopes must comply with the operating and emergency procedures described in this manual.

1.3 Responsibility

A. Radiographers

All radiographers must follow the procedures as set forth in this manual and comply with those regulations governing our radiographic operations. The radiographer assumes complete responsibility for the safe use of all radiographic equipment, radiation instruments and safety equipment that has been furnished for his use. The radiographer is held accountable to the Radiation Safety Officer for the following:

- 1.) Contacting the Radiation Safety Officer promptly in any emergency or unusual incident involving radiation.
- 2.) Personally supervising the safe use, transport, temporary storage and return of all radiographic equipment, survey meters and safety equipment entrusted to him.

- 1.3
- 3.) Perform radiation safety survey as required.
 - 4.) Preparing required records and reports.
 - 5.) Maintaining an up-to-date copy of the company's safety procedures manual, including a copy of current NRC license and copies of appropriate NRC and State regulations.
 - 6.) Assuring that no radiography will be performed unless all radiography personnel have film badges and dosimeter pencils, a survey meter is available and is operational, and that he can perform the required radiography without undue risk.
 - 7.) Annually review his copy of Radiographic Personnel Operating and Emergency Procedures Manual, NRC and State regulations.
 - 8.) Properly indoctrinating assistant radiographers and trainees through exemplary practices of radiological safety.
 - 9.) Recharging dosimeters and recording readings.
 - 10.) Notifying the RSO of any violations or unsafe practices he has observed or learned of that may affect the company and/or its employees.

B. Assistant Radiographers

The assistant radiographer is to assist the radiographer in his work. He is responsible for:

- 1.) Demonstrating an understanding of the operating and emergency procedures as contained in this manual.
- 2.) Exhibiting the competence to use radiographic equipment survey meters and safety devices under the direct supervision of the radiographer.

C. Radiography Trainees

A trainee is restricted to a limited assignment of duties under the radiographer's supervision. He is responsible for obtaining and understanding of radiographic methodology and the operating and emergency

C. Radiography Trainees Cont'd.

procedures in this manual. With the radiographer's personal supervision, the trainee may assist in the movement of equipment, the posting of areas, and the processing of films. Under NO circumstances is the trainee allowed to use radiographic exposure devices for the purpose of industrial radiography.

1.4 Changes in Operating Procedures

No changes or modification are to be made in any part of this manual or of any operating or emergency procedure until the proposed has been submitted to the RSO in writing and approved by him. The proposed changes will then be transmitted to the appropriate regulatory agencies for their review and comments. Upon approval by the official agencies, appropriate changes will be made in these procedures and distributed to each person so that he can up-date his copy of this manual.

2.0 PERSONNEL MONITORING AND THE USE OF PERSONNEL MONITORING EQUIPMENT

2.1 General Information and Instructions

Under no circumstances shall any individual work with radioactive materials or radiation producing equipment unless he is wearing both a film badge and dosimeter pencil.

2.2 Procedures for Use of Film Badges

- A. The Radiation Safety Officer will issue film badges at the beginning of each month. The film insert from the previous month will be returned to the RSO. The film badge is not to be worn longer than one (1) month.
- B. The film badge will be identified by the worker's name, serial number, and date of issue. The worker is to wear only his film badge and at no time will any individual exchange a film badge with another person.
- C. Film badges must be worn by all radiographers, radiographer's assistants, and trainees in the same location as the dosimeter pencil during all radiographic operations. Dosimeters will be worn on the upper, front torso between the belt and the neck. Or it may be worn on the front part of the belt in a pouch similar to Tech/Ops Model P75 Personal Dosimeter pouch.
- D. The film marked "Control" is not to be worn by any individual.
- E. Deliberate tampering with personnel monitoring equipment that has been assigned to an individual or intentional exposures of such devices to radiation or falsifying an occupational radiation exposure record will be considered to be justification for discharge.

2.3 Procedure for Use of Dosimeter Pencil

- A. All radiographers, radiographer's assistants, and trainees must wear a pocket dosimeter pencil capable of detecting radiation at least 200 Millirems in the same location as the film badge. Dosimeters must be worn on the portion of the body most likely to receive maximum radiation. See Para. 2.2(C).
- B. All dosimeter pencils shall be charged at least daily, prior to the beginning of radiographic work on that day. The dosimeter reading must be recorded and the dosimeter recharged, if the reading exceeds half scale (e.g. 100 mR on a 200 mR dosimeter).

- 2.3 C. The dosimeter pencil must be read periodically during the radiation operations and upon completion of the required work. It is the responsibility of each radiographer, radiographer's assistant, or trainee to record the pencil reading daily on the Daily Dosimeter Pencil Readings Form (see Figure 2.01). This record must be in the possession of each radiographer, radiographer's assistant, or trainee at all times when working in a radiation area
- D. Dosimeter pencils are delicate instruments and must be treated as such. Jarring or dropping the pencil may cause a high reading. If the pencil is damaged or goes off scale, operations shall be immediately suspended and the Radiation Safety Officer notified.
- E. If a dosimeter pencil becomes fully discharged, the RSO is to be notified immediately. The film badge must be submitted immediately to the RSO to determine if an over-exposure has taken place. All radiographic operations by the individual wearing the off-scale pencil must be suspended pending evaluation of the situation by the Radiation Safety Officer.
- F. Procedure for Re-Charging Dosimeter Pencil
- 1.) Insert dosimeter pencil into charging socket.
 - 2.) Hold dosimeter pencil in contact (press down).
 - 3.) Turn large knob on charger to adjust dosimeter pencil to zero.
 - 4.) Remove dosimeter pencil from the charger and check hair-line position by looking through dosimeter at a source of light. Dosimeter pencil must be horizontal while being read. Any other position will give erroneous reading.
 - 5.) Hair line should be set to zero or as low as possible prior to radiographic operations.

2.4 Records

Radiographers, assistant radiographers, and trainees will be responsible for the accurate maintenance and record of their daily dosimeter pencil readings.

2.5 Dosimeter Pencil Calibration Procedure

Dosimeters will be calibrated at least once annually for response to radiation using a dosimeter calibrator Model 3060. Dosimeters must calibrate within $\pm 30\%$ of actual radiation output of calibrator.

- 1.) Place dosimeter into one of the four (4) inner holes in the calibrator for six (6) hours. Record reading. Should read 50 mR $\pm 30\%$.
- 2.) Zero dosimeter. Replace in inner holes of calibrator. Expose for 18 hours. Dosimeter should read 150 mR $\pm 30\%$.
- 3.) Zero dosimeter and place away from any source of radiation for 24 hours. Dosimeter should not drift more than $2\% \pm 1\%$ in 24 hours.
- 4.) Record all readings on Dosimeter Calibration Record Form (Figure 2.02).

Figure 2 - 01
Daily Dosimeter Pencil Readings

RADIOGRAPHER _____

MONTH _____

DOSIMETER READING (MR)

DATE	START	FINISH	DOSAGE (MR)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

NOTED BY: Radiation Safety Officer _____ DATE _____

Figure 2 -02
DOSIMETER CALIBRATION RECORD

Manufacture:

Range: 200 milliroentgens

Source Used for Calibration: Cesium 137

Dosimeter S/N	Actual Exposure	Indicated Exposure	% of Error	% Leakage in 24hours	Person to Whom Issued
S/N Date:					
S/N Date:					
S/N Date:					
S/N Date:					
S/N Date:					

3.0 THE USE, MAINTENANCE AND CALIBRATION OF RADIATION SURVEY INSTRUMENTS

3.1 General Information

No radiography is permitted without a calibrated and operable survey meter capable of detection 2mR/hr of X or gamma radiation. Calibrated and operable survey meters must be maintained and used when radiography is performed.

- A. The following geiger tube survey meters will be used for surveying radiographic operations:

Victoreen 492

3.2 Calibration

No radiography will be performed unless the radiation survey instrument is calibrated at intervals not to exceed three (3) months, and after each instrument servicing. Each survey meter shall have a label, similar to Figure 3.02, attached, which indicated the date calibrated, recalibration due date and instrument serial number.

- 3.2 Survey meters are delicate instruments and it is essential that reasonable care be taken to assure reliability. Survey instruments should be protected from rain, excessive heat, or dust by placing it in a clean plastic bag when not in use.

3.4 Methods and Occasions for Conducting Surveys

A. General Information

In order that company personnel and other individuals are protected from radiation hazards during radiographic operations, it is the responsibility of the radiographer to conduct physical radiation surveys.

B. Operating Procedure for Radiation Survey Meters

Prior to using a survey meter, carry-out the following steps:

- 1) Check the Instrument Service Record, (Fig. 3.01) on the survey meter to see that it has been calibrated within the last three (3) months.

- 3.4 B 1) If the instrument has not been calibrated, it must be returned to the Radiation Safety Officer and another meter must be obtained.
- 2) The survey instrument should be checked as to operations response with the selector switch at various settings. If the survey meter is damaged and is inoperable or is found to be unreliable, all radiographic operations must be stopped until the instrument has been replaced or repaired.
- 3) Operation of Victoreen-Gamma Survey Meter 492
- a. Turn the selector switch to the "bat" position. If the meter does not read within the check band, the batteries must be replaced. The battery test may be performed at any time whether the instrument is in a radiation field or not.
- b. Radiation Measurements: Three (3) operating ranges (X1, X10 and X100) are provided. These correspond respectively to 10, 100 and 1000 milliroentgens per hour (mR/h) full scale. For best reading accuracy, switch to the range which provides a reading in the upper 80% of the meter scale. The sensing portion of the instrument, the geiger tube, is mounted near the front of the case, centered vertically and slightly to the right of center horizontally. For greatest accuracy, the radiation should be incident from the front of the case in line with the geiger tube.

C. Physical Radiation Surveys

Physical radiation surveys shall be performed by radiographers during the following phases of their duties and in the manner listed below:

1. Surveys Prior to Radiographic Operations

Prior to the removal of an exposure device from any storage area or vehicle, the radiographer shall check the device with a survey meter. With the meter "ON" (mR/hr. Range), approach the exposure device while the meter is held between the operator and the device or container. Survey the surface of the device (360° around at 6" including guide tube) and record the reading on the Radiation Survey and Utilization Record (Fib. 3.02).

- 3.4 C 1) Upon completion of the radiographic Operation, a survey at the same point on the surface should give the same value. If results of the radiation survey show readings greater than the specified limits given below. The RSO is to be contacted immediately.
- a. Limits on levels of radiation for radiographic exposure devices (The radiation levels specified are with the sealed source in the shielded (i.e. "off") position.)
1. Radiographic exposure devices measuring less than four (4) inches from the sealed source storage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches from any exterior surface of the device. The following exposure device possessed by Technical Services meets this criteria: Gamma Ind. Model Century SA, the C-10 Source Changer, Tech/Ops Model 660 Projector and Model 650 Source Changer also meet this criteria.
 2. Radiographic exposure devices measuring a minimum of four (4) inches from the sealed source storage position to any exterior surface of the device, and all storage containers for sealed sources or for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface. The following exposure device possessed by Technical Services meets this criteria: Gamma Industries Model Gammatron 100. The Gamma Industries Model C-8 Source Changer also meets this criteria.

2) Surveys During Exposure Periods

A physical radiation survey must be made at the restricted area perimeter: (Posting of Radiographic Area is discussed in Section 4 of this Manual).

- a. With the survey instrument at its proper selector setting, survey all boundaries of the area. Results of the survey are to be recorded on the Radiation Survey and Utilization Record.

- 3.4 C 2) b. Make adjustments in the perimeter as necessary to maintain radiation levels at 2 mR/hr. or less.
- c. A radiation survey shall be performed for each exposure to determine if adjustment of the restricted area perimeter is necessary.

3) Surveys Following Individual Exposures

Upon completion of each radiographic exposure, the sealed source must be returned to its "off" (safe) position in the exposure device. The following procedures must then be followed:

- a. With the survey meter "On" (mR/hr) the operator should approach the device while the meter is held in front of him. Check the source tube and the surface of the exposure device (360° around at 6") for radiation levels.
- b. After it is determined by meter readings that the sealed source is in the safe position, the device must be locked.

4) Surveys Prior to Storage After Completing Exposures

After determining by meter readings that the sealed source is in the safe position in the exposure device, perform the following:

- a. Lock the device and remove key from lock, then properly position safety plugs.
- b. Survey the surface of the exposure device with the meter and record results on the Radiation Survey and Utilization Record.
- c. Return the exposure device to the authorized storage area and secure (lock) storage area.

5) Surveys of Outer Surfaces of Transporting Vehicles

(See Section 7 of this procedure.)


FIGURE 3.01
INSTRUMENT SERVICE RECORD

INSTRUMENT SERVICE RECORD

Calibrated by _____ on _____

Calibration void after _____

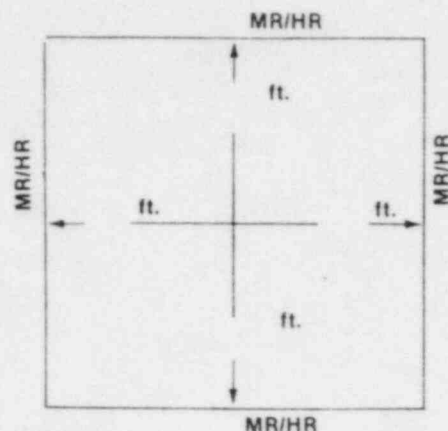
PLEASE RETURN TO APPLIED HEALTH PHYSICS, INC. FOR RE-CALIBRATION PER NRC REGULATION 10-CFR-34

 **Void**

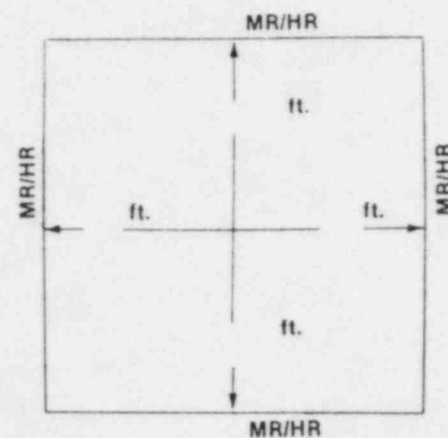
Applied HEALTH PHYSICS Inc.

2985 INDUSTRIAL BLVD. • BETHEL PARK, PA. 15102 • Phone: (412) 563-2242

RADIATION SAFETY SURVEY REPORT AND SHIPPING DOCUMENT (FIELD GAMMA)

AREA RADIATION SURVEY

COMMENTS:



COMMENTS:

RADIOACTIVE MATERIALS SHIPPING DOCUMENT

COMPANY VEHICLES

☐ RADIOACTIVE MATERIALS WERE NOT TRANSPORTED

SHIPPER:

CONSIGNEE:

NUMBER OF CURIES:

MR/HR @ SURFACE OF SHIPPING CONTAINER:

MR/HR @ 36"

VEHICLE SURVEY: MR/HR @ OUTSIDE SURFACES

MR/HR @ DRIVER'S SEAT

DESCRIPTION OF CONTENTS

CONTENTS: IRIIDIUM 192 COBALT 60 (CIRCLE ONE)

110 Curies maximum

RADIOACTIVE MATERIAL SPECIAL FORM N.O.S. UN
TRANSPORT INDEX: NOT OVER 1

NOTE: DO NOT TRANSPORT IF SURFACE OF CONTAINER

IS OVER 50 MREM/HR AND/OR OVER 1.0 MREM/HR @ 36"

(ADDITIONAL SHIELDING SHALL BE REQUIRED TO MEET

SHIPPING REQUIREMENTS OF RADIOACTIVE YELLOW II
LABEL)

TYPE B SHIPPING CONTAINER INSPECTION

S/N _____ ACCEPTABLE

CERT. NO. _____ UNACCEPTABLE

CERTIFYING STATEMENTS AND SIGNATURE

THIS IS TO CERTIFY THAT THE ABOVE NAMED ARTICLES ARE PROPERLY CLASSIFIED, DESCRIBED, PACKAGED, MARKED, LABELED AND ARE IN PROPER CONDITION FOR TRANSPORTATION ACCORDING TO THE APPLICABLE REGULATIONS OF THE DEPARTMENT OF TRANSPORTATION AND THAT ALL RADIOGRAPHIC PROCEDURES AND PRECAUTIONS REQUIRED BY TECHNICAL SERVICES RADIATION SAFETY AND CONTROL PROGRAM SECTION 10.4 OPERATING AND EMERGENCY PROCEDURES WERE OBSERVED. THE PERIMETER OF THE SOURCE STORAGE AREA WAS SURVEYED PRIOR TO REMOVING THE EXPOSURE DEVICE FROM STORAGE AND IMMEDIATELY AFTER RETURNING THE EXPOSURE DEVICE TO STORAGE. THE MAXIMUM RADIATION LEVEL WAS NOT IN EXCESS OF 2MR/HR.

SIGNED

INSTRUCTIONS (SURVEY REPORT)

1. THIS FORM IS TO BE COMPLETED FOR EACH DAY OR JOB. THIS INCLUDES PERIODS THE EXPOSURE DEVICE IS REMOVED FROM STORAGE, BUT IS NOT USED TO PERFORM RADIOGRAPHY.
2. CUSTOMER - SELF EXPLANATORY
3. DATE - SELF EXPLANATORY
4. JOB LOCATION - SELF EXPLANATORY
5. TECHNICIAN - RADIOGRAPHER, ASS'T RADIOGRAPHER AND OTHER MONITORED INDIVIDUALS NAMES.
6. FILM BADGE/TLD NO. - SELF EXPLANATORY
7. DOSIMETER NO. - SERIAL NUMBER OF YOUR DOSIMETER.
8. DOSIMETER READING START - DOSIMETER READING AT START OF EACH DAY OR JOB. DOSIMETERS ARE TO BE ZEROED AT THE BEGINNING OF EACH DAY OR JOB.
9. DOSIMETER READING STOP - DOSIMETER READING AT THE END OF EACH DAY OR JOB.
10. SOURCE MATERIAL AND S/N - RECORD THE TYPE OF BYPRODUCT MATERIAL (IR 192, CO 60) AND THE SERIAL NUMBER OF THE CAPSULE.
11. EXPOSURE DEVICE MODEL AND S/N - SELF EXPLANATORY.
12. DAILY MAINTENANCE INSPECTION - PERFORM THE DAILY MAINTENANCE INSPECTION AS BY SECTION NOTE THE CONDITION AS ACCEPTABLE OR UNACCEPTABLE. IF UNACCEPTABLE, THE ITEM SHOULD BE NOTED IN THE REMARKS COLUMN AND BROUGHT TO THE RADIATION SAFETY MONITORS ATTENTION. DO NOT USE THE EXPOSURE DEVICE UNTIL IT IS REPAIRED.
13. SURVEY METER - RECORD THE MAKE AND MODEL OF THE SURVEY METER USED, THE SERIAL NUMBER, AND THE DATE THE SURVEY METER WAS CALIBRATED.
14. EXPOSURE DEVICE SURVEY WHEN REMOVED FROM STORAGE - RECORD THE HIGHEST READING IN MR/HR AT THE SURFACE OF THE DEVICE AND AT THE PORT.
15. EXPOSURE DEVICE SURVEY AT CONCLUSION OF LAST RADIOGRAPHIC EXPOSURE — RECORD THE HIGHEST READING IN MR/HR AT THE SURFACE OF THE DEVICE AND AT THE PORT. SURVEYS OF THE EXPOSURE DEVICE ARE PERFORMED EACH TIME THE SOURCE IS RETURNED TO THE SHIELDED POSITION AS DESCRIBED BY PROCEDURE PARAGRAPH . THE SURVEY AT THE CONCLUSION OF THE LAST RADIOGRAPHIC EXPOSURE IS RECORDED.
16. EXPOSURE DEVICE SURVEY WHEN RETURNED TO STORAGE - RECORD THE HIGHEST READING IN MR/HR AT THE SURFACE OF THE DEVICE AND AT THE PORT. THE READINGS SHOULD BE THE SAME AS WHEN REMOVED FROM STORAGE. IF NOT, IT SHOULD BE SUSPECTED THE SOURCE IS NOT IN THE SAFE POSITION.
17. AREA RADIATION SURVEY - RECORD THE DISTANCES AND READINGS. WHEN THE GEOMETRY CHANGES MORE THAN 3 TIMES, ADDITIONAL REPORTS ARE TO BE USED.

INSTRUCTIONS (SHIPPING REPORT)

THIS RADIOACTIVE MATERIAL SHIPPING DOCUMENT IS DESIGNED TO FULFILL D.O.T. REQUIREMENTS. THIS FORM IS ORIENTED TOWARD COMPANY VEHICLES TRANSPORTING RADIOACTIVE MATERIAL TO AND FROM FIELD SITES.

1. IF RADIOACTIVE MATERIALS WERE NOT TRANSPORTED, CHECK BOX "RADIOACTIVE MATERIALS WERE NOT TRANSPORTED".
2. SHIPPER AND COSIGNEE - ENTER THE SHIPPER'S AND COSIGNEE'S ADDRESS IN THE SPACES PROVIDED.
3. NUMBER OF CURIES - ENTER THE NUMBER OF CURIES AS OF THE DAY BEING TRANSPORTED.
4. MR/HR @ SURFACE OF SHIPPING CONTAINER AND MR/HR @ 36" - ENTER THE HIGHEST READING AT THE SURFACE OF THE SHIPPING CONTAINER AND THE HIGHEST READING @ 36" FROM THE CONTAINER. THE READING AT 36" IS THE TRANSPORT INDEX.
5. VEHICLE SURVEY - ENTER THE HIGHEST READING AT THE SURFACE OF THE VEHICLE AND THE HIGHEST READING AT THE DRIVER'S SEAT. NO RADIATION LEVEL IS TO EXCEED 2 MR/HR @ THESE AREAS
6. CONTENTS - CIRCLE CONTENTS. IRIIDIUM 192 OR COBALT 60.
7. TYPE B SHIPPING CONTAINER INSPECTION - ENTER THE SERIAL NUMBER, CERTIFICATION NUMBER AND NOTE THE CONDITION OF THE SHIPPING CONTAINER.
8. PREPARATION FOR SHIPPING
 - A. PLACE EXPOSURE DEVICE IN A TYPE B SHIPPING CONTAINER. TYPE B EXPOSURE DEVICES MAY NECESSITATE THE USE OF NONSPECIFICATION OVERPACKS.
 - B. BLOCK OR BRACE THE PACKAGE TO PREVENT SHIFTING DURING TRANSIT.
 - C. SHIPPING CONTAINER SHALL HAVE AFFIXED AN ADDRESS LABEL (SAME AS USED FOR SHIPPER AND COSIGNEE) AND ALL D.O.T. REQUIRED IDENTIFICATION.
 - D. SHIPPING CONTAINER SHALL HAVE AFFIXED, TWO "YELLOW II" LABELS. INFORMATION REQUIRED ON LABELS ARE AS FOLLOWS:

 CONTENTS (SPELL OUT IRIIDIUM 192 OR COBALT 60) TRANSPORT INDEX - NOT OVER 1.

 NOTE: DO NOT TRANSPORT IF TRANSPORT INDEX IS OVER 1 (1.0 MREM/HR @ 36") OR SURFACE READING IS OVER 50 MREM/HR. ADDITONAL SHIELDING WILL BE REQUIRED.
9. CERTIFYING STATEMENTS AND SIGNATURE -
SIGNING THIS DOCUMENT - VALIDATES THE STATEMENT TO INDICATE ALL APPLICABLE REGULATIONS, PROCEDURES WERE ADHERED TO IN THE PERFORMANCE OF RADIOGRAPHY AND THE PREPARATION OF THE SHIPPING PACKAGE.

4.0 SECURITY MEASURES FOR INDUSTRIAL RADIOGRAPHY

Method for Controlling Access to Radiation Areas

4.1 General Information

It is the responsibility of the radiographer or radiographer's assistant to keep each radiographic area under constant surveillance at all times during radiographic operations. Whenever industrial radiography is carried out, it will be necessary to establish certain restricted areas on all sides of the radiographic operations during the exposure in order to prevent unnecessary radiation and to comply with specific radiation regulations. In general, these restrictions must extend to include those areas in which radiation levels are such that a person continuously present in that area could receive exposure in excess of 2 millirems in any one hour or could result in his receiving a dose in excess of 100 millirems in any seven consecutive days. It is essential for radiographers to make certain that maximum attention is paid to controlling access into the radiation area during radiographic exposures. Unauthorized personnel must be kept from entering the radiographic area during radiographic operations.

4.2 Posting Requirements

Radiographic areas will be posted as follows:

A. High Radiation Area

Any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material at such that a major portion of the body could receive in any one hour a dose in excess of 100 millirem. The limits of this area must be posted with signs bearing the radiation caution symbol and the words "Caution High Radiation Area".

B. Radiation Area

Any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirems. It is the practice of this company's radiographer to set up their radiographic areas at the two (2) millirem perimeter (Restricted Areas) therefore no action need be taken concerning the "Radiation Area".

4.0 4.2 C. Restricted Area

Any area which is controlled, for radiation safety, by the licensee. "Restricted Area" shall not include any areas used as residential quarters, although a separate room or rooms may be set apart as a restricted area. This restriction must also be extended to include those areas containing radiation levels such that a person continuously present in the area could not receive an exposure in excess of 2 millirems in any one hour. The radiographer will set the perimeter of the restricted area at 2 mR/hr regardless of the duration of exposure. Long exposures are to be taken after the work force has left the area. The restricted area must be posted with signs bearing the radiation caution symbol and words "Caution Radiation Area".

D. Radioactive Material

The area in which radioisotopes are stored must have the "Radioactive Material" sign.

4.3 Controlling Access to Area

A. Field Radiographic Operations

The following procedure must be conducted when performing radiographic operations at field sites:

1. Establish a restricted area by locking, barricading, or roping off all access routes to the radiographic area at distances corresponding to those that would reduce the radiation levels to that which have been previously defined for posting requirements (Radiation Area, High Radiation Area). The exposure area will be clearly marked with radiation danger signs in such a manner that they are clearly visible to the approach of personnel from any direction. Warning lights will be used in conjunction with the ropes and signs if considered necessary by the radiographer. The area bounded by the 100 mR/hr isodose line will be posted with signs reading "Caution High Radiation Area". The area bounded by the 2 mR/hr isodose line will be posted with signs reading "Caution Radiation Area" to indicate the division between restricted and unrestricted areas during radiography.

- 4.0 4.3 A. 2. If a public address system is available at the field side, the plant manager shall be notified and an "X-Ray in progress" announcement made.
3. Expose source as outlined in operating procedure and survey the perimeter of the radiation area. If adjustments of the radiation area boundary are necessary, make them immediately.
4. A Radiation Survey (Fig. 3.02) is to be completed for every radiographic field operation. Results of the survey in "3" (above) will be recorded on the form.
5. Keep restricted area under constant surveillance during radiographic operations, keeping out all unauthorized persons.
6. Remain outside Restricted Area and watch for Unlawful Entry.
7. Upon completion of radiographic work, remove all signs and barricades.

B. In-Plant Radiographic Operations

Except under unavoidable circumstances, all radiographic operations will be performed in one of the shielded rooms. Controlling access to the radiographic area will involve the following steps:

1. Make certain no one has entered the Radiography Room unnoticed prior to making an exposure.
2. Lock the shielded room.
3. Make the exposure in accordance with the procedure in Section 5 of this manual.
4. Survey the outside of the shielded room in accordance with Section 3.4, (C., 2.), and record the readings on the survey form (Fig. 3.02). If the radiation level outside the shielded room is greater than 2 mR/hr, a restricted area will be established as described in "A" above.

5.0 USE, INSPECTION AND MAINTENANCE OF RADIOGRAPHIC EQUIPMENT

PROCEDURES

A. General Information

1. A calibrated radiation survey meter must be used to monitor the radiographic device before removing it from the storage area, and upon return to storage area, and to monitor the radiographic device after each exposure to positively determine that the source has returned to the shielded position.
2. No radiographic device shall be moved unless it is locked and caps inserted into the openings to which the source cable and the control cable join to the main shielded portion of the device.
3. No radiographic device shall be used which is not within the prescribed 6-month leak test period and has been found to be free of radioisotope leakage in excess of .005 microcuries. A current leak test certificate shall be attached to the exterior of the device.

5.1 A. Daily Maintenance Check of Radiography Device (Gamma Industries Equipment)

The Radiographer will perform a daily maintenance check of the exposure device and related radiographic equipment. This inspection will be conducted prior to the use of the equipment on each day that radiographic work is to be performed. Report defective equipment to the RSO immediately. Do not attempt to use defective equipment. After determining that the equipment is operative, the radiographer shall record on the Radiation Survey and Utilization Record (Fig. 3.02) the condition of the radiographic equipment.

1. Inspect the radiographic equipment for:
 - a. Inspect cables for cuts, breaks and broken fittings.
 - b. Inspect crank for damage and loose hardware.
 - c. Check operation of cable connection.
 - d. Check operation of control for freedom of source movement.

5.1

- A. 1. e. Inspect source tube for cuts, crushing, and broken fittings.
- f. Inspect shield for damage to fittings, lock, fasteners, and labels.
- g. Safety plugs in place.
- h. Survey for excessive radiation levels.
- i. Any impairment of locking mechanism.
- B. Setting Up the Radiographic Equipment(Gamma Industries Equipment)

- 1. The radiography device shall be surveyed prior to removal from the storage area with a radiation survey instrument and the results recorded on the Radiation Survey and Utilization Log. No radiographic device shall be moved unless it is locked and all safety plugs are properly inserted. The radiographer or radiographer's assistant shall be in constant attendance during the movement of the exposure device.
- 2. Position the shielded container for radiography where it will not fall or be damaged.
- 3. Remove the protector cap from the lock box thereby exposing pigtail connector.
- 4. Crank the control cable to a length of approximately six (6) inches.
- 5. Connect the Saf-T-Key Couplings on control cable and source pigtail.
- 6. Crank control cable in so that male connecting thread can be screwed into lock box.
- 7. Screw control cable into lock box.
- 8. Stretch the control cable away from exposure device in as straight a line as possible. It is preferable to have the radiographer with the control handle as far as possible from the point where the source is to appear. (Radiographer should take advantage of local shielding when possible to limit the amount of radiation he receives.)

5.1

- B. 9. Remove safety plug from protruding nipple approximately one (1) inch from top of unit. Connect source tube.
10. Place free end of source tube in desired position trying to keep in a straight line without kinks. The end of the tube may be held in position by tape, test tube clamps, wooden blocks, with a hole, or in any other suitable manner. Straighten the source tube and re-position the exposure device if necessary. Examine the source tube to make certain it is not crimped or damaged. DO NOT USE IF ANY dents are found which might obstruct the source.
11. Clear all personnel from the area and post appropriate radiation warning signs at the approximate distances from the source relative to the amount of radioactivity used.

C. Making the Radiographic Exposures

1. Clear all personnel from the area and post appropriate radiation warning signs as shown in Section 4 of this manual.
2. Unlock the unit. Note: The Gamma Century SA, and Gammatron 100A units are unlocked by turning the control crank handle back (counter-clockwise) which will permit the key to be turned.
3. Crank source out as smoothly as possible. When you feel that source is approaching end of source tube, slow turning speed so that pigtail does not strike the end of the source tube with undue force. DO NOT FORCE THE CRANK HANDLE. If the source does not move freely through the tube, retract it into the shielded container, survey, lock it and notify the RSO.
4. Survey the area and check the locations of radiation warning signs.
5. Maintain continuous surveillance or security of the restricted area to make certain no one enters this area during the exposure. The radiographer is responsible for making any necessary adjustments in the restricted area so that the allowable radiation levels will not be exceeded.

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5.1

- C. 6. At end of exposure, retract source into unit. To positively determine that the source is in the safe position, the radiographers must make a radiation survey of the exposure device and the entire length of the source tube after each exposure to confirm that the source is in the shielded position. The radiation survey should yield the same results as the survey performed prior to removal of the device from the storage area. Note: A zero radiation level could indicate that the source did not return to the storage position. If this should happen, the radiation emergency procedures shall be followed.
7. Depress lock plunger. Note: On the Gamma Century SA, and Gammatron 100A units turn crank handle back (counter-clockwise) and depress lock plunger.

D. Dismantling the Radiographic Equipment

1. Survey the entire length of the source tube to doubly ensure that the source has not remained in the tube. Return to the exposure device and re-survey.
2. Disconnect control cable from the lock assembly, swing the connector end of the control cable at a right angle to the end of the "pigtail", and disconnect. Insert safety plug in the lock assembly.
3. Disconnect source tube from the exposure device and insert the safety plug.
4. Re-survey the device and record results on the Radiation Survey and Utilization Record.
5. Return the exposure device to the appropriate storage location and lock.
6. Read and record your dosimeter reading.

E. Procedure for Changing the Exposure Device Source

1. General Information

All changes of radiographic sources will be made under the direct supervision of the Radiation Safety Officer using the procedure described below.

- E. 1. The source change will be conducted as any other radiographic operation would be with regards to surveys, area restrictions and other safety procedures as detailed in this manual. The source change must be performed at Technical Services shielded room facility.

2. Procedure for Gamma Industries Changers

Always have properly operating survey meter at hand when changing sources.

- A. Survey source changer with meter. Surface reading should not exceed those specified in Section 3 of this manual. (The radiation levels specified are with the sealed source in the shielded position). If the unit shows readings greater than these, the RSO will be notified immediately so that corrective action may be undertaken
- B. Connect the short exchange tube provided to the empty lock box with the other end attached to the source outlet of your camera.
- C. Unlock the lock box on the source changer.
- D. Connect your control cable to the pigtail and unlock your device.
- E. Crank source from your camera into shipping container.
- F. Survey using the radiation survey meter to monitor the source changer, the exposure device, and the source tube to make certain that the source is in a safe position within the container. Surface reading should not exceed those specified in Section 3 of this manual. (The radiation levels specified are with the sealed source in the shielded position). If the unit shows readings greater than these, the RSO will be notified immediately so that corrective action may be undertaken.
- G. Lock the lock box. Be certain to position ball on pigtail directly beneath lock plunger.
- H. Disconnect source tube from shipping container.

5.1

- E. 2. I. Disconnect pigtail from the control cable.
- J. Connect control cable to new pigtail.
- K. Screw exchange tube into coupling of container.
- L. Unlock new source side.
- M. Standing as far away as possible, retract control cable which will pull source out of shipping container and into your camera.
- N. Survey using the radiation survey meter to monitor the source changer, the exposure device, and the source tube to make certain that the source is in a safe position within the container. Surface reading should not exceed those specified in Section 3 of this manual. (The radiation levels specified are with the sealed source in the shielded position). If the unit shows readings greater than these, the RSO will be notified immediately so that corrective action may be undertaken.
- O. Lock camera and shipping container.
- P. Disconnect control cable from pigtail.
- Q. Unscrew the exchange tube from your camera and from shipping container and replace all safety plugs.

A. DAILY INSPECTION OF TECH/OPS EQUIPMENT MODEL 660
EXPOSURE DEVICES

Daily inspection of the system is required to ensure that the equipment is in proper operating condition. The inspection should be performed prior to the start of each shift.

1. Inspect the entire length of each source guide tube section and control housing to ensure that each section is free from cuts and dents.
2. Inspect the end fittings to ensure that they are tightly connected. Check the threads on the fittings, the control cable connector and the male source connector for damage.
3. During the first exposure of the shift, check the operation of the selector ring, lock assembly and control crank. If operation is difficult, retract the source to the stored position and survey the equipment according to the Operating Instructions. The system must be serviced before further operation.

B. ASSEMBLY OF TECH/OPS MODEL 660 EXPOSURE DEVICE

1. Position and secure the source stop of the master source guide tube at the radiographic focal position using the tripod stand and swivel clamps.
2. Determine where the exposure device will be positioned and connect the extender source guide tubes as required, laying them as straight as possible and with no bend radius less than twenty inches. (Smaller bend radii will restrict the movement of the control cable).

WARNING

Never operate the system with more than three guide tube sections (including the master).

3. Remove the storage plug from the exposure device and connect the source guide tube(s) to the exposure device.

- B. 4. Determine where the control unit will be positioned (as far away from the radiographic focal position as possible and preferably behind a radiation shield) and lay out the control housing with no bend radii less than 36 inches.
5. Connect the control unit to the exposure device.
6. Before operation check all connections and bend radii, and check the position of the source stop, which represents the radiographic focal position of the source.
7. Check the operation of the survey meter by reading the radiation level 6 inches from the surface of the exposure device. It should read no more than 50 mR/hr for a 100 curie ¹⁹²Iridium source.
8. Unlock the exposure device lock and rotate the selector ring to the OPERATE position. The source is now free to move.

C. OPERATION

1. Return to the control unit. Adjust the odometer reset knob to obtain a 000 reading on the odometer.
2. Recheck to be sure that no unauthorized personnel are inside the Restricted Area.
3. Rapidly rotate the crank in the EXPOSE (counter-clockwise) direction to move the source to the radiographic focal position. The survey meter should read about full scale (1000 mR/hr) for a 100 curie Iridium¹⁹² source when the source first leaves the exposure device, drop gradually as the source is driven to the radiographic focal position, and remain steady during the exposure. The survey meter readings will be substantially reduced if the meter is operated behind a radiation shield or if a collimator is used.
4. When the source reaches the source stop, the hand crank will stop turning. Never exert more than 5 ft-lbs of torque on the hand crank, as this may cause damage to the control unit or drive cable. The odometer reading will indicate the total distance the source has traveled (approximately 7 ft. for one source guide tube section, 14 ft. for two source guide tube sections, and 21 ft. for three sections). Set the brake to ON to prevent movement of the source during the exposure.

- C. 5. Figure the specimen exposure time from the moment the source reaches the source stop.
6. During the exposure, spend as little time as possible in the Restricted Area to minimize personnel exposure.
 7. To return the source to the exposure device after the desired exposure time as elapsed, turn the brake to OFF and rapidly turn the crank in the RETRACT (clockwise) direction until the crank will no longer move. The odometer should read 000. During this process, the survey meter should indicate a continually increasing radiation level up to approximately 1000 mR/hr for a 100 curie Iridium¹⁹² source, then drop to background level when the source is shielded in the exposure device.
 8. Approach the exposure device with the survey meter and survey the exposure device on all sides. The meter should indicate the same radiation level as observed in step 7 of ASSEMBLY.
 9. Survey the entire source guide tube with the survey meter. If the meter shows a sharp increase, the source could still be exposed or incompletely shielded.
 10. If the source is still exposed, attempt to store it properly by cranking the source a short distance toward the source stop and retracting it, repeating if necessary.
 11. If the source becomes jammed in an exposed position, do not try to retrieve the source. Treat the situation as an emergency; notify the Radiation Safety Officer.
 12. When the source is properly stored in the exposure device, rotate the selector ring from the OPERATE position to the LOCK position and secure it with the exposure device lock.

NOTE

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 be 000. Turn the hand crank to the full clockwise (RETRACT) direction.

D. DISASSEMBLY

1. Unlock the exposure device and rotate the selector ring from LOCK to CONNECT. The control unit connector will partially disengage.
2. Disengage the control unit from the exposure device.
3. Replace the storage cover in the control unit connector and rotate the selector ring to the LOCK position. Remove the key and engage the lock to secure the exposure device. Survey the entire circumference of the exposure device with the survey meter to ensure the source is properly secured.
4. Unscrew the source guide tube sections and remove the master guide tube from the tripod stand. Place the plastic caps on the tubes and on the Model 661 connector to eliminate dust and dirt from entering the tubes.
5. Insert the storage plug into the guide tube connector and tighten.

E. PROCEDURE FOR TECH/OPS MODEL 650 SOURCE CHANGER

To perform a source change, do the following:

1. Survey the source changer to ensure the source is in the proper storage position.
2. Position the source changer and exposure device close together so that one section of source guide tube will connect them with no sharp turns or bends. The bend radius of the guide tube should never be less than twenty inches. Shorter bend radii can restrict source movement in the source guide tube.
3. Remove the storage plug from the exposure device, and attach the source guide tube. Remove the source changer cover and attach the other end of the tube to the empty chamber of the source changer.
4. Attach the control unit to the exposure device as in Section 5.2 B-ASSEMBLY
5. Crank the source rapidly from the exposure device to the source changer. During this process, the survey meter reading should increase (to approximately 1000 mR/hr for a 100 curie Iridium¹⁹² source) as the source is first exposed, fall slightly as the source is being cranked out, then drop to background when the source is in the source changer.

- E. 6. Approach the source changer and source guide tube with the survey meter to ensure that the source is fully within the source changer.
7. Open the source guides and disconnect the drive cable from the source assembly by moving the lock pin down and sliding the drive cable connector ball out through the keyway.
8. Disconnect the source guide tube from the source changer. If a replacement source is to be installed in the exposure device, connect the source guide tube to the fitting above the chamber containing the new source and couple the drive cable to the new source. If the source is being removed to service the exposure device, connect the drive cable to the jumper that is clipped inside the storage cover of the exposure device.
9. Return to the controls and crank the new source (or jumper) into the exposure device. If a new source is being transferred, the survey meter reading should increase as the source leaves the source changer and approaches the exposure device, then drop to background level when the source is shielded in the exposure device. If a jumper is being transferred, the survey meter should indicate only background radiation levels.
10. Survey the exposure device to ensure that the process has been properly completed. Radiation levels should read no more than 50 mR/hr at 6 inches from the surface of the exposure device if a new 100 curie source has been transferred. If the jumper is in the exposure device, only background radiation should be detected by the survey meter. Rotate the selector ring to the LOCK position.
11. Survey the source guide tube and source changer to check that the source has been correctly transferred.
12. Secure the source(s) in the source changer in accordance with the appropriate source changer instruction manual.
13. Disconnect the control unit and source guide tube from the exposure device as in Section 5.2 D. Disassembly, and disconnect the source guide tube from the source changer.

- 5.2 E. 14. Remove the source identification plate from the exposure device and attach it with seal wire to the source holddown cap.
15. If the exposure device contains a source, affix the identification plate of the new source to the exposure device. If not, attach an EMPTY tag to the handle of the exposure device.
16. If the source changer is to be transported, survey it to determine the correct shipping label required as in Section IV.- Shipping Radioactive Material. (Radiation levels must not exceed 200 mR/hr at the surface nor 10 mR/hr at 3 feet from the surface). Bolt the source changer cover in place and secure it with seal wire.
17. Return the source changer promptly to Tech-Ops, Inc.

5.3 QUARTERLY INSPECTION AND MAINTENANCE OF THE RADIOGRAPHIC EXPOSURE DEVICE

A. General Information

Periodic inspection of the exposure device will be performed by the radiographer or Radiological Safety Officer at intervals not to exceed 90 days.

B. Procedures

The following procedures will be used for inspection and maintenance of the radiographic exposure devices. The results of the inspection will be recorded on the radiographic Equipment Quarterly Inspection Record (Fig. 5.01).

1. Quarterly Inspection and Maintenance of the Radiographic Exposure Device (Gamma Industries Equipment)

- a. Inspect labeling on exposure device. The warning signs and source identification tags should be distinct and legible.
- b. Perform a physical radiation survey. (The radiation levels specified are with the sealed source in the shielded (i.e., "off" position)). If the unit shows readings greater than these, it will be locked in the storage vault, a survey will be performed around the outside of the storage vault and the RSO will be notified immediately so that corrective action may be undertaken.

- 5.3 B. 1. b. 1. Radiographic exposure devices measuring less than four (4) inches from the sealed source storage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches from any exterior surface of the device. For the appropriate exposure device, see Section 3.4, C., 1.
2. Radiographic exposure devices measuring a minimum of four (4) inches from the sealed source storage position to any exterior surface of the device, and all storage containers for sealed sources or for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface. For the appropriate exposure device, see Section 3.4, C., 1.
- c. Inspect the source outlet by first removing safety plug. The outlet should be round and smooth so that it will match with the I.D. of the source tube. If the exposure device has a threaded outlet port, the threads should be clean to accept the threaded source tube connection. The threads should not be stripped or worn, otherwise the source tube will not fit properly when threaded, and the source could possibly become jammed in that area. Threads can be kept in excellent condition by inserting the correct safety plug when unit is not in use.
- d. Check unit for proper position of pigtail in the locked position in unit. Make certain that the pigtail cannot be retracted from the lock box of unit. When in the locked position, the pigtail should be free to move in and out approximately 1/2" for connection of the inner drive cable connector. If unit is locked and pigtail is able to be moved in and out more than 1/2", either the fork on the lock is worn or bent, in which case the lock should be replaced. End connector on the pigtail should mate with the connector on the end of inner drive cable connector.

- 5.3 B. 1. e. The lock plunger should be inspected and checked for ease of operation. Foreign matter may at times foul the plunger and make it inoperative. This would prevent free travel of the source in and out of the lock box. When the key is inserted into the lock to unlock the unit, normally the lock should spring upwards abruptly, due to the spring tension within. When the lock is depressed to secure the unit, the operator should feel a sufficient amount of spring tension from the lock, and it should produce an audible click when fully locked. If the lock fails to spring up when unlocked, and remains in the locked position when the key is turned or a gritty sound or feeling is encountered when the lock is pulled up or pushed down, and if the lock fails to click when depressed, the following procedure must be used to rectify the difficulty:

Maintenance -

The lock must be removed from the unit by unscrewing the set screws in the side of the lock box. The pigtailed must be held in the "locked" position with tape. Insert key into lock and twist upwards to remove lock from housing. Observe the bottom plate on the lock to see if the plate has come off, due to pressure. This plate should be pressed on tightly. If this plate is off, replace with a new lock. If there is corrosion and dirt or caked oil and grease inbedded in the lock, this can be cleaned with electronic spray cleaner or suitable cleaner, and a fine stiff brush. Apply cleaner and brush vigorously until the normal spring tension and smoothness of operation returns. Never lubricate with regular oil or grease. If lubrication is necessary, powdered graphite should be dusted into the lock sparingly. However, if the lock has been fused shut or eaten away by corrosion, replace with a new lock. Replace lock by placing it in the same position and tighten set screws enough to hold in place.

The lock housing should be flush with the exposure device container. If it is loose and not flush, this situation can be rectified by tightening the set screws around the edges of the lock housing.

- 5.3 B. 1. e. The threading on the inside of the housing should not be cracked, chipped, or worn. Check for this condition by screwing in a control cable end.

When the lock is removed for cleaning or replacement, the cavity for the lock should be wiped free of grease, oil, or dirt around the pigtail opening as well as the lock cavity.

2. Inspection of the Source Tube

- a. Inspect source tubes for damage such as crimps, foreign matter, ease of connecting, and disconnecting from exposure device.
- b. Check source tube for proper length to match the correct length of control cables. Source tube must be shorter in length than control cables.
- c. Check all mating sections to be certain that all connectors are proper and be certain that the source tube has a sealed source end adapter.

Maintenance -

Crimps, kinks, and other damaged places may be cut out, and connectors placed on ends so that tube is not shortened excessively. New connectors can be put on the source tube, if the old ones are unsatisfactory. Foreign matter may be washed from tube with solvent and blown with compressed air. If the swivel adapter does not turn freely around the flare, clean it with electronic spray cleaner and a brush. If lubrication is necessary, dust a small quantity of dry graphite between swivel and flare. If this treatment does not help, or the threads are stripped or cracked, the source tube will be replaced.

3. Inspection of the Control Cables

- a. Inspect the swivel adapter. The swivel adapter is the threaded piece which threads into the remote unit, through which the inner drive cable connects to the pigtail. It should be tightly threaded to the control cable. The threads should not be worn or broken. The swivel should turn freely and should not extend over the flare

- 5.3 B. 3. b. Inspect the drive cable for wear, rusty sections, causing cable to become stiff and non-flexing, kinks, or other damaging conditions that would prevent cable from running on gear in the gear box housing. To inspect this, crank it out slowly into a clean container while inspecting the cable for defects. The cable should not be rusty. This can be prevented by periodically wiping the cable with trichlorethane and a cloth. Then lubricate it with a thin film of molykoat. Observe the connector on the cable for signs of wear. If the round key-hole through which the pigtail connects is enlarged or loose on the inner drive cable, the inner drive cable must be replaced. The connector on this inner drive cable should be crimped tightly to the cable. This can be determined by passing a small nail through the key-hole and abruptly pulling on it and twisting. If it is fastened securely, it will not pull off. The connector must mate properly with the pigtail.

Maintenance -

The drive cable should be cleaned with a solvent such as varsol or diesel fuel. This is done to remove sand, dust and other foreign matter that will cause abrasions in the exposure device and gear box drive mechanism.

Drive cable that has become rusty and non-flexible should be replaced. Failure to replace cable may cause controls to become stiff, hard to operate, wear excessively, and possibly break. The cable would usually break when the source is exposed. Lubrication of the drive cable is important. In areas where there is a problem with sand or other abrasive material, dry powdered graphite is excellent. Graphite should not be packed continually since it will tend to pack in the gear box and cause excessive wear to the gear housing and to the gear. Where the control cables can be kept reasonably clean, a light oil will be adequate.

- c. Inspect the control assembly. This assembly consists of the gear box assembly and the crank handle. The bronze bushings in the gear housing and the plate are the most likely places to find wear. When these bushings are worn they tend to permit the gear to wobble and eventually wear out. Usually (due to some build-up on the drive cable or the gear teeth) there will be some wear around the inner circumference of the housing. This will permit the drive cable to slip on the gear and prevent source from moving properly through the exposure device.

5.3 B. 3. c. Maintenance -

It is suggested that if powdered graphite is used as a lubricant the gear box be cleaned with compressed air occasionally so as to remove any packed graphite in the gear mechanism. The application of some type of light oil on bronze bushings will help prevent excessive wear. If tubing threads are broken, teeth are missing, or the bronze bearing has excessive wear, request a replacement. Check handle assembly for wear and periodically tighten the screws which hold the handle assembly together.

- d. Inspect drive cable housing or conduit. This conduit can be damaged by dripping it across a hot weld, severe kinking, or by dropping some object on the conduit. Any of these can prevent the drive cable from moving freely. The conduit at the end connections may become damaged from excessive flexing while being assembled or disassembled

Maintenance -

In any case where the inner liner has been damaged, the conduit must be replaced. When the outer covering has been damaged, waterproof tape should be wrapped around the break to prevent the entrance of water or other corrosive substance. If the extreme ends of the conduit are damaged, they tend to permit the gear to wobble and eventually wear out.

C. Quarterly Inspection and Maintenance of Model 660 and 680 Exposure Device Control Unit (TECH/OPS EQUIPMENT)

1. Drive Cable, Control Housings and Source Guide Tubes - Disassembly

To service the drive cable, control housings and source guide tubes, follow these steps:

- A. Disconnect the control unit from the exposure device.
- B. Turn the hand crank of the control unit in the EXPOSE (counter-clockwise) direction until the crank will no longer turn. Do not use force, as this may damage the drive wheel inside the control box. The emergent cable should be cranked into a bucket or other container to keep it clean.
- C. Disconnect the control housing from the RETRACT side of the crank and remove the stop spring from the drive cable. The drive cable will now pass through the crank.

- 5.3 C. 1. D. Turn the crank until the drive cable is totally disconnected.
- E. Pull the drive cable out through the Model 661 control cable connector and coil it with a radius of no less than 4 inches.
- F. Remove the Model 661 control cable connector and connector plug from the control housings, and disconnect the other control housing from the crank. Label the housings for proper reassembly.
- G. Clean the drive cable with chlorothene and flush the control housings and source guide tubes.
- H. Using compressed dry air (15psi max.) thoroughly dry the drive cable, control housings and guide tubes. Any remaining solvent can cause permanent damage.
- I. Check the source guide tubes for binding by holding them vertical and dropping a dummy source (or jumper) through them.
- J. Wipe the guide tubes and control housings with a cloth soaked in chlorothene and flex them to check for internal damage. Damage is evidenced by a crunching feeling when the housing or tube is bent. While doing this, feel for dents. Cut, flattened or burnt control housings or guide tubes should be repaired or replaced.
- K. The guide tubes or control housings may be covered with tape where only the outer plastic is cut through.
- L. Using a Model 550 no-go gauge, check the male connector of the drive cable. If the ball of the connector fits through the hole of the gauge or the ball shank fits into the slot in the gauge, the connector is worn and the cable must be replaced. Refer to Figure 7.1
- M. Lightly grease the cable using TEXACO "Uni-Temp" grease. Other grease may form tar or corrosive compounds when exposed to radiation.

5.3 C. 2. Crank Assembly - Model 693 Control Unit

To service the 693 control unit, perform the following steps:

Disassembly

- A. Remove the control housing and drive cable from the crank assembly as described in the previous section.
- B. Remove the control box housing from the frame by unscrewing the four binder head screws and 3/8" nuts.
- C. Remove the crank arm assembly from the control box housing by removing the 5/16" hex head bolt.

CAUTION

Make sure the cable adapters stay in the lower control box housing during separation. Care should be taken to avoid possible injury from or loss of the tension-loaded wear strip.

- D. Separate the two halves of the control box housing, keeping the cable adapters in the lower control box housing to ensure the wear strip does not fly out. Remove the drive wheel, wear strip, two cable adapters, two brake jaws, brake arm and brake bearing.
- E. The two ball bearing assemblies in each side of the control housing may be left in place.
- F. Remove the odometer mount cover from the odometer mount and check the odometer unit for proper operation. The unit should turn freely and without excessive play. Clean the helical gear with chlorothene and lightly grease it. If the odometer assembly is defective, it must be replaced as a unit.
- G. To service the odometer, remove the odometer mount cover from the odometer mount. Remove the odometer reset knob by unscrewing the two set screws, and unscrew the two attaching large round head screws.

5.3 C. 2. Reassembly

- A. Clean all the control box parts in chlorothene and dry them thoroughly with compressed dry air (15 psi Maximum). Inspect for damage and excessive wear. Replace and defective parts.
- B. Lightly grease all moving parts at their contact surfaces.
- C. Place two cable adapters in the lower control box housing with the angled sides facing inward in order to provide clearances for the drive wheel.
- D. Place the wear strip in the control housing.

CAUTION

Insert the wear strip with care, since it will be under tension and could pop out.

- E. Place the drive wheel (6) in the lower control box housing (4).
- F. Position the two brake jaws (15), brake bearing (13) and brake arm (16) in the lower control box housing. When installing the brake jaws, face the worn sides away from the drive wheel, as this increases their life.
- G. Place the upper control box housing over the lower control box housing while keeping them level, and press them together.
- H. Check the control box for proper reassembly by turning the shaft. It should spin freely. If not, disassemble and reinspect the parts for damage and proper alignment. Reassemble and check the operation again.
- I. Resecure the odometer to the odometer mount (20) and secure the odometer reset knob(29) and odometer mount assembly cover (34) in place.

- 5.3 C. 2. J. Secure the control box to the control handle (17) and odometer mount (20) with the four large binder head screws and 3/8" nuts, and secure the crank arm assembly (3) to the shaft with 5/16" bevel washer and 5/16" hex head bolt. Follow step 12 of the previous section for checking of operation.

5.4 INDUSTRIAL X-RAY MACHINES

A. General Information

The potential hazards associated with industrial X-ray equipment are electrical and radiological. The equipment currently used by this company has been designed to control these hazards. The X-ray units will be operated and serviced only by personnel who are authorized by the Chief Radiographer or Radiation Safety Officer to perform such work.

B. The following procedure will apply to all use of X-ray equipment by authorized personnel:

1. Have an operating survey meter on hand always and use it.
2. The transportation of an X-ray machine to a site requires no shielding or posting of the vehicle because an X-ray machine must be energized. The device will be secured in the vehicle to prevent unauthorized removal.
3. An area on the site to perform the radiography will be selected that is as remote from other personnel as possible or an area will be cleared and roped off to prevent entry during exposures. Sufficient "CAUTION RADIATION AREA" signs will be posted and the radiographer will position himself so as to see anyone who might enter the area.
4. Obtain key for X-ray machine.
5. Position all equipment for making the radiograph. (Radiographer should take advantage of local shielding when possible to limit the amount of radiation he received.

- 5.4 B. 6. The radiographer or assistant radiographer will record on a Technique Sheet all pertinent variables for each radiographic exposure. This record will be signed or initialed by the operator responsible for the shot.
7. Clear all persons from the radiation area, post appropriate radiation warning signs at the approximate distance from the X-ray tube relative to the amount of radiation used, and place the area under surveillance or secure all entrances.
8. Proceed with the exposure. Survey the area and check the locations of radiation warning signs. Record results of survey on the Radiation Survey and Utilization Record form.
9. Maintain continuous surveillance of high radiation areas except if the area is equipped with a radiation control device or an alarm system, or, where the high radiation area is kept locked to prevent any accidental or unauthorized entrance. The radiographer will at no time leave the vicinity of the control console while an exposure is in progress; if anyone enters the restricted area the machine will be shut-off and the person removed from the area. If the radiographer and his assistant leave the vicinity of the machine, the machine will be locked and the key removed to prevent anyone from operating the machine.
10. In the event of a malfunction of the unit, the line voltage plug will be removed until the malfunction is corrected.
11. Secure equipment upon completion of exposure, making sure the current to the X-ray tube is off.
12. Record dosimeter pencil reading.
13. If the machine is to be left at a site overnight, or longer, it will be secured in a manner to prevent it from being removed and the lid key and the control key will be retained in the radiographer's possession.

5.5 PRODUCT MALFUNCTIONS AND DEFECTS

A. Malfunctions and defects to be reported:

- 5.5 A. 1. All defects found as listed on daily check list.
2. Any condition that could cause a source to malfunction during operation such as guide tube crimps, control cable end loose, key hole is not round; if in doubt do not use equipment and notify R.S.O.
- B. When are malfunctions and defects to be reported.
1. All malfunctions and defects are to be reported immediately and will be evaluated prior to equipment use.
2. All malfunctions and defects are to be recorded on the survey and utilization record and signed by the radiographer.
- C. The person to report any malfunction of equipment.
1. An assistant radiographer reports to the radiographer in charge.
2. The radiographer reports to the R.S.O. immediately prior to use of the equipment.

FIGURE 5.01(A)

DATE _____

INSPECTED BY _____

GAMMA INDUSTRIES EQUIPMENT
QUARTERLY INSPECTION AND MAINTENANCE
OF EXPOSURE DEVICE

Equipment _____ S/N _____

- 1) Labeling, warning signs and source ID distinct and legible. (yes) (no)
 - 2) Physical radiation survey within required limits. (yes) (no)
 - 3) Source pigtail in locked position. (yes) (no)
 - 4) Condition of lock box and lock plunger inspected for ease of operation. (yes) (no)
 - 5) Outlet port mates with source guidetube. (yes) (no)
 - 6) List corrective measures. _____
- _____

SOURCE TUBE

Length _____ Material _____

- Does tube have any crimp markings? (yes) (no)
- Do fittings match unit? (yes) (no)
- Is tube fraying near adapters? (yes) (no)
- Source stop end proper and connected? (yes) (no)
- List any unusual conditions. _____
- _____

List corrective measures. _____

CONTROL CABLES

Length of control cable _____

- Swivel adapter OK? (yes) (no)
- Drive cable inspected in accordance with 5.3 (B)(3)(b). (yes) (no)
- List any unusual conditions _____

List corrective action _____

Control Assembly inspected IAW 5.3 (B)(3)(c). (yes) (no)

List any unusual conditions _____

List corrective measures _____

Drive cable conduit inspection OK? (yes) (no)

List any unusual conditions _____

List corrective measures _____

DATE _____ INSPECTED BY _____

TECH/OPS EQUIPMENT
 QUARTERLY INSPECTION AND MAINTENANCE
 OF EXPOSURE DEVICE

Equipment _____ S/N _____

- 1) Labeling, warning signs and source ID distance and legible. (yes) (no)
- 2) Physical radiation survey within required limits. (yes) (no)
- 3) Source pigtail in locked position. (yes) (no)
- 4) Condition of lock assembly inspected for ease of operation. (yes) (no)
- 5) Outlet port mates with source guidetube. (yes) (no)
- 6) List corrective measures _____

SOURCE TUBE

Length _____ Material _____

- Does tube have any crimp markings? (yes) (no)
- Do fittings and sections match master section? (yes) (no)
- Is tube fraying near adapters? (yes) (no)
- Source stop end proper and connected? (yes) (no)
- List any unusual conditions. _____

List corrective measures. _____

CONTROL CABLES

Length of control cable _____

- Drive cable inspected in accordance with 5.3 (C)(1). (yes) (no)
- List any unusual conditions. _____

List corrective action. _____

Control Assembly inspected IAW 5.3 (C)(2). (yes) (no)

List any unusual conditions _____

List corrective measures _____

Drive cable conduit inspection OK? (yes) (no)

List any unusual conditions _____

List corrective measures _____

6.0 METHODS AND OCCASIONS FOR LOCKING AND SECURING RADIOGRAPHIC EXPOSURE DEVICES AND STORAGE CONTAINERS

6.1 General Information

All radiographic exposure devices and storage containers are provided with suitable locks or locking devices to prevent unauthorized or accidental removal of the radioactive material. The exposure devices or X-ray machines must be kept locked at all times, except when under the direct supervision of a radiographer or his assistant.

6.2 Locking and Securing

- A. During radiographic operations, the exposure device must be locked and surveyed after each exposure. The survey limits must not exceed those listed in Section 3.4, C.
- B. Upon completion of radiographic operations, the exposure device must be locked, safety plugs inserted and secured in its proper storage container and the container locked (providing the exposure device has a storage container).
- C. The device or storage container will then be locked in the transporting vehicle while returning the device to its permanent storage area.
- D. After returning the exposure device or storage container to its permanent storage area, the storage area will be locked.
- E. When vehicles are used for storage areas overnight, the exposure device and storage container must be locked and then locked in the vehicle. The keys must be kept in the possession of the radiographer. In the event it is necessary to secure the source by locking it in the trunk of a car or body of a truck, sufficient shielding must be provided so that maximum radiation levels on the surface of the vehicle or enclosure will not exceed 2 mR/hr. The exterior of the vehicle will be identified by posting the sign, "CAUTION-RADIOACTIVE MATERIAL".
- F. In the course of field work with radioactive materials, it is necessary at times to temporarily leave work site to process film, discuss interpretations, etc. In those cases, the exposure device must be locked and secured with a chain and lock to an immovable object. Keys shall be kept in the possession of the radiographer during his absence. The exterior of the device must be posted with the sign, "CAUTION - RADIOACTIVE MATERIAL".

- 6.2 G. Rooms or areas may be utilized at field locations overnight, provided that proper signs are posted around storage container or device and approval has been granted by client and client is aware of the storage area location.
1. Lock device in storage container.
 2. Lock storage container.
 3. Post "CAUTION - RADIATION AREA" and "CAUTION - RADIOACTIVE MATERIAL" warning signs at entrance to storage room.

In the event that an adequate storage facility is not available at the field location, the device or container will be secured with a chain and locked to the work or the building and radiation warning signs posted.

H. In-Plant Storage

A radioisotope storage area is provided for the safe storage of the exposure devices. The storage area must be posted with the warning signs containing the words, "CAUTION-RADIOACTIVE MATERIAL". The exposure devices must be returned to the radiographic storage vault when operations are completed. The entrance to this area must be kept locked at all times.

7.0 TRANSPORTATION OF RADIOGRAPHIC DEVICES

7.1 General Information

Exposure devices or source changers can be transported by truck, boat, aircraft or automobile, provided that appropriate regulations of the Department of Transportation, U. S. Nuclear Regulatory Commission and State Vehicle laws are obeyed.

7.2 Transporting Remote Operated Radiographic Devices to Job Sites

- A. Prior to the removal of an exposure device from any storage area, the radiographer shall check the device with a survey meter. If results of the radiation survey show readings greater than the specified limits given below, the RSO is to be contacted immediately.
- 1) Limits on levels of radiation for radiographic exposure devices and storage containers (the radiation levels specified are with the sealed source in the shielded (i.e., "off") position).
 - a) Radiographic exposure devices measuring less than four (4) inches from the sealed source storage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches from any exterior surface of the device. For the appropriate exposure device, see Section 3.4, C., 1.
 - b) Radiographic exposure devices measuring a minimum of four (4) inches from the sealed source storage position to any exterior surface of the device, and all storage containers for sealed sources for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface. For the appropriate exposure device, see Section 3.4, C., 1.
- B. The radiographer or radiographer's assistant shall be in constant attendance during preparation of the device or container for transportation.

- 7.2 C. No radiographic device shall be moved unless it is locked and all safety plugs are properly inserted. All exposure devices must be locked in their storage containers.
- D. The remote operated radiographic devices and source changers used by Technical Services are provided with their own shipping containers and need not be crated, but must be properly positioned in the transporting vehicle and firmly secured by the use of ropes, straps or blocks so as to avoid bouncing, sliding or other movements.
- E. A radiation survey must be conducted on the outer surfaces of the vehicle to assure that radiation levels do not exceed 200 mR/hr.
- F. A radiation survey must be within the passenger compartment to assure that radiation levels are not above 2 mR/hr. If necessary, lead or concrete shielding should be secured around the device or storage container to reduce radiation levels to 2 mR/hr. or less.
- G. The exterior of the transporting vehicle must contain the placard "Radioactive" when required by DOT Regulations. This placard must appear on all of the four sides of the vehicle and must meet the requirements of DOT. This placard is to warn passersby and emergency crews that radioactive material shipments are in the vehicle. The placard will alert emergency crews to the need for taking appropriate precautions in case such vehicles are involved in accidents.
- H. Except when a vehicle containing an exposure device is under the direct surveillance of the radiographer or the assistant radiographer, it shall be kept locked at all times.
- I. Keys to exposure devices, storage containers and the vehicle shall be retained by the radiographer during the transportation of exposure devices.
- J. If overnight stops are required enroute, the vehicle should not be parked on main thoroughfares.
- K. In the event of a road accident involving the transporting vehicle, the instructions in Section 8.6 must be followed.

7.3 Transporting X-ray Machines

- A. The transportation of an X-ray machine to a site requires no shielding or posting of the vehicle because an X-ray machine must be energized. The device will be secured in the vehicle to prevent unauthorized removal.
- B. If the machine is to be left at a site overnight, or longer, it will be secured in a manner to prevent it from being removed and the lid key and the control key will be retained in the radiographer's possession.

7.4 Transportation of Exposure Devices by Commercial Carrier

The Radiation Safety Officer is responsible for preparation of the packaging and necessary forms for shipment of exposure devices by commercial carrier. The radiographer is not to offer a radiographic exposure device to a commercial carrier for shipment.

8.0 MINIMIZING EXPOSURE OF PERSONS IN THE EVENT OF ACCIDENTS

8.1 General Instructions

Radiation accidents can occur wherever radiation equipment or radioactive materials are used or stored. Radiation may be an added hazard in the event of a fire or a variety of other emergencies. Adequate preparedness and care can avoid most accidents and can minimize radiographic exposure damages resulting from accidents if they do happen.

When any of the following occurs, it shall be considered an accident and the appropriate emergency procedure shall be followed:

- A. Damage to radiographic equipment
- B. Fire involving a sealed source
- C. Theft of a sealed source
- D. Loss of a sealed source
- E. Accident involving the vehicle which is transporting a sealed source
- F. Unauthorized or accidental entry to restricted area
- G. Accidents involving possible overexposure

- 8.2 G. After reporting the accident and/or leaving word for the RSO to provide assistance, the radiographer will return to the restricted area and continue to maintain surveillance until corrective action can be taken by the RSO or personnel authorized by the RSO to retrieve the source.
- H. DO NOT, at any time, threaten your own safety by trying to retrieve or repair exposure device. Stay out of the area until the Radiation Safety Officer arrives, regardless of the time lapse for him to get to the restricted area.
- I. Upon the arrival of your Radiation Safety Officer, you may aid him in taking the necessary steps to relieve the hazards.
- J. Dosimeter pencils must be checked constantly during the emergency conditions in order that you may account for all exposure received during your assignment. Calculations must be made to determine radiation levels when making the necessary repairs. Time, distance and shielding must be calculated to determine the allowable working limits.
- K. The radiographic exposure device will not be used again until repairs are made by the manufacturer and the equipment is inspected by the Radiation Safety Officer.

8.3 Fire Involving a Sealed Source

- A. Return source to exposure device.
- B. Lock device and perform radiation survey of guide tube and device to assure source is in shielded position.
- C. Disconnect source cables and insert safety plugs, if possible.
- D. Remove the exposure device from the fire zone, if possible.
- E. Notify fire company nearest your area, giving them the name and address of the location of the fire.
- F. Notify Radiation Safety Officer and give him complete details.

8.2 Accidents Involving Radiographic Equipment

- A. The radiographer will attempt to retract the source if possible.
- B. If source cannot be retracted, immediately re-survey the restricted area and adjust perimeter of roped off area to 2 mR/hr. or less and position additional "CAUTION - RADIATION AREA" signs where needed.
- C. Do NOT try to repair damaged equipment or retrieve a loose source.
- D. Keep restricted area under constant surveillance, keeping out all unauthorized personnel.
- E. If the radiographer does not have a helper on this assignment, locate a responsible person such as plant guard, shop foreman or a person whom you feel is safety conscious and would keep unauthorized personnel out of the restricted area during your absence. Give the responsible person instructions not to permit any person in the area and in the event of accidental entry, get individual's name, address and telephone number and his location while in the area.
- F. The radiographer will telephone the RSO and give complete details of the emergency.

RADIATION SAFETY OFFICER

Edward Handrahan - Technical Services Division of
Vector Corporation

Business Phone: 412-687-7100
Home Phone: 412-265-3873

If the RSO cannot be located, leave word with the RSO's office and/or the switchboard, emphasizing the urgency of locating the RSO and obtaining his assistance. The radiographer can also call Applied Health Physics collect (412) 563-2242, stating that this is an emergency and assistance is needed and give the telephone number where he can be contacted at or near the emergency site. The radiographer must be certain that the telephone number he gives to AHP or the switchboard will be attended and the person answering that telephone will be able to get in touch with the radiographer after he returns to the restricted area to await help.

- 8.3 G. If unable to remove the sealed source from the fire zone, be sure to give the firemen the location of the radioactive material. DO NOT permit firemen to enter Radiation Area after fire has been extinguished until a thorough examination evaluates the extent of the damage to the radiographic equipment.
- H. Gather all facts pertinent to the accident and be ready to present them to the proper persons. This should include names, addresses and telephone numbers of all persons suspected of having been in, near or over the radiation area.

8.4 Theft of Sealed Source

- A. Notify the foreman at job location and/or plant guard to assure that no person will leave the premises without first being monitored.
- B. Notify your Radiation Safety Officer, giving him complete details of the emergency, so he may in turn notify the proper authorities immediately.
- C. Gather all facts pertinent to the theft and be prepared to present the facts to the proper authorities.

8.5 Loss of Sealed Source

- A. Notify the foreman at job location and/or plant guard to assure that no person will leave premises without first being monitored.
- B. Notify your Radiation Safety Officer giving him complete details of the emergency, so he may in turn notify the proper authorities immediately.
- C. Gather all facts pertinent to the loss and be prepared to present the facts to the proper authorities.

8.6 Vehicular Accident

Assuming that you are physically able and your survey meter is working properly:

- A. Survey vehicle for radiation intensities. If source has been knocked out of the safe position, restrict the area to a 2 mR/hr. or less and allow no unauthorized curious bystanders near the vehicle and/or restricted area.
- B. Get notification of accident to local law authorities.

- 8.6 C. Upon arrival of local law authorities, describe the conditions that exist and have them control your Radiation Area until you have notified your Radiation Safety Officer, giving him complete details and have received instructions for corrective action.
- D. If survey instrument has been damaged and a visual examination detects any indication of damage to the source or source container, the vehicle shall be isolated and arrangements made to secure an operable survey instrument. In any event, locate an operable survey meter before entering the radiation area. Colleges, hospitals and State Health Departments have survey instruments available that can be borrowed or rented in case of an emergency. If this accident occurs on a turnpike or expressway, traffic must be routed around the vehicle at a safe distance depending on the type of isotope and its strength. Local authorities must be cautioned about the hazards that could develop by curious bystanders loitering near the vehicle.

Assuming that you are unconscious, the warning signs on the vehicle will advise the general public and local authorities that you are hauling radioactive material. We must assume that the local authorities are trained to handle a situation of this nature and will take the necessary action to apply medical aid for your protection. This is the importance of placing signs on the vehicle: "DANGEROUS - RADIOACTIVE MATERIAL" or "RADIOACTIVE" to warn them of the potential hazards involved.

If the radioactive material you are hauling has been locked and secured as prescribed by this document, then this should minimize the danger of the source becoming loose or free from its prescribed storage container.

8.7 Unauthorized or Accidental Entry to Restricted Area

- A. Immediately remove person or persons from Restricted Area and to not permit any individual to re-enter the area again.
- B. Notify Radiation Safety Officer and give complete details.
- C. Gather all facts pertinent to the accident and be ready to present them to the proper persons. This should include names, addresses and telephone numbers of all persons suspected of having been in the radiation area.

8.8 Accidents Involving Possible Overexposure

If any of the items listed in General Instructions shall cause or threaten to cause an overexposure to personnel, the radiographer must:

- A. Remove personnel involved from radiographic operations area immediately.
- B. Post area properly, if hazard exists.
- C. Notify the Radiation Safety Officer immediately.
- D. In case unauthorized personnel are involved, get the name, address and telephone number of the person or persons suspected and gather all facts pertaining to the cause of the exposure.
- E. Have the person or persons complete a statement of facts on just how the exposure occurred and present the report to the Radiation Safety Officer.

9.0 PERSONS TO CONTACT IN THE EVENT OF AN EMERGENCY

9.1 General Information

In the event of an accident or any difficulty involving the use of radioactive materials, the Radiation Safety Officer is to be notified immediately. DO NOT minimize the seriousness of the emergency. Improper or incomplete information over the telephone may be misconstrued and might result in improper corrective action.

9.2 Persons to Notify

RADIATION SAFETY OFFICER

Name: Edward Handrahan

Plant Phone: (412)687-7100

Home Phone: (412)265-3873

Name: John Chabal

Plant Phone: (412)687-7100

Home Phone: (412)337-4074

10.0 MAINTENANCE OF RADIATION RECORDS AND REPORTS

10.1 Records

The various records that must be maintained by radiography personnel have been shown in various sections of this manual. These records must be accurate and up to date at all times.

Below is a summary of those records which must be completed by radiography personnel during the course of their work.

Daily Dosimeter Pencil Readings - Figure 2.01;
Section 2.3,C.

Radiation Survey and Utilization Record -
Figure 3.02; Sections 3.4,C; 4.3,A;
4.3,B; 5.1,B; 5.2,D.

Radiographic Equipment Quarterly Inspection
Record - Figure 5.01; Section 5.3,B.

Mark V Leak Test Data Form - Figure A.01;
Section A.3,3.

10.2 Statements

In addition to records that must be maintained per regulations, we require statements to be made when certain unusual circumstances develop. These statements must be prepared by the person or persons involved in the unusual circumstances and must be forwarded to the Radiation Safety Officer. Statements shall be made on the following unusual events:

- A. Overexposure
- B. Dosimeter Pencil off scale
- C. Lost Film Badge
- D. Lost Dosimeter Pencil
- E. Film Badge dropped in exposure area during radiographic operations.
- F. Possible Overexposure
- G. Emergencies that require corrective action.
- H. Malfunction of the Radiographic Exposure Device.

ITEM 10.5

LEAK TEST PROCEDURE

1.0 LEAK TESTING PROCEDURES

1.1 General Instructions

Each sealed source shall be tested for leakage at intervals not to exceed six months. In the absence of a certificate that a test has been made within the six months, the sealed source shall not be put into use until tested. It is essential that such tests be performed in accordance with regulations of the U. S. Nuclear Regulatory Commission and/or applicable State Radiological Health Agency. It is essential that such tests be performed in accordance with these regulations and conditions of our Byproduct Materials License.

1.2 Radiation Protection Measures During Leak Test

Precautionary measures must be observed by the individual authorized to leak test sealed sources with the Mark V Leak Test Kit for radioisotope users licensed by the U. S. Nuclear Regulatory Commission and/or Agreement-State. They may be summarized as follows:

1. Remote controlled radiographic exposure devices shall be leak tested by conducting the test on accessible surfaces of the device upon which contamination might be expected to accumulate. (For example, the interior of the source tube tip)

NOTE: When testing such devices, the sealed source must be in the "SAFE" position. This must be confirmed by conducting a radiation survey of the device prior to performing the leak test.

2. The individual conducting the test shall wear a film badge and pocket dosimeter as required by the NRC license conditions. With this same consideration, personnel monitoring devices should also be worn by other individuals permitted to remain in the area where leak testing is being performed.
3. The leak tester must monitor the test area and any adjacent areas with calibrated survey meters, and any required signs must be posted in accordance with Section 4 of this manual.
4. Sources must not be allowed to come into contact with the hands or other portions of the body.

5. When necessary, accessory shielding devices shall be used in the leak testing area.
6. Sealed sources should be leak tested following any incidents wherein they may be damaged. Should a source be subjected to chemical or physical stresses beyond those for which it was designed, an immediate leak test is recommended.

1.3 Instructions for Use of Leak Test Kit on Sealed Sources

1. Pre-Test Procedures

Preparation of the Mark V Leak Test Kit:

- a) Remove the plastic plug-cap with its cotton swab insert from the plastic test tube. Add a few drops of water to dissolve the powdered wetting agent in the tube. Slightly dampen the swab's cotton tip with the wetting agent solution and discard any unused solution that may remain in the tube.

Return the prepared swab to the test tube.

- b) Complete the information required on the self-sticking, circular leak test label which is included in the kit and securely attach to the midsection of the test tube.
- c) Carry out final preparation for all radiation protection measures that must be employed.

2. General Testing Procedures

The following general testing procedures shall be used on sealed sources:

- a) Survey the radiographic device to make certain the source is fully retracted and locked.
- b) Remove the safety plug from the source tube fitting. Do not expose the source nor unlock the device.
- c) Carefully swab the interior of the source hole, running the applicator as far into the shielded container as possible. Rotate the swab inside the source hole to collect any residual contamination that might be deposited if the source is leaking.

1.3 2

- d) Immediately following the wiping procedure, securely replace the plug-cap and its swab insert into the labeled plastic rest tube. Avoid touching the cotton tip to the body or other objects.
- e) Replace the safety plug on the radiography device.

3. Post-Test Procedures

Pursuant to completion of the leak test, these steps must be taken:

- a) Complete the Mark V Leak Test Data Form (Fig. A.01) in a legible fashion. This form must be signed by the individual who performed the sealed source leak test.
- b) Enclose the Data Form and the sealed plastic test tube in the mailing box and seal the box. Fill in the proper return address on the Applied Health Physics, Inc.'s shipping label and securely attach to the box.
- c) Monitor all external surfaces of the mailing box with a calibrated survey meter, such as Geiger-Muller meter with an end-window probe detector. Post Office Department regulations require that radiation levels at any surface of the box must be less than 10 milliroentgens for 24 hours; i.e., an average of approximately 0.4 milliroentgens per hour.
- d) If results of the survey meet these requirements, proceed with mailing the Mark V Leak Test Kit to Applied Health Physics, Inc. Should the survey indicate that any surface of the box has a dose rate greater than 0.4 milliroentgens per hour, immediately notify the Radiation Safety Officer.
- e) In the event the specimen indicates leakage and/or contamination of 0.005 microcurie or more, Technical Services requests immediate notification so that appropriate action may be taken.
- f) If the analysis indicates less than 0.005 microcurie of radioactivity on the leak test specimen, a "Certificate of Leak Test" similar to Figure A.02, and a sticker, similar to Figure A.03, shall be issued by Applied Health Physics, Inc. The sticker shall be applied to the radiographic exposure device.

APPLIED HEALTH PHYSICS, Inc.

MARK V LEAK TEST DATA FORM

Complete this form in a legible fashion and return with the appropriate leak test specimen to Applied Health Physics, Inc., 2986 Industrial Blvd., P.O. Box 197, Bethel Park, PA 15102. Phone Area Code (412) 563-2242.

NOTE: DO NOT TEST MORE THAN ONE (1) SEALED SOURCE PER KIT.

This is to certify that I have followed the instructions governing the procurement of the enclosed leak test specimen using the Mark V Leak Test Kit. This specimen _____ (leak test tube label number) was taken by: _____

on _____ (date).

person performing test

SOURCE DESCRIPTION:

<u>Radioisotope</u>	<u>Activity(mC)</u>	<u>Model No.</u>	<u>Serial No.</u>	<u>Manufacturer</u>
---------------------	---------------------	------------------	-------------------	---------------------

INSTALLED IN:

<u>Device</u>	<u>Model No.</u>	<u>Serial No.</u>	<u>Manufacturer</u>
(gauging, exposure, therapy, storage)			

LOCATION:

Company

Address

By-product Materials License Number _____

In the event this specimen indicates leakage and/or contamination of 0.005 microcurie or more, I request that you notify me promptly by the method denoted below and I agree to take appropriate action as required by Title 10-CFR-31.5d(s)(6) and/or 34.25(d), or conditions of the above-mentioned license.

☐ Telephone(Collect)

_____ (person to be contacted)

☐ Telegraph(Collect)

Area Code: () _____

☐ Air Mail Spec. Del.

Telephone Number _____

Do not write below this line.

Analysis of the leak test specimen, No. _____, by Applied Health Physics, Inc. indicated the presence of _____ microcurie of _____ activity on _____.

Pursuant to the results of this leak test, the following action is recommended:

☐ Analysis indicated 0.005 microcurie or more of radioactivity on the leak test specimen. Immediately withdraw the source from use. Decontaminate and repair it or conduct disposal in accordance with applicable regulations. File a report with the regulatory agency within the time period prescribed.

☐ Analysis indicated less than 0.005 microcurie of radioactivity on the leak test specimen. The sealed source may be used as authorized. This source must be leak tested again, on or before _____ or within any such time period required by the regulatory agency.

This certificate is an essential record and should be maintained for inspection by the regulatory agency.

BY: _____

CERTIFICATE NO. _____

DATE: _____



ESTABLISHED 1957

Applied HEALTH PHYSICS inc.

2990 Industrial Blvd. • Box 107 • Bethel Park, Pa. 15002 • Phone 412 • 364-2042

CERTIFICATE OF LEAK TEST

NO. _____

This is to certify that the source indicated below was leak testing using an approved method. The leak test was performed by _____, on _____.

SOURCE DESCRIPTION:

<u>Radioisotope</u>	<u>Activity</u>	<u>Model No.</u>	<u>Serial No.</u>	<u>Manufacturer</u>
---------------------	-----------------	------------------	-------------------	---------------------

INSTALLED IN:

<u>Device</u>	<u>Model No.</u>	<u>Serial No.</u>	<u>Manufacturer</u>
---------------	------------------	-------------------	---------------------

LOCATION:

CompanyCompany Address

Analysis of the leak test specimen, No. _____, By Applied Health Physics, Inc. indicated the presence of _____ microcurie of _____ activity on _____.

Pursuant to the results of this leak test, the following action is recommended:

☐ Analysis indicated 0.005 microcurie or more of radioactivity on the leak test specimen. Immediately withdraw the source from use. Decontaminate and repair it or conduct disposal in accordance with applicable regulations. Also, file a report with the regulatory agency within the time period prescribed - if required.

☐ Analysis indicated less than 0.005 microcurie of radioactivity on the leak test specimen. The sealed source may be used as authorized. This source must be leak tested again, on or before _____ or within any other such time period required by the regulatory agency.

This certificate is an essential record and should be maintained for inspection by the regulatory agency.

APPLIED HEALTH PHYSICS, Inc.

BY: _____

DATE: _____

FIGURE A.03

LEAK TEST CERTIFICATE NO.

This source or device was leak tested on _____
_____, and analysis indicated less than
0.005 microcurie of removable contamination.
In compliance with pertinent regulations, leak
testing must be repeated again, on or before



HEALTH PHYSICS inc.
P. O. BOX 197 • BETHEL PARK, PA. 15102

ITEM 11

WASTE MANAGEMENT

Radioactive material sources will be returned to supplier
for disposal.