A-1

VOID SHEET

76.12 F ✓ 03006110
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116092

TO: License Fee Management Branch

FROM: Region I

SUBJECT: VOIDED APPLICATION

Control Number: 116092

Applicant: CMI-Quaker Alloy, Inc (37-03671-01)

Date Voided: 9/17/92

Reason for Void: Licensee requested termination
MCTL# 116581
Before Review

Cynthia O'Daniell 9/17/92
Signature Date

Attachment:
Official Record Copy of
Voided Action

FOR LFMB USE ONLY

Final Review of VOID Completed:

Refund Authorized and processed

No Refund Due

Fee Exempt or Fee Not Required

Comments: _____

_____

_____ 10130

Log completed

Processed by: B/B

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PDR ADOCK 03006110
B PDR

"OFFICIAL RECORD COPY" ML 10

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CMI-QUAKER ALLOY, INC.
720 South Cherry St. Myerstown, PA 17067
A SUBSIDIARY OF CMI INTERNATIONAL INC.

(717) 866-6511

RADIOGRAPHIC OPERATIONS MANUAL

FOR

CMI-QUAKER ALLOY, INC.

MYERSTOWN, PENNSYLVANIA 17067

Copy No: 1

Issued to: Nuclear Regulatory Commission

Date: 1-20-92

Issued by: Drm

116092

CMI-QUAKER ALLOY, INC.
720 South Cherry St. Myerstown, PA 17067
A SUBSIDIARY OF CMI INTERNATIONAL INC.
(717) 866-6511

RADIOGRAPHIC DEPARTMENT

RADIOGRAPHIC OPERATIONS

Book No.	
1	Nuclear Regulatory Commission
2	Nuclear Regulatory Commission
3	D. Callihan
4	D. Edwards
5	Safety Director
6	J. Kimmel
7	
8	C. Kinloch
9	Maintenance Department Head
10	S. Klick
11	G. Frantz
12	M. Landis

TITLE: RADIOGRAPHIC OPERATIONS MANUAL FOR CMI-QUAKER ALLOY INC.

ATTACHMENTS

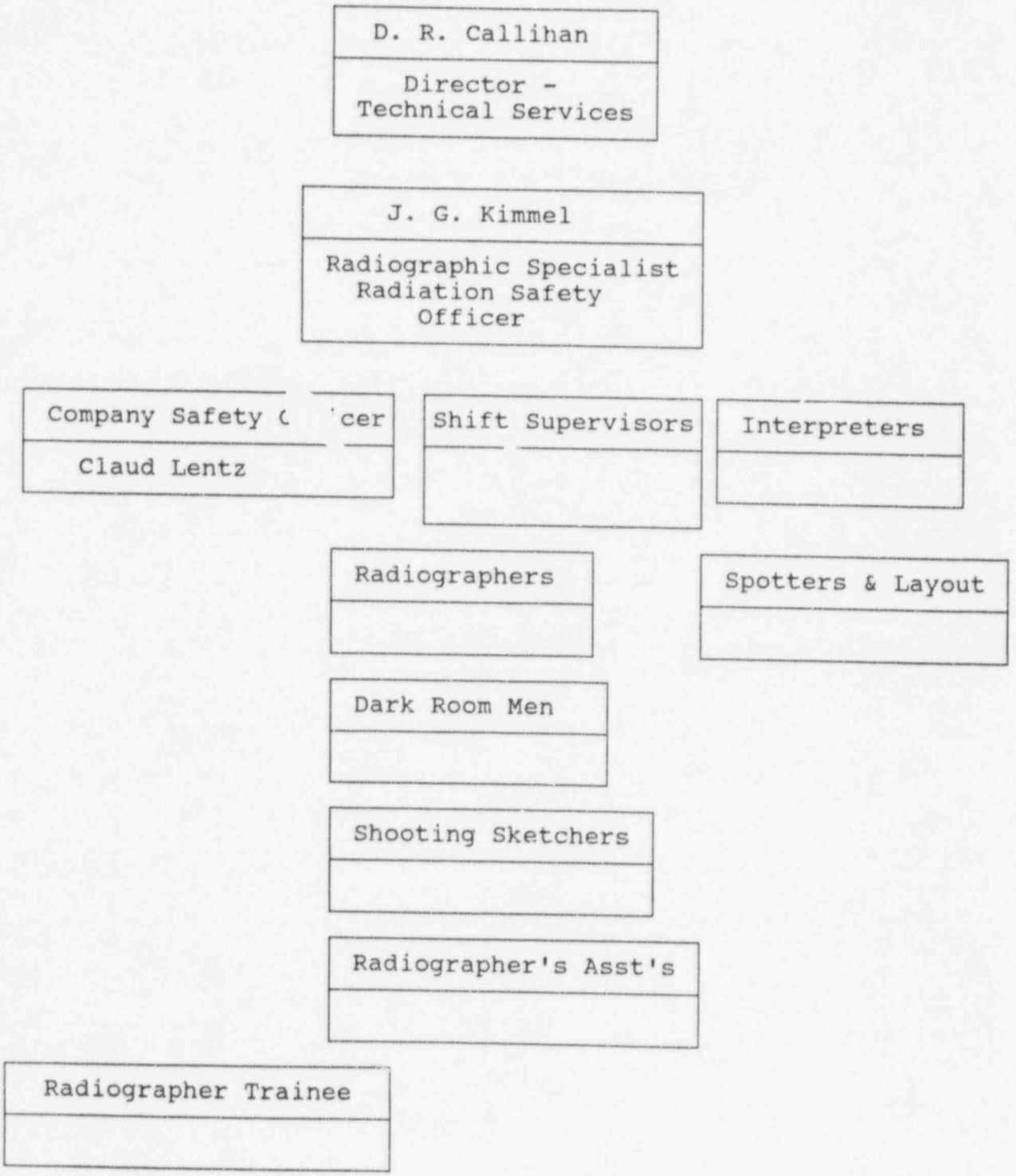
1.0 PURPOSE

To establish a radiation safety program for handling radioactive material within the radiographic facilities at CMI-Quaker Alloy Inc.

2.0 SCOPE

This procedure shall govern all radiographic activities performed by CMI-Quaker Alloy Inc. employees. The company and each individual must assure a high degree of responsibility to assure total safety for the public and company personnel in an operation of this nature. A program for performance which will assure safety has been outlined within for the operating procedure. Any employee that willfully violates the requirement of this procedure or State and Federal rules and regulations shall be subject to dismissal.

3.0 Organization Structure of Radiographic Facility



3.0 Organizational Structure of the Radiographic Program

3.1 Responsibility

3.1.1 The entire radiation protection program of the CMI-Quaker Alloy, Inc. is directed by Douglas R. Callihan.

3.1.1.1 Joseph G. Kimmel assists in this responsibility in the absence of D. R. Callihan. He shall be responsibility for original preparation, revision and institution of all written procedures in compliance with State and Federal regulations.

3.1.1.2 Claud Lentz is the CMI-Quaker Alloy, Inc. Health and Safety Director. He participates in audits and documentation of the radiation safety program and receives copies of all reports.

3.1.2 Joseph Kimmel, Radiation Safety Officer, is immediately responsible for the safe operations and implementation of the procedures of the program. He is also responsible for the initial training, qualification, and periodic training of all radiographers, radiographers' assistants and trainees; and maintenance of records of training and qualification. He shall review all radiation records at least monthly in order to maintain control of the record-keeping system. He is also responsible for receipt and shipment changing and leak testing of all by-product material in accordance with Section 9 of this manual. The Radiation Safety Officer shall assume control and institute corrective action in emergency.

3.1.3 Radiographers shall perform radiographic operations; and as part of the training program, work with a radiographer's assistant. The radiographer is responsible to assure that radiography is performed in accordance with Nuclear Regulatory Commission regulations and these procedures.

3.1.4 Radiographer's Assistant performs radiographic operations using exposure devices, sealed sources, related handling tools and survey instruments while under the direction and personal supervision of a radiographer in compliance with Nuclear Regulatory Commission regulations and these procedures.

3.1.4.1 Under no circumstances may the duties and responsibilities of a radiographer be delegated to a radiographer's assistance.

3.1.5 Radiographer Trainee undergoes classroom and on-the-job training to qualify as a radiographer's assistant.

3.2 Radiation Related Training and Experience Record

3.2.1 Personnel Qualification - Director Technical Services.

3.2.1.1 Douglas R. Callihan - associated with radiographic activities since 1977, both directly and indirectly through training, experience, and managerial activities related thereto.
1977-1981 - Indirect but active association with radiography as professional metallurgist in various occupational persuits.
1981-Present - Quaker Alloy Inc. managerial and administrative responsibility for radiographic facility described in this manual.
1982 (March 2) Certified Level I operator of radiographic test methods in accordance with MIL-STD-271E and NAVSHIPS 250-1500-1.
1990 (Jan.) NDT Test Examiner to MIL-STD-2132, Radiography.
1992 (Jan.) Certified Level III SNT-TC-1A.

3.2.2 Personnel Qualification - Radiographic Specialist Radiation Safety Officer.

3.2.2.1 Joseph G. Kimmel - Training 28 years. Initial training including identification of signs and symbols regarding identification of signs and symbols regarding radioactivity, radiation sources and restricted areas. Initial training regarding radiation hazards, definitions of radiation areas, high radiation area, labels, visible, and audible signals and control devices. Initial training regarding safety fundamentals inherent to established rules and regulations of State and Federal authorities. Periodic training including verbal, written, and visual information about radioactive materials and controls. Periodic safety meetings attended for discussions regarding use of radioactive materials, protection, operating and emergency procedures, detection of radiation and limitations of permissible dose of monitoring exposure of individuals and determination of accumulated occupational dose. This included film badges, dosimeters and survey meters. Initial training involving the health hazards associated with exposure to radioactive materials or radiation. Initial training in precautions and safety procedures to minimize exposure to radioactive materials and radiation. On-the-job training of the worker's responsibility in seeing that the

State and Federal regulations and controls of this manual are adhered to. On the job instruction regarding reporting procedures and responsibility to promptly report any condition potentially violating State and Federal regulations. On-the-job training in the response to warnings made in the event of unusual events or malfunctions that could result in exposure to radiation or radioactive material. On-the-job training regarding actual handling of sources of radiation (x-ray, gamma rays, and by-product isotopes). Successful completion of testing conducted by employer to prove extent of knowledge and training.

3.2.2.2 Experience - 28 years
Worked in all subordinate phases, including radiographer and radiographer's assistant, of radiographic examination using such devices as X-ray equipment and crank-out radioisotopes (Co60 and Ir192) in a jobbing shop-type operation involving steel castings and welds. Kept all health physics records applicable to State and Federal regulations. Conducted training program for subordinate personnel, radiographers and radiographer's assistants.

4.0 Internal Inspection System

4.1 Scope

4.1.1 This section covers the system for internal inspection of radiographic operations and record keeping. The system provides for documentation and correction of deficiencies in the program.

4.2 Type of Inspections

4.2.1 Management inspections of records and facilities shall be conducted quarterly. This inspection shall be performed by the Director of Technical Services or his designated subordinate and the Company Safety Director. Two of the inspections will be announced and two will be unannounced.

4.2.2 The Radiation Safety Officer shall conduct a monthly inspection of records and facilities. The Company Safety Director will be invited to participate, at his discretion, in these inspections. Approximately half the inspection shall be on an unannounced basis with the remainder being announced.

4.2.3 Weekly inspections of facilities shall be conducted by the Radiation Safety Officer. These may be conducted on either an announced or unannounced basis.

4.3 Record Inspection

4.3.1 The record keeping instructions will consist of a review of all applicable records,

i.e., exposure device inspection and leak test logs, dosimeter logs, utilization logs and quarterly inventory. These records shall be reviewed to assure that they are being completed in a timely manner and that complete and accurate information is being entered. These records are available for review by the Nuclear Regulatory Commission upon request. Discrepancies discovered in the records system will be documented. The responsible individual shall be made aware of the error or discrepancy and a corrective action will be filed with the inspection report.

4.4 Facility Inspection

4.4.1 Facility inspections will consist of observation of radiographic personnel during performance of routine operations, and an inspection of exposure devices and survey instruments.

4.4.2 Personnel observations will be performed to assure that individuals are performing radiographic operations, including logging of required data, in accordance with the operating procedure and the Nuclear Regulatory Commission rules and regulations.

4.4.3 Discrepancies or errors in operation will be reviewed with the responsible individual. Retraining shall be performed as required by each situation.

The individual will be observed following retraining to assure that he is totally aware of the requirements and performs accordingly.

4.4.4 Door locks, interlocks, and alarms shall be inspected to assure that they are in proper working condition.

4.4.5 Equipment inspection will be performed to assure that exposure devices are in working order and that moving parts do not show excessive wear, also that the devices are clean and lubricated and are properly marked. Survey instruments will be checked for proper operation and current calibration stickers.

4.5 Inspection Reports

4.5.1 Inspections shall be documented on the "Report of Record and Facility Inspection" form.

4.5.2 Copies of the report shall be available for review by the Company Safety Director, Director of Technical Services, Radiation Safety Officer, and the Shift Supervisor involved.

4.5.3 The Radiation Safety Officer is responsible to notify the Company Safety Director and Director of Technical Services, in writing within five (5) days, of the action to correct the deficiencies noted in the inspection report.

4.5.4 The Company Safety Director and Director of Technical Services are responsible to follow up on all corrective action to ascertain that is has been initiated and is effective.

4.5.5 A copy of all inspection reports and corrective action shall be maintained by the Radiation Safety Officer.

5.0 FACILITIES

5.1 The radiographic f. .lities consist of 11 individual radiographic cells. A detailed sketch of the building which house the facilities is attached. (Attachment #1) All radiographic activities shall be performed within these cells. As shown on Attachment #1, certain cells are not in use. The use of radiographic cells is determined by work load and type of work. The outside of the building is fenced and marked with High Radiation Area signs.

5.2 Radiographic sources and exposure devices shall be surveyed prior to initiating a regular radiography program with the sources and machines in operation. A re-survey shall be made whenever a change in the type or quantity of the radioactive material, shielding or exposure conditions such as, but not limited to, source location or use of collimators.

5.2.1 The results of the survey shall be documented and maintained as part of the permanent facility record.

5.3 Radiation levels in unrestricted areas will be maintained within the limitation that an individual could not receive a dose exceeding 2 mr in any one hour or 100 mr in any seven consecutive days.

6.0 RADIATION DETECTION INSTRUMENTATION

6.1 Utility Alarm System

Radiation monitoring equipment which was permanently installed is indicated on the facilities sketch (Attachment #1). The equipment consists of a Gamma-Interlock Alarm System. These components control Audible and Visual alarms for each cell. They are connected to the doors so that the Audible alarm sounds if the doors are opened during an exposure.

6.2 Individual monitoring equipment shall consist of a pocket Dosimeter and Film Badge. Spare Pocket Dosimeters will be available for use as required.

6.2.1 Four (4) types of Dosimeters are available for use:

6.2.1.1 Victoreen, Model 541A, 541R - Range 0 - 200mr/hr.

6.2.1.2 Bendix, Model 862 Range 0-200 mr/hr.

6.2.1.3 Landsverk, Model L50 Range 0-200 mr/hr.

6.2.1.4 Dosimeter Corp. Model 002, 862 Range 0 - 200 mr/hr.

6.2.2 Pocket Dosimeters will be checked for correct response to radiation as listed in Appendix H.

6.2.3 Film badges are supplied by R.S. Landuer and/or Tracer Lab.

6.3 Survey Meters

Eberline Instrument Survey Meters, Models E510G and E130G with a 0 to 1,000 mr/hr range shall be used by the Quaker Alloy Inc. to detect Gamma Radiation.

6.3.1 Each survey meter shall be calibrated at three months intervals. Calibration shall be performed by Bionics, Technical Operations, Branch Radiography Lab or Eberline Instrument. A survey meter log will be maintained with calibration dates. There shall be calibrated survey meters assigned to all operating radiographic cells using isotope radiation and at least one calibrated meter available as a spare. An additional meter shall be rotated for calibration. If a meter requires repairs it shall be calibrated immediately following the repair. A sticker shall be attached to each meter identifying the meter number, the date of last calibration and the due date for next calibration.

7.0 GENERAL DESCRIPTION OF THE RADIATION SAFETY TRAINING PROGRAM

7.1 Responsibilities

7.1.1 The Radiation Safety Officer with the Assistant Radiation Safety Officer shall be responsible for the training and qualification of all radiographic personnel in accordance with the program outlined by this section. Qualifications shall be established by written and oral tests and personal observations.

7.1.2 Radiographic Shift Supervisors shall participate in the program by assisting in the on-the-job instruction as outlined in Para. 8.1.3.

7.2 Program Sequence

7.2.1 The following sequence shall be followed for training and qualification of untrained personnel (Radiographer Trainee).

7.2.1.1 Initial training - classroom

7.2.1.2 On-the-job training - instructions and observation only.

7.2.1.3 Qualification examination - this exam, if passed, shall qualify the individual as radiographer's assistant.

NOTE: See Para. 8.1 for detailed description of each phase of training and qualification.

7.2.2 After successfully completing the training and qualification of Para. 8.1, and having worked as radiographer's assistant for a minimum of three months, the individual may become eligible for further training and qualification as a radiographer. Training and qualification shall consist of:

7.2.2.1 Additional classroom instruction.

7.2.2.2 Successful completion of the training programs and completion of a radiographer qualification examination.

NOTE: See Para. 8.2 for detailed descriptions of each phase of training and qualification.

7.2.3 If an individual is hired with previous training and experience, he shall be given a Radiographer's Assistart examination. If he passes, he will be classified as a Radiographer's Assistant. The qualification requirements shall be the same as required by Para. 7.2.2 except minimum working time shall be determined by the Radiation Safety Officer.

8.0 TRAINING AND QUALIFICATION REQUIREMENTS

8.1 Initial Training

8.1.1 The initial classroom training for untrained personnel, shall consist of forty (40) hours classroom instruction, covering all items in Appendix A of 10CFR Part 34. Each trainee will be provided a copy of the Quaker Alloy Inc. Operating and Emergency Procedures and applicable Nuclear Regulatory Commission rules and regulations.

8.1.2 Classroom Instruction - Initial classroom instruction shall, as a minimum, cover the following subjects:

(a) "Radioactive Materials and Their Use in Industry." A five (5) hour session defining radioactive materials and how they will be used in the Quaker Alloy facility.

(b) "Fundamentals of Radiation Safety". Twenty-five (25) Hours.

1. "Units of Radiation Dose" - Defining dose, rad, rem, and dose limits as defined by title 10 Part 20.
2. Review of CFR parts 19, 20, and 34.
3. "Precautionary Procedures" Discussing the use of survey meters, film badges, dosimeters, gamma alarm system, signs, radiation area, high radiation areas, restricted area and unrestricted areas, as they apply to the Quaker Alloy facility.

4. Review of case histories of radiography accidents in NUREG/DR-0001, Vol.1 .

(c) "Operating and Emergency Procedures." - Ten (10) hours.

1. Use of exposure devices employed by Quaker Alloy, and conducting surveys, methods and frequency.
2. Record maintenance, dosimeter logs, utilization logs, Quarterly inventory records, etc., and "Emergency Procedure". Who to notify and what to do.

8.1.3 On-The-Job Training

On-the-job training shall consist of demonstration and instruction, by the Radiation Safety Officer, Assistant Radiation Safety Officer, or Radiographic Shift Supervisor.

(a) In the use of exposure devices. This includes how to attach cables, use of the plugs and locking device.

(b) "Use of Survey Instruments". Checking for proper operations, survey techniques and interpretation of readings.

(c) Use of beam collimators to produce satisfactory radiographic results and reduce scatter radiation.

(d) "Use of Personal Monitoring Devices". Dosimeter and film badge.

(e) "Required Record Keeping". Dosimeter logs and utilization log, including daily exposure device inspection.

8.2 Examination for Qualification as Radiographer's Assistant

8.2.1 After the classroom and on-the-job training listed in 8.1, and having observed several radiographic operations, the trainee will be given a written examination of twenty-five (25) questions. A sample test examination is shown in Appendix A of this manual. A minimum grade of 80% shall be required for qualification.

8.2.2 The trainee will also perform a radiographic set up, and termination operation under the direction of a Radiographer, the Radiation Safety Officer or Assistant Radiation Safety Officer who will observe the operation and grade the trainee accordingly. The grading will be based on the trainee's ability to:

1. Complete the operation without undue delay.
2. Perform safety related activities including proper operation of the survey instruments and documentation of all applicable records.

8.3 Examination for Qualification as a Radiographer

8.3.1 After the classroom instruction, and on-the-job training listed in 8.1, and after having worked satisfactorily as a Radiographer's Assistant for three (3) months, the individual will be eligible for examination as a Radiographer.

8.3.1.1 A written examination consisting of fifty (50) questions covering all items in Appendix A to CFR Part 34 will be given. A sample test is shown in Appendix A of this manual. A minimum grade of 80% shall be required for qualification.

8.3.1.2 The Radiation Safety Officer or Assistant Radiation Safety Officer will further observe that the individual demonstrate satisfactory ability to:

(a) Perform a radiographic operation without assistance.

(b) Use survey meter to assure that source is in shielded position prior to unlocking device.

(c) Ability to make mechanical connections without difficulty, (Portable Sources).

(d) Assures the cell is cleared before exposing the source.

(e) Proper use of survey instruments after exposure is complete.

(f) Documentation of records including dosimeter log, survey meter calibration log and check-list log book.

8.3 Periodic Training

8.3.1 Periodic training shall be provided on a monthly basis to assure that radiographic personnel are up-to-date with regard to changes in the radiographic program and to insure that personnel maintain a continuing awareness of existing procedures.

8.3.1.1 Changes which will be covered are listed below:

(a) Revision to Radiation Safety Procedure

(b) Amendments to applicable commission requirements.

(c) Changes of radiographic equipment or survey instruments.

(d) Any other changes which might result in excessive exposure to any individual.

8.3.2 A written examination covering the subject matter of the monthly sessions shall be conducted at least once per year by the Radiation Safety Officer or Assistant Radiation Safety Officer.

9.0 BY-PRODUCT MATERIAL CONTROL

9.1 Receipt and Shipment of Sealed Sources

9.1.1 Receipt: Immediately upon receipt of a new source the shipping container shall be checked with a survey meter to assure that the source is in the shielded position. The Radiation Safety Officer shall check the decay curve to assure that the source is within the activity level provided for by the Nuclear Regulatory Commission License. He shall also check for the date of the date of the last leak test then enter in the quarterly inventory log the following information.

(a) Date of receipt of source.

(b) Model and serial number of source.

(c) Type and activity of source.

(d) Model and serial number of exposure container which will shield the source.

(e) Receiving container model and serial number.

9.1.2 Shipment: When the old source is shipped the Radiation Safety Officer shall enter in the quarterly inventory log the following information:

(a) Date shipped.

(b) Source Activity.

(c) Shipping container model and serial number.

The Radiation Safety Officer shall be responsible for seeing that all handling is in compliance with Part 20, Title 10.

9.1.3 Quarterly Inventory
An inventory of all sourced in CMI-Quaker Alloy's possession must be made quarterly. The quarterly inventory log shall contain the following information:

(a) Date of receipt of source
(b) Model and serial number of source
(c) Type and activity of source
(d) Model and serial number of exposure container which will shield the source
(e) Model and serial number of the receiving container

9.2 Sourced Leak Test:

9.2.1 A leak test of all sources in CMI-Quaker Alloy's possession MUST be made twice a year. No source may be used unless a leak test has been performed within the six (6) month period. The Procedure for Leak Testing Sealed Sources in included as Appendix B of this manual.

9.3 Removal of Decayed Sources

9.3.1 The Radiation Safety Officer shall change the sources from the shipping container to the exposure container and from the exposure container to the shipping container. This shall be performed in strict accordance with the instructions provided by the container manufacturer.

9.3.1.1 Source Change Procedure for Gamma Industries' C-10 Source Changer is included as Appendix C of this manual.

9.3.1.2 The following exposure device will utilize Gamma Industries C-10 Changer: 9.3.1.2.1 Radionics Model P192-1000.

9.3.1.3 Technical Operations Manual, Source Changer, Model 414, Iridium 192 is included as Appendix D of this manual.

9.3.1.4 The following exposure device will utilize Technical Operations Model 414 Source Changer:

9.3.1.4.1 Technical Operations Model 660

9.3.1.5 Technical Operations Manual, Source Changer Model 650, Iridium 192 is included as Appendix G of this manual.

9.3.1.6 The following exposure device will utilize Technical Operations Model 650 Source Changer.

9.3.1.6.1 Technical Operations Model 660.

9.3.2 Non-Portable Sources

9.3.2.1 Radionics Exposure Devices

9.3.2.1.1 Under no circumstances will sources by removed from the containers here. Replacement of these sources must be made by Gamma Industries or other licensed supplier in their facility.

9.3.2.2 Picker Cyclops Exposure Device.

9.3.2.2.1 Picker Cyclops source may be exchanged here utilizing a source changer supplied by Picker X-ray. This operation must be performed under the direction of a qualified representative of the manufacturer.

10.0 INSPECTION AND MAINTENANCE OF RADIOGRAPHIC EXPOSURE DEVICES AND STORAGE CONTAINER.

10.1 Radiographic exposure devices shall be inspected quarterly by the Radiation Safety Officer or his assistant to assure they are in working order.

10.1.1 Moving parts shall be examined to see that there is no excessive wear.

10.1.2 Devices shall be kept clean and lubricated for proper operation.

10.2 The procedure for Periodic Inspection and Maintenance for Radiographic Exposure Devices for portable sources is included as Appendix E of this manual. The Devices (6 in number) are as follows:

10.2.1 Four (4) Radionics Model P192-100

10.2.2 Two (2) Technical Operations Model 660

10.3 The procedure for Periodic Inspection and Maintenance of Radiographic Exposure Devices - Nonportable Sources, shall be limited to inspection and maintenance to assure proper closure of the shutter mechanism located under the dust cover on the source container, including proper operation of the shutter drive unit consisting of drive motor, gears, belts or clutches micro switches, wiring and electrical components of the source container, console and interlock systems. The non portable sources are as follows:

1 One (1) Radionics Model 60-2000

2 One (1) Picker Cyclops Model 6115020

10.3.1 The maintenance will be performed by Quaker Alloy personnel and/or Gamma Industries, Technical Operations, TFI Corporation or Temsi Corporation under the direction of the Radiation Safety Officer or the Assistant Radiation Safety Officer. Inspection and maintenance personnel will carry and observe an operating survey meter and wear a film badge and/or pocket dosimeter. Satisfactory operations shall be verified by the Radiation Safety Officer prior to resuming radiographic operations. Dosimeter readings will be recorded in the daily dosimeter log.

10.4 In the event a portable or nonportable source in the exposed position will not retract, the Radiation Safety Officer or the Assistant Radiation Safety Officer will be notified. Proper corrective action will be taken under their direction.

10.5 Corrective maintenance of a more serious nature, which would involve source displacement or shutter removal, shall be performed only by authorized personnel of Gamma Industries, Technical Operation , TFI Corporation or Temsi Corporation.

11.0 SUBJECT - 10 CFR PART 21

11.1 Scope

11.1.1 This section covers the system for compliance to the regulations of 10 CFR Part 21 in accordance with Quaker Alloy's procedure "Reporting of Defects and Noncompliance in Nuclear Basic Components According to 10 CFR Part 21."

11.2 Purchasing

11.2.1 The Manager of Purchasing and the Director of Technical Services or their designee, shall be responsible for specifying on procurement documents when applicable: "Compliance with the regulations issued by the United States Nuclear Regulatory Commission as set forth by 10 CFR Part 21 must be acknowledged regarding the facility, activity or basic component(s) represented by this Purchase Order No. _____, dated _____."

11.3 Receiving

11.3.1 Upon receipt of any material in which there is a defect or suspected deviation, the Director of Technical Services will immediately be notified by the Radiation Safety Officer or Assistant Radiation Safety Officer.

11.4 Inspections

11.4.1 When performing the programs of Internal Inspection (Section 4) and Inspection and Maintenance (Section 6), if a deviation is found that may create a substantial safety hazard, the Director of Technical Services will immediately be notified by the Radiation Safety Officer or Assistant Radiation Officer.

12.0 SUBJECT - USER OF NRC APPROVED PACKAGE DESIGNS

12.1 Scope

12.1.1 This section covers the system for compliance to regulation 10 CFR Part 71, as applicable to Quaker Alloy as a user of NRC approved package designs for shipping of radioactive material.

12.2 Responsibilities

12.2.1 The Radiation Safety Officer or his assistant will be responsible for the activities outlined in this section.

12.3 Quality Assurance Program Procedure.

12.3.1 Certifications

12.3.1.1 Certifications will be obtained from our supplier and kept on file, assuring us that an adequate Quality Assurance program was in force during the manufacture of the package.

12.3.2 Receipt of Package

12.3.2.1 The package will be checked with a survey meter to ascertain that source is in proper storage position and that package is damage free. Further receipt procedures are outlined in Section 91. of this manual.

12.3.3 Shipment of Package

12.3.3.1 When the package is returned to the supplier, it will be checked with a survey meter. The maximum radiation level should not exceed 200 MR per hour at contact or 10 MR at three (3) feet from exterior surface.

12.3.3.2 The package will be checked for damage, proper seal and proper labeling.

APPENDIX A

A written examination similar to the attached but varying from time to time, will be given to each candidate at the conclusion of classroom training. Management reserves the right to repeat this or similar test whenever it deems necessary or when there is reason to believe that radiographer proficiency needs evaluation for any reason.

The examination will consist of a minimum of twenty (20) questions. Correct answers will be awarded 5 points, partially correct, multiple choice will be given appropriate points based on weight-percentage. A passing grade of 80 is required. For all candidates, wrong answers will be reviewed verbally to complete understanding. The question will be re-phrased orally by the examiner and the examinees answer (verbal) will be evaluated and graded. A written, oral and practical composite grade of 80% shall determine suitability of candidate for radiographer or radiographer assistant.

Practical on-the-job demonstration, involving safety, radiation surveys, record maintenance and operation of equipment shall be conducted by the examiner to show competence of the examinee in the use of all related equipment to be used by the individual.

APPENDIX A - EXAMINATION

RADIOGRAPHER'S ASSISTANT

a) What is the maximum permissable weekly dose as established by the Atomic Energy Commission?

A. 75 milliroentgens
B. 100 milliroentgens
C. 150 milliroentgens

b) What is the radioactive half life of Cobalt 60?

A. 1500 years
B. 2 years
C. 5.3 years

c) What is the radioactive half life of Iridium 192?

A. 75 days
B. 150 days
C. 30 days

d) How many roentgens per hour per curie at one foot does Cobalt emit?

A. 24.4 roentgens
B. 9.2 roentgens
C. 14.4 roentgens

e) How many roentgens per hour per Curie at one foot does Iridium 192 emi

A. 9.2 roentgens
B. 14.4 roentgens
C. 5.9 roentgens

f) Can you feel that you are in a high radiation area or that you are in an area of radiation exposure?

A. Yes
B. No
C. Don't know

g) How many rems or M.R. are permissable for calendar year?

A. 5 rem or 5000 M.R.
B. 12 rem or 12,000 M.R.
C. 8 rem or 8,000 M.R.

h) What is the maximum permissable dose for calendar quarter for whole body?

A. 1-1/4 rems or 1,250 M.R.
B. 3 rems or 3,000 M.R.
C. 2-1/2 rems or 2,500 M.R.

i) Name three types of radiation detection equipment.

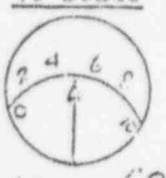
A. FILM BADGES
B. SURVEY METERS
C. POCKET DOSIMETERS
D. GAMMA ALARM

j) The unit for measuring penetrating external radiation exposure is the

A. Rem
B. R
C. M.R.

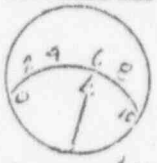
k) What would the readings on survey meter be on the following drawings?

10 Scale



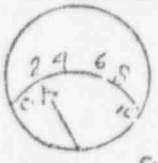
Ans. 50

100 Scale



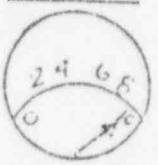
Ans. 600

1 Scale



Ans. 2

10 Scale



Ans. 100

l) What is meant when an area is posted with the words "Radiation Area"?

An area which the body can receive in one hour a dose excess of:

A. 5 millirems
B. 10 millirems
C. 100 millirems

m) What is meant when an area is posted with the words "High Radiation Area"?

An area which the body can receive in one hour a dose in excess of:

A. 100 millirems
B. 200 millirems
C. 500 millirems

n) What is meant when an area is posted with the words "Unrestricted Area"?

A. An area is not controlled by the Licensee for purpose of protection of an individuals from exposure.

B. An area where the source is located.

o) What is the permissable level of radiation in an unrestricted area?

A. 2 M.R.
B. 5 M.R.
C. 10 M.R.

p) What personnel monitoring equipment do we use. Name at least 2 items.

1. FILM BADGE
2. POCKET DOSIMETER
3. _____

q) Where can Form NRC-3 Notice to Employees be found?

In Main X-ray building BULLETIN BOARD.

In New X-ray building BULLETIN BOARD.

r) Your film badge may be worn by more than one person during a period of one week?

True _____ False X

s) A. Pocket dosimeter should be read and doses recorded weekly.

True _____ False X

B. Pocket dosimeters should be capable of measuring doses from zero to at least 75 milliroentgens.

True _____ False X

t) A physical radiation survey shall be made after each radiographic exposure during a radiographic operation to determine that the sealed source has been returned to its shielded position.

True X False _____

u) A physical radiation survey shall be made to determine that each sealed source is in its shielded position prior to securing the radiographic exposure device for a weekend or a long shutdown.

True X False _____

v) Calibration of the survey meter shall be done at intervals not to exceed three (3) months.

True X False _____

w) A dose of C would be dangerous, if not fatal, if applied to entire body in a short period of time.

A. 1.5 to 15 rem.
B. 25 to 70 rem.
C. 200 to 800 rem.
D. All of the above doses would most likely be fatal.

x) A mild dose of radiation is considered:

A. 25 to 50 rem.
B. 50 to 200 rem.
C. 200 to 600 rem.

y) Which of the following types of rays has the least amount of penetration.

A. Gamma
B. Beta
C. Alpha

APPENDIX A

EXAMINATION - RADIOGRAPHER

1.) Radioactive Materials and Their Use in Industry.

Radiography, in industrial applications, depends on penetration and absorption capabilities of x - and gamma radiation to detect discontinuities in metal products such as castings and welds.

__X__ TRUE _____ FALSE

2.) Basic steps of radiographic testing are listed. Put them in order in which they are performed.

__4__ Expose film
__2__ set up
__3__ Establish ffd
__6__ Interpret radiograph
__1__ Assure all safety precautions
__5__ Process exposed film

3.) List three advantages of radiographic examination.

1. Suitable for dense steel.
2. Permanent, visual record obtained.
3. Reveals internal conditions of material.
4. Determines extent of corrective action, such as repairs.
5. Determines freedom from defects.

4.) The dangers of radiation to the human body are not sensitive to senses of sight, smell, taste, hearing or touch.

__X__ TRUE _____ FALSE

5.) Radiography is safe unless which vital rule is ignored?

Do not continue a[illegible]tep in a radiographic procedure unless ALL safety provis[illegible] have been complied with.

6.) Radiographic examination is not concluded until interpretation of results.

__X__ TRUE _____ FALSE

7.) Radiation can damage cells of living tissue, why are the units for X-ray and gamma ray sources so destructive in this regard?

They generate great amounts of radiation.

8.) Show by sketch the principal of differential absorption.

9.) Select at least three correct statements regarding X-rays and gamma rays.

1. Have the same properties but not always the same wave length.
2. They are electromagnetic.
3. They travel in straight lines.
4. They are visible.
5. They have no electrical charge.
6. They have no mass.
7. They do not ionize matter.
8. They can penetrate matter.
9. The energy of the range is indirectly proportioned to their wave length.
10. They are scattered by matter.

10.) List two types of equipment or sources producing radiation here.

1. X-rays - 220 Kvp X-ray, 1-1/4 Mev Resotron
2. Gamma rays - Cobalt 60 and Iridium 192 isotopes

11.) Show a sketch depicting the <u>inverse square law</u> -

$$\frac{I_1}{I_2} = \frac{D_2^2}{I_1^2}$$

I = Intensities

D = Distance

12.) State the inverse square law.

The intensity of an X-ray varies inversely (indirectly) with the square of the distance from the radiation source.

13.) Show the symbol of isotopes used here and their appropriate half-life.

Co-60	5.3 years
Ir-192	75 days

14.) Isotopes have an ever-present radiation hazard, how should they be handled?

Only with extreme care with the first consideration being safety and in strict accord with written operations manuals, etc.

15.) What is the maximum permissable weekly dose as established by the Atomic Energy Commission?

A. 75 milliroentgens
B. 100 milliroentgens
C. 150 milliroentgens

16.) What is the radioactive half-life of Cobalt 60?

A. 1500 years
B. 2 years
C. 5.3 years

17.) What is the radioactive half-life of Iridium 192?

A. 75 days
B. 150 days
C. 30 days

18.) How many roentgens per hour per curie at one foot does Cobalt emit?

A. 24.4 roentgens
B. 9.2 roentgens
C. 14.4 roentgens

19.) Can you feel that you are in a high radiation area or that you are in an area of radiation exposure?

A. Yes
B. No
C. Don't know

20.) How many rems or M.R. are permissable for calendar year?

A. 5 rem or 5000 M.R.
B. 12 rem or 12,000 M.R.
C. 8 rem or 8000 M.R.

21.) What is the maximum permissable dose for calendar quarter for whole body?

A. 1-1/4 rems or 1,250 M.R.
B. 3 rems or 3,000 M.R.
C. 2-1/2 rems or 2,500 M.R.

22.) Name three types of radiation detection equipment.

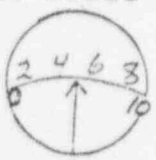
A. Film Badges
B. Survey Meters
C. Pocket Dosimeters
D. Gammalarm

23.) The unit for measuring penetrating external radiation exposure is the

A. Rem
B. R
C. M.R.

24.) What would the readings on survey meter be on the following drawings?

10 Scale



Ans. 50

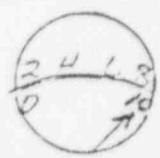
100 Scale

Ans. 600

1 Scale

Ans. 2

10 Scale



Ans. 100

25.) What is meant when an area is posted with the words "Radiation Area"?

An area which the body can receive in one hour a dose excess of:

A. 5 millirems
B. 10 millirems
C. 100 millirems

26.) What is meant when an area is posted with the words "High Radiation Area"?

An area which the body can receive in one hour a dose in excess of:

A. 100 millirems
B. 200 millirems
C. 500 millirems

27.) What is meant when an area is posted with the words, "Unrestricted Area"?

A. An area is not controlled by the Licensee for purpose of protection of an individuals from exposure.
B. An area where the source is located.

28.) What is the permissable level of radiation in an unrestricted area?

A. 2 M.R.
B. 5 M.R.
C. 10 M.R.

29.) What personnel monitoring equipment do we use? (Name at least two)

1. Film Badge 2. Pocket Dosimeter
3. _____

30.) Where can Form NRC-3 Notice to Employees be found?

In Main X-ray Building Bulletin Board
In New X-ray Building Bulletin Board

31.) Your film badge may be worn by more than one person during a period of one week?

_____ TRUE __X__ FALSE

32.) Pocket dosimeter should be read and doses recorded weekly.

_____ TRUE __X__ FALSE

33.) Pocket dosimeters should be capable of measuring doses from zero to at least 75 milliroentgens.

_____ TRUE __X__ FALSE

34.) A physical radiation survey shall be made after each radiographic exposure during a radiographic operation to determine that the sealed source has been returned to its shielded position.

__X__ TRUE _____ FALSE

35.) A physical radiation survey shall be made to determine that each sealed source is in its shielded position prior to securing the radiographic exposure device for a weekend or a long shutdown.

__X__ TRUE _____ FALSE

36.) Calibration of the survey meter shall be done at intervals not to exceed three (3) months.

__X__ TRUE _____ FALSE

37.) A dose of __C__ would be dangerous, if not fatal, if applied to entire body in a short period of time.

A. 1.5 to 15 rem.
B. 25 to 70 rem.
C. 200 to 800 rem.
D. All of the above doses would most likely be fatal.

38.) A mild dose of radiation is considered:

A. 25 to 50 rem.
B. 50 to 200 rem.
C. 200 to 600 rem.

39.) Which of the following types of rays has the least amount of penetration.

A. Gamma
B. Beta
C. Alpha

40.) What is the basic set of rules of the United States Nuclear Regulatory Commission for enforcing safety regulations in handling or using radiation producing sources?

Title 10, Parts 19, 20 and 34

41.) Do you have a personal copy of the Rules and Regulations, Operating manual and Maintenance manuals?

X YES _____ NO

42.) Define the following terms; simply but accurately.

DOSE: Quantity of radiation abosrbed, per unit of mass, by the body or any portion of the body

OCCUPATIONAL DOSE: Exposure of an individual to radiation in a restricted area or in the course of employment.

ROENTGEN (r): Measure or quantity of X- or Gamma radiation in air.

MILLIROENTGEN (mr): One thousandth of a roentgen

REM: Means roentgen equivalent man and defines the biological effect of radiation on man, relative to a dose of one (1) roetgen (r) from x-ray or gamma-ray.

RAD: Means radiation absorbed dose, represents an absorption of 100 ergs of energy per gram of irradiated material, at the place of exposure from any type of radiation.

43.) What are three cardinal safeguards in controlling body exposure to radiation?

(1) Time (2) Distance (3) Shielding

44.) Name the most common shielding materials.

Air, lead, concrete

45.) No radiation level is permitted in excess of 50 milliroentgens per hour at six inches from any exterior surface of a radiographic exposure device measuring less than 4 inches from the sealed source storage position to an exterior surface of the device.

46.) Radiographic exposure devices measuring a minimum of four 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 one meter from any exterior surface.

47.) List 3 radiation detection and exposure instruments

1.) Pocket dosimeters or chambers
2.) Film badges
3.) Survey meters
4.) Geiger counters
5.) Ionization chambers or area alarms

48.) State definition of "licensed"material.

Nuclear material used or transferred under a license issued by the Nuclear Regulatory Commission in accordance with Federal and/or State regulations.

49.) Define "High Radiation Area".

Any area, accessible to personnel, in which radiation originates 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 100 millirem.

50.) If any person becomes locked inside the cell, he can get out by Turning door latch inside cell, this should be checked daily by operator.

PROCEDURE FOR LEAK TESTING SEALED SOURCES

1.0 Scope

1.1 This procedure covers the technique for leak testing sealed sources. Each sealed source shall be tested for leakage or contamination at intervals not to exceed six (6) months.

2.0 Instrumentation

2.1 Leak tests shall be performed using either Technical Operation Leak Test Kit Model 518 or Gamma Industries Leak Test Kit.

3.0 Test Procedure

3.1 Leak testing of both the portable and nonportable sources will be done with the source secured in the shielded position. An operating survey meter shall be used to insure that the radiation levels are normal.

3.1.1 For portable sources the source tube shall be removed from the storage containers.

3.1.2 For nonportable sources the cap shall be removed from the face of the camera. For Radionics cameras it is necessary to remove the collimator prior to removing the cap.

3.2 Insert the swab into the interior of the storage container and thoroughly wipe the inner walls of the device normally in contact with the source during the operation.

3.3 Withdraw the swab and place it in the plastic envelope.

3.4 Monitor by turning the survey meter to the most sensitive range. Place the meter in a low background area and move the swab in the plastic envelope to the meter to check for radiation.

3.5 If there is no indication of the meter or if the indication is NO MORE than 2 mr per hour above background, the plastic envelope with the swab and identification sheet shall be sent to the supplier in accordance with instructions received with the kits.

3.5.1 In the event that radiation from the swab exceed 2 mr per hour, the supplier of the kit shall be contacted for specific instructions.

4.0 Leak Test Certificates

4.1 Leak test certificates, when returned from the kit supplier, shall be filed for inspection by the Nuclear Regulatory Commission.

5.0 Personnel

5.1 The below-listed personnel are authorized to perform tests in accordance with this procedure for leakage or contamination of the sealed sources.

5.1.1 Joseph Kimmel - Radiographic Specialist and Radiation Safety Officer.

5.1.2 Ray Tobias - Shift Supervisor and Asst. Radiation Safety Officer.

5.1.3 Charles Kinloch - Shift Supervisor

APPENDIX C

IMPORTANT - READ CAREFULLY BEFORE CHANGING SOURCE

SOURCE CHANGING INSTRUCTIONS

FOR C-10 SHIPPING CONTAINER
Revised 4/22/74

Attached is a cross-sectional view (Dwg. 323-Revision 1) of the shipping container used for transporting your pigtail source. The container has two lock boxes--one on each side. The upper lock box is labeled "NEW SOURCE" and the upper tube contains the new source. The lower lock box and tube contain a safety plug when shipped to you. The lower tube will be used to return the decayed source to Gamma Industries.

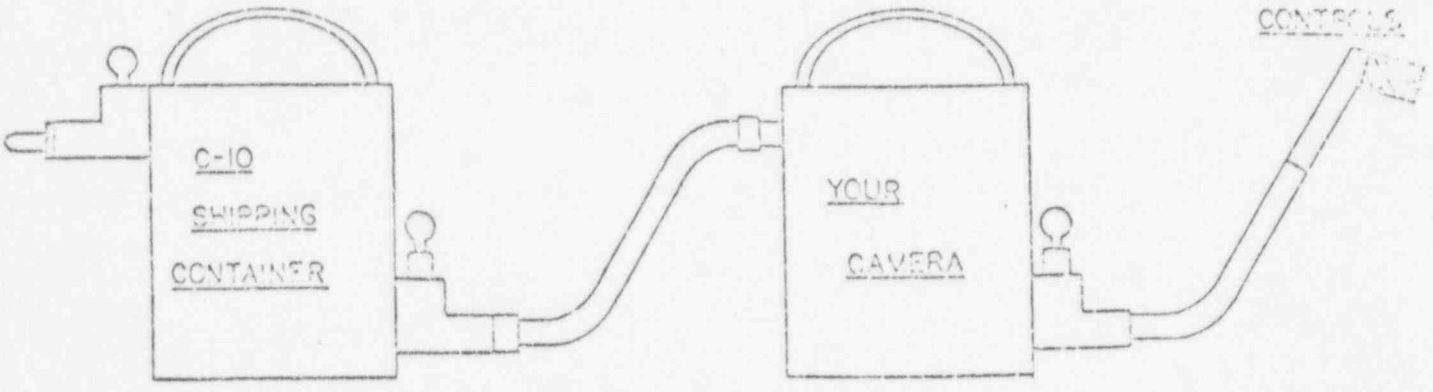
The following procedure should always be followed in the source changing operation:

ALWAYS HAVE A PROPERLY OPERATING SURVEY METER AT HAND WHEN CHANGING SOURCES!

1. Survey the C-10 shipping container with meter. The radiation intensity should not exceed 10 mr/hr at 1 meter from any surface of the C-10.

2. Open the lower lock of the C-10 shipping container. Remove the safety plug.

3. Connect one end of short exchange tube (provided in the shipping barrel) to the lower lock box of the C-10 shipping container. Attach the other end of the short exchange tube to your camera.



4. Crank your old source into the C-10 shipping container until it reaches a definite stop.

13. Survey.

14. Lock your camera lock.

15. Remove the short exchange tube from your camera. Remove the short exchange tube from the C-10 shipping container.

16. Insert the safety plug into the upper tube of the C-10 shipping container. Lock the upper lock of the C-10 shipping container.

17. Survey.

18. Place the C-10 into the barrel in the same orientation which it was received. Place the short exchange tube into the barrel. Place the top on the barrel and secure with the locking ring.

19. Insert a safety seal into the barrel locking ring.

20. Survey. (The radiation intensity should not exceed 200 mr/hr at any barrel surface or 10 mr/hr at one meter from any barrel surface.)

END OF SOURCE INTERCHANGE INSTRUCTIONS

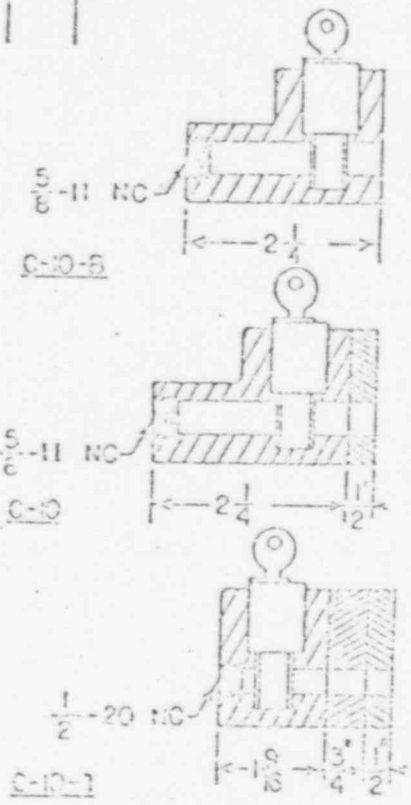
Be sure that you:

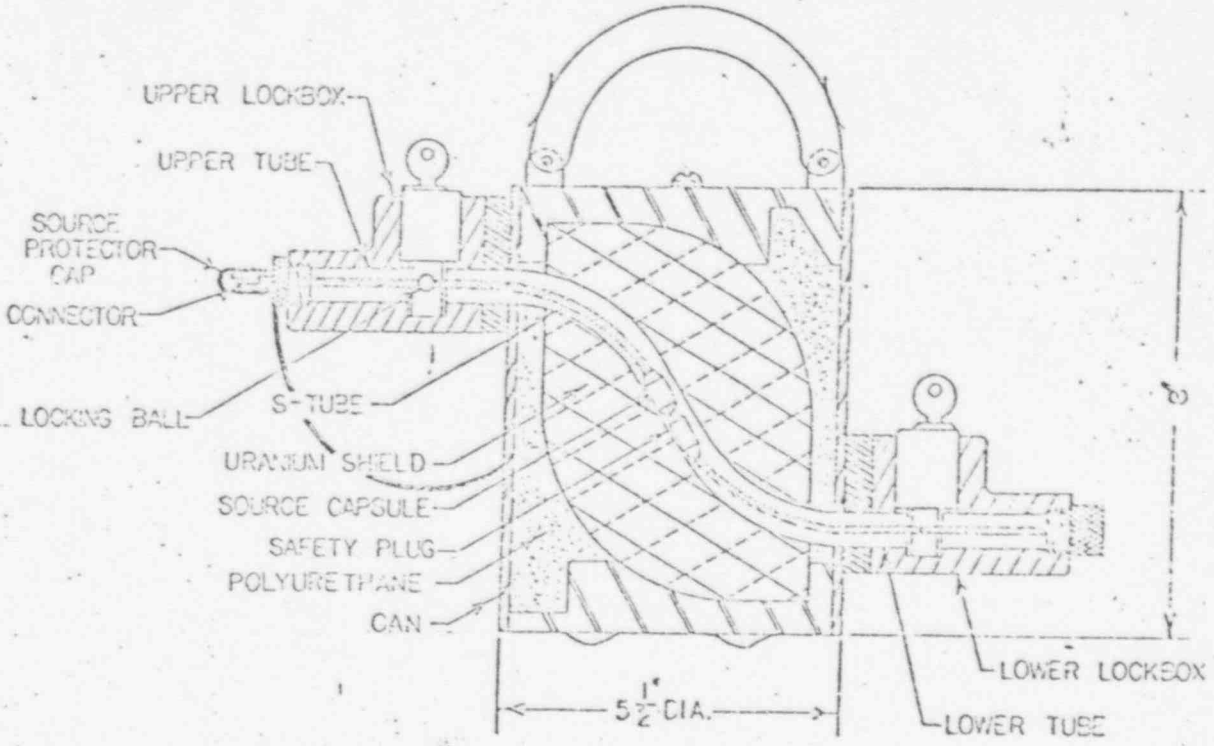
1. Attach two "Radioactive Yellow-II or III" Labels as applicable to the barrel.

2. Measure and write the transport index upon the affixed labels.

3. Properly fill out all shipping documents.

E. SOURCE	DATE	BY
A SOURCE (NOT SHOWN)	4-22-73	ADL





NOTE: BY REMOVING C-10 LOCK ASSEMBLY AND REPLACING WITH EITHER C-10-B OR C-10-T LOCK ASSEMBLIES THE SHIPPING CONTAINER CAN BE MADE UP TO CONTAIN SOURCES AS LISTED.

C-10-B	B-4-B	D-1-G
	B-4-G	D-1-R
	B-5-B	B-1-B IR^{192}
	B-5-G	B-1-G
C-10	A-1-A	T-1-T
	A-1-G	T-1-A
	A-2-A	T-1-G
	A-2-G	
C-10-T	T-3-T	

C-10 ASSEMBLY

NOTE - THIS IS NOT A WORKING DRAWING. TO BE USED ONLY FOR SCHEMATIC ARRANGEMENTS.

GAMMA INDUSTRIES B.R., I.A.

SCALE: NONE | APPROVED BY: [signature] | DRAWN BY:

DATE: 6-18-73 | REVISED

SHIPPING CONTAINER

MODEL NOS. C-10, C-10-B, C-10-T

DRAWING NUMBER: 323-REV-1

Appendix C

ATTACHMENT #7

LEAK TEST PROCEDURES FOR CRANKOUT DEVICES GAMMA INDUSTRIES CODE 5

1. Using a survey meter, ascertain that the source is in the safe or shielded position.

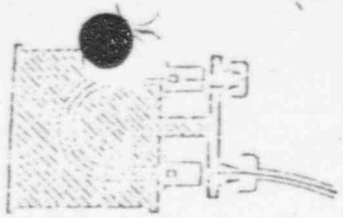
2. With unit locked and secure, disconnect the source tube.

3. Remove the swab from the leak test kit and thoroughly wipe the inner walls of the device outlet nipple or other orifice or surface normally in contact with the source during operation.

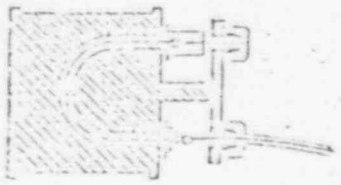
4. After wiping, place the swab in the plastic bag and seal securely. Slide the plastic bag containing the swab into the return envelope and seal the flap.

5. Using a survey meter, determine if there is any radiation being emitted from the swab.
   a. If there is no detectable radiation, the leak test kit should immediately be mailed back to Gamma Industries. Results will be reported by return mail.
   b. If there is detectable radiation, DO NOT MAIL the leak test kit. Immediately call Gamma Industries for further instructions.

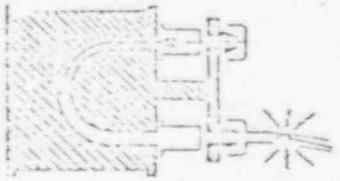
NOTE: Be sure requested information on the envelope is provided as completely as possible



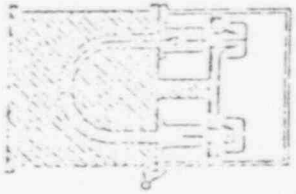
2. Screw on the source tube from your projector.



3. Open the coupler assembly and snap the drive cable connector into the female source cable connector. Check for a positive connection and close the coupler assembly.



4. Return to the projector control unit and retract the source into the source shield until the "Safe" lamp is flashing and the radiation monitor indicates a safe level of activity.



5. Unscrew the source tube, screw on your terminal source tube, and replace the cap (and hold down rod) on the now empty source channel. Close, bolt, and seal the source changer. Return to Technical Operations, Inc. within 7 days. Containers held over this period are subject to rental fees. Labels and seals are provided with shipment.

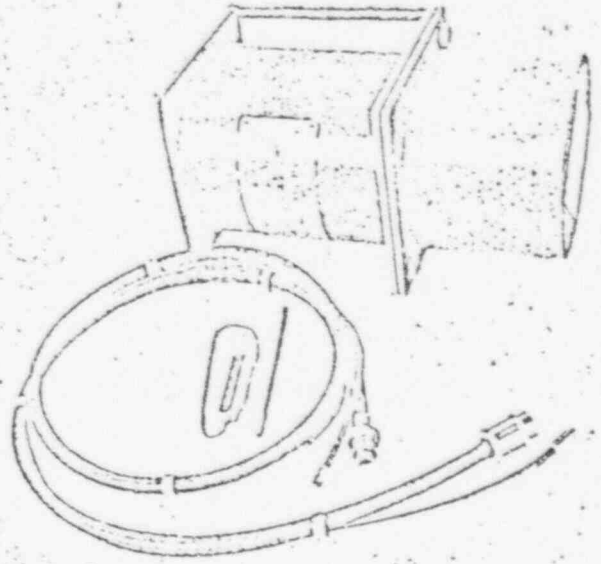
SAFETY During the process of transferring sources be sure to observe the same precautions with respect to monitoring activity and restricting personnel as you employ in making radiographic exposures.

WARRANTY Technical Operations, Inc. guarantees the equipment to be free of defects for a period of one year from the date the equipment is received.

Technical Operations does not assume responsibility or liability for the misuse of radioactive material.

December 1958

OPERATION MANUAL



Appendix D

Model 414

IRIDIUM 192

Source Changer

tech/ops

TECHNICAL OPERATIONS INC. BURLINGTON, MASSACHUSETTS

DESCRIPTION

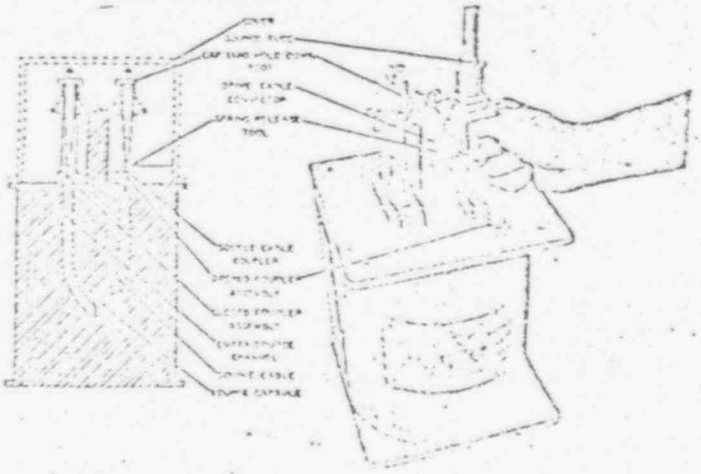
GENERAL PURPOSE

The Technical Operations Model 414 Iridium Source Changer is a shielded shipping and storage container designed to permit field exchange of old for new sources without exposure to the operator to unsafe radiation levels.

SPECIFICATIONS

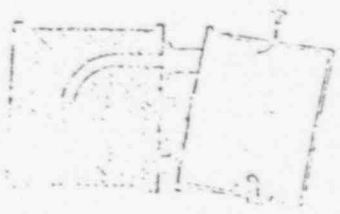
1. New weight: 175 lbs.
2. Maximum safe contents: 100 curies iridium
3. Surface radiation: Less than 2 milliroentgens per hour per curie.

PARTS AND THEIR TERMINOLOGY

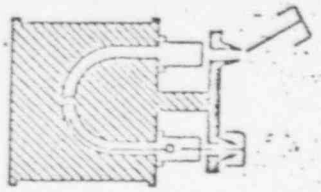


OPERATING INSTRUCTIONS

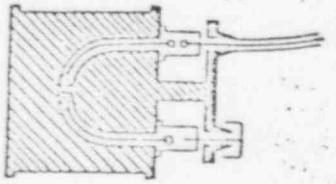
REMOVING THE OLD SOURCE FROM YOUR PROJECTOR



1. After setting up the projector as for an exposure, omitting the terminal source tube, place source changer nearby and remove the cover by cutting the seals and unscrewing the 4 bolts. Position the source changer horizontally for optimum ease of performance.

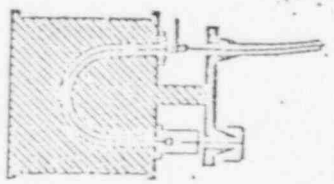


2. Unscrew and remove the cap (and hold down rod) from the empty channel. Open the coupler assembly to make a positive visual check before continuing.

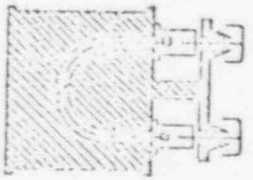


3. Screw on the source tube from your projector and crank the old source all the way into the empty channel.

NOTE: Check this operation with your radiation monitor. At the completion of this step the rate of radiation from the source changer should not be significantly higher than originally.



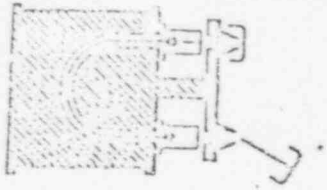
4. Open the coupler assembly and disengage the connectors with the spring release tool, separating the drive cable from the source cable.



5. Unscrew the source tube, replace the cap (and hold down rod) and tape the coupler assembly shut to complete this operation.

Mark or tag the channel containing the old source to avoid a possible mix-up.

INSTALLING THE NEW SOURCE IN YOUR PROJECTOR.



1. Unscrew cap (and hold down rod) from source channel containing the new source.

OPERATION MANUAL, SOURCE CHANGER

TECHNICAL OPERATION, INC.

MODEL 414, IRIDIUM 192

This supplement includes mandatory surveys which shall be conducted and recorded during source changes in conjunction with this manual.

Page 2

REMOVE OLD SOURCE

Paragraph 1

Prior to initiating the source change sequence, survey the Model 414 shipping container with a survey meter. The radiation intensity should not exceed fifty (50) milliroentgens per hour at six (6) inches from any exterior surface. Immediately, the Radiation Safety Officer shall secure the cell and will contact the vendor in the event of radiation in excess of this amount.

Paragraph 3

Monitor with a survey meter when this step is concluded. The old source is in a safe position if the radiation intensity does not exceed fifty (50) milliroentgens per hour at six (6) inches from the exterior surface. The Radiation Safety Officer, in the event of excessive readings will secure the cell and contact the vendor.

INSTALL NEW SOURCE

Paragraph 4

Using a survey meter, check the source changer and the source projector to assure safe condition of radiation intensity. At six (6) inches from any exterior surface the radiation shall not exceed fifty (50) milliroentgens per hour. If reading are excessive, the Radiation Safety Officer will secure the cell and contact the vendor.

APPENDIX E

PERIODIC INSPECTION AND MAINTENANCE OF RADIOGRAPHIC EXPOSURE DEVICES AND STORAGE CONTAINERS - PORTABLE SOURCES

1.0 Scope

1.1 The inspection and maintenance detailed in this procedure relates to the quarterly inspection of exposure devices or storage containers.

NOTHING SHALL BE DONE TO THE CAPSULE OR ENCASED SOURCE.

1.2 Precautions - The Radiation Safety Officer shall be responsible for all maintenance performed by this procedure.

1.2.1 Prior to entering the high radiation area, individuals will assure they have a dosimeter and/or film badge. In addition, a survey meter shall be carried. Prior to entry into the cell, the source shall be retracted to the safe position.

1.2.2 With the survey meter, it shall be determined that the room is safe to enter and proceed to lock the source in the safe position. The individual performing the inspection will carry the key at all times he is in the room.

1.2.3 All work shall be carried out in a planned and expeditious manner. Particular attention shall be given to assure that the unit is properly re-assembled and that the room is cleared of all personnel before the key is re-inserted into the lock.

1.2.4 The radiation Safety Officer shall operate the unit, verify proper operation before turning unit over to Radiographer for resumption of radiography.

1.3 The procedure for preventive maintenance shall include location of the exposure device and storage containers in a clean, dry area protected from adverse weather conditions. External conditions of a nature that could result in mechanical damage to these units shall be minimized.

1.4 Drive gear box. Disassemble the gear box and clean with a organic solvent, such as trichlorethylene. Air dry, removing all previous lubricant and dirt.

1.4.1 Inspect gear, particularly looking for sharp edges. Replace gear if there is any doubt that snug fit would not exist for the cable around the gear wheel.

1.4.2 Inspect evidence for bushing or pin wear which could prevent cable from running on the gear freely. Lightly oil bushings and apply powdered graphite to the gear. Replace worn parts.

1.5 Drive cable conduit. Preventive maintenance includes careful attention in seeing that the control assembly is coiled and uncoiled properly and not subject to undue mechanical abuse.

1.5.1 Inspect for kinks, cuts, and dents. The cable conduit shall be blown free of any foreign material. Replace any section in which there is evidence of damage or deterioration of the inner wall. Additional protection can be provided with waterproof tape wrapped on the outer covering of the conduit if damaged is superficial and does not effect free movement of the drive cable.

1.5.2 Examine the conduit at the end connections for localized damage. Replace if necessary to assure free cable movement.

1.6 Drive Cable. Preventive maintenance involves keeping cable clean and lubricated with powdered graphite.

1.6.1 Inspect drive cable for wear, dirt, kinks, or other conditions detrimental to free operation.

1.6.2 Clean with solvent similar to trichlorethylene.

1.6.3 Lubricate with powdered graphite.

1.7 Source Tube. Preventive maintenance shall include special attention to avoid accidental damage in the way of dents or breaks and keeping the source tube clean.

1.7.1 Inspection the flexible source tube, damaged sections shall be replaced by removal and rejoining tube with a suitable connector.

1.7.2 Clean the tube by blowing through with dry, clean air.

1.8 Locking Assembly. Preventive maintenance includes washing the lock in place with a solvent such as trichlorethylene. Dust lightly with flake graphite.

1.8.1 If the lock, on inspection, does not function properly in any way, the source unit must be taken out of service and the lock replaced immediately.

1.9 Storage Container. Any evidence or suggestion of the container having been exposed to excessive dirt or water must be acknowledged. In this case the unit shall be withdrawn from service(and the manufacturer contacted for rectification or instructions).

1.10 Micro-Switches. Inspect micro-switches which activate the audible and visual alarm. Repair or replace as necessary.

APPENDIX F

QUAKER ALLOY, INC.
South Cherry & Richland Ave.
Myerstown, Pa. 17067
Phone 717/866-6511

RADIOGRAPHIC DEPARTMENT

ACCIDENT RESPONSE FORM

DATE: _____

NAME: _____

ADDRESS: _____

TELEPHONE # OR PLACE WHERE YOU CAN BE REACHED _____

AGE (DATE OF BIRTH) _____ _____

CELL IN WHICH YOU WERE EXPOSED _____

SOURCE STRENGTH IN CURIES _____ IRIDIUM _____ COBALT _____

X-RAY _____

SERIAL # OF GEIGER COUNTER _____

LOCATION OF DOSIMETER AND FILM BADGES (ON BODY) _____

DOSIMETER READING _____ BADGE NUMBER _____

SHIFT _____

ACCIDENT WAS REPORTED TIME: _____

SUPERVISOR: _____

HOW LONG WERE YOU EXPOSED TO RADIATION? _____

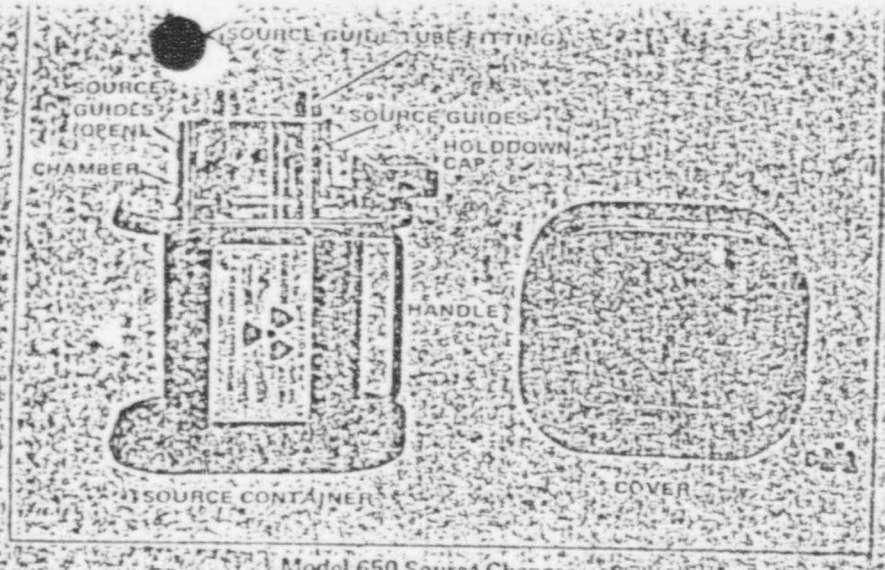
INFORMATION ON CASTING BEING RADIOGRAPHED AT TIME OF ACCIDENT

1. CUSTOMER'S NAME: _____
2. PATTERN NUMBER: _____
3. SERIAL NUMBER: _____
4. EXPOSURE NUMBER BEING MADE AT TIME OF ACCIDENT _____

   TIME OF EXPOSURE _____
5. TOTAL AMOUNT OF EXPOSURES MADE PRIOR TO INCIDENT _____
6. DISTANCE FROM SOURCE TO FILM _____
7. SIZE AND TYPE OF FILM BEING USED _____

EXPLANATION IN DETAIL OF WHAT OCCURRED WHEN BEING EXPOSED TO RADIATION:

(For additional information use reverse side of paper).



Model 650 Source Changer
(Source in a chamber — Parts Identification)

NOTICE

This container is for shipping only licensed sources of Technical Operations, Inc. No attempt to use the equipment should be made unless the user is throughly familiar with the instructions in this manual.

USER WAIVER AGREEMENT

The user agrees that Technical Operations, Inc. is not liable for any claims alleged to be due to use of the product.

The NRC forbids the use of this equipment and the exchange of sources unless the user is specifically authorized by the terms of his license.

If user is not authorized to make source changes, contact Technical Operations, Inc. It has licensed personnel that can perform this operation. If user is licensed to perform source changes, application should be made to the Materials Branch, Office of Nuclear Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555. The application, in letter form, should specify by whom and under what conditions source exchanges are to be made. Refer to this instruction manual for detailed procedures. Additional copies may be obtained for incorporation in your operating procedures manual.

Prior to the first use of this source changer, the user in addition should register as such with the Transportation Branch, Office of Nuclear Safety and Security, U.S. Nuclear Regulatory Commission. The user should have in his possession a copy of Certificate of Compliance No. 9032 issued for this source changer.

GENERAL DESCRIPTION

The Source Changer Model 650 is a portable, shielded container for transferring encapsulated radioisotope sources into radiography projectors. The changer is designed to safely contain the radiographic sources during shipment and to permit field exchange of old for new sources without exposing the operator to unsafe radiation levels. The source changer has depleted uranium for shielding.

QUICK REFERENCE DATA

Source Types	Sealed sources (Tech/Ops sources only) Isotope: Iridium-192 Radiation: Gamma rays
Container capacity	Iridium-192: 200 Curies + 20%
Shielding	Depleted Uranium (U238), weight 35 lbs.
Housing	Steel
Design	Type B Radioactive Material Shipping Container (USNRC Certificate of Compliance No. 9032 and IAEA Certificate of Competent Authority No. USA-DOT-5-69).
Effective radiation shielding	Well below regulatory mR/hr limits prescribed in 10CFR34.21 and 49CFR393(i)
Dimensions	13¼ in. H X 10 in. L X 8¼ in. W
Shipping weight	66 lbs.

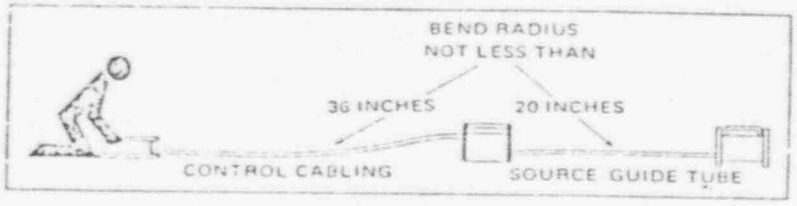
SHIPMENT DATA

1. Source decay chart and leak test certification. Keep for user's records.
2. Source identification (ID) plate. Affix to user's projector.
3. Return shipping labels.
4. Tamperproof seals.
5. Instruction manual.

precautions used when making radiographic exposures must be followed.

Wear personnel monitoring devices during all source changing operations. Monitor all operations with a calibrated, operable survey meter.

1. Upon receipt of the source changer, survey the source changer to ensure that the source is in the proper storage position.
2. Locate the source changer and projector in a restricted area. Locate the devices so as to avoid sharp bends in the guide tube or control housing.



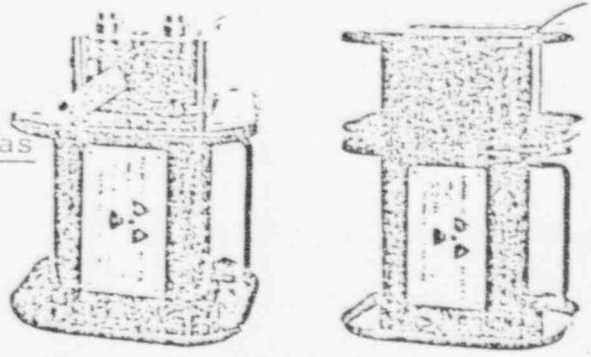
Typical Source exchange Arrangement

3. Set the projector as for an exposure.
4. Remove the cover from the source changer by breaking the seal wire and removing the bolts.
5. Remove the source holddown cap by breaking the seal wire and unbolting.

   CAUTION: When the source holddown cap is removed, the source connector is exposed. Care must be taken to ensure the source is not dislodged when handling the changer.

6. Connect one end of a guide tube extension to the projector and the other end to the fitting above the empty chamber in the source changer.
7. Close and latch the source guides.
8. At the projector controls, crank the source from the projector to the source changer.
9. Approach the projector with the survey meter. Survey the projector on all sides, survey the guide tube and survey the source changer on all sides to ensure the source has been properly transferred. The maximum radiation level at the source changer should be less than 200 milliroentgens per hour at contact.
10. Open the source guides. Disconnect the drive cable from the source assembly by moving the lock pin down and sliding the drive cable connector out through the keyway.
11. Disconnect the guide tube from the source changer. Connect the guide tube to the fitting above the chamber containing the new source.
12. Connect the drive cable to the source assembly by sliding the drive cable connector into the keyway, and engaging the lock pin. Test for proper engagement.
13. Close and latch the source guides.
14. At the projector controls, crank the source from the source changer to its storage position in the projector.
15. Approach the projector with the survey meter. Survey the projector on all sides, survey the guide tube, and survey the source changer on all sides to ensure the source has been properly transferred.
16. Lock the projector.
17. Disconnect the source guide tube from the source changer.
18. Affix the identification plate of the new source to the projector and attach the identification plate of the old source to the source holddown cap.
19. Bolt the source holddown cap in place and seal wire.
20. Bolt the source changer cover in place and seal wire.
21. Survey all exterior surfaces of the source changer to ensure that the radiation level does not exceed 200 milliroentgens per hour at contact.
22. Measure the radiation level three feet from all exterior surfaces of the source changer and ensure that the radiation level is less than 10 milliroentgens per hour. The maximum radiation level measured three feet from any exterior surface is the Transport Index. (Example: With a maximum radiation level of 2.2 milliroentgens per hour, the Transport Index is 2.2.)
23. Complete the "RADIOACTIVE III* shipping labels. For contents, list the radioisotope contained (Iridium-192). Indicate the activity as the number of Curies. Record the Transport Index as determined above.
24. Apply the RADIOACTIVE III* shipping labels, properly completed, to two opposite sides of the container.
25. Return the container to Technical Operations Inc.

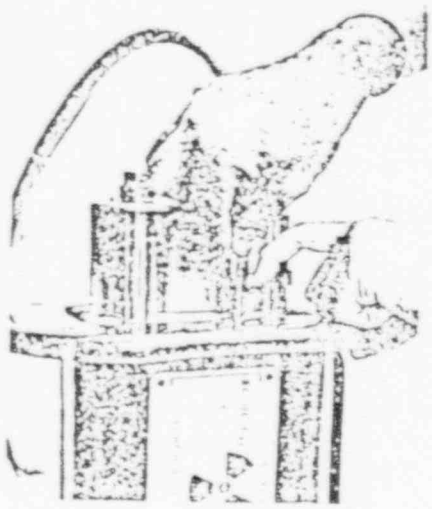
* Radioactive II or III Labels as Applicable.



Preparing Source Changer for Shipment

NOTE

Please return container promptly. Rental charges will be made for containers held beyond normal transportation time.



Connecting/Disconnecting

Testing Connection

WARNING

Do not move source assembly more than 1/2 inch from its stored position when connecting/disconnecting or when testing for proper connection.

TO ENGAGE CONNECTORS

1. With fingernail move lock pin back from keyway. (Pressure on pin is downward toward stored position of source.)
2. Slide drive cable connector into keyed sleeve and release pin.
3. Test connection by pulling between source and drive cable. (Note WARNING.)

TO DISENGAGE CONNECTORS

1. With fingernail move lock pin back from keyway.
2. Slide drive cable connector out through keyway and release pin.

CAUTION

Move connector sideways only. Do not bend or twist.

Figure A. Procedure for engaging and disengaging the Model 550 source assembly connector. Testing for proper connection must be performed.

OPERATION MANUAL, SOURCE CHANGER

TECHNICAL OPERATIONS, INC.

MODEL 650, IRIDIUM 192

This supplement includes mandatory surveys which shall be conducted and recorded during source changes in conjunction with this manual.

Page 2
Paragraph 1

Upon receipt of the source changer, survey the source changer with a survey meter to insure that the source is in the proper storage position.

REMOVE OLD SOURCE

Page 2
Paragraph 2

When this is completed, survey the projector, guide tube and source changer with survey meter.

The maximum radiation level at the source changer should not exceed 200 milliroentgens per hour at contact.

INSTALL NEW SOURCE

Page 2
Paragraph 11 through 22

When this is completed, survey the projector, guide tube and source changer to insure the source has been properly transferred. The maximum radiation at the source changer should not exceed 200 milliroentgens per hour at contact.

Measure the radiation level three (3) feet from all exterior surfaces of the source changer to insure that radiation level is less than 10 milliroentgens per hour for transport.

In the event the radiation level exceeds the limits mentioned in the above paragraphs, the Radiation Safety Officer will secure the cell and contact the vendor.

APPENDIX H

PROCEDURE FOR CALIBRATION OF DOSIMETERS

1.0 Scope

1.1 This procedure explains the technique of calibration of portable pocket dosimeters.

2.0 Instrumentation

2.1 Calibration will be performed using the Victoreen dosimeter calibrator model 541-205.

2.2 Dosimeter Corporation charger - Model 909 is used for the resetting of the dosimeters to zero.

3.0 Test Procedure

3.1 Select the dosimeters to be calibrated and by using the dosimeter charger set each one back to zero milliroentgens. This calibration must be precise.

3.2 Insert Victoreen Isotope Model 844-39-10 into center of calibration cylinder.

3.3 Carefully insert the zero set dosimeters to be checked into the holes provided in the cylindrical calibrator, charging end first.

3.4 This exposure is conveniently accomplished over a weekend but may be done using any time interval. Total elapsed time must be recorded in order to calculate reading.

3.5 Note the time inserted, the time removed. Compute the mR/h received by the dosimeter from its reading and compare with the mR/h given in the calibration sheet for that particular model of dosimeter.

3.6 Using the dosimeter calibrator decay curve and applying the mr/hr formula you can compute the dosage received.

3.7 Tolerances used for dosimeter calibration can be plus or minus thirty (30) percent of the true radiation exposure.

4.0 Frequency

4.1 All dosimeters in use at Quaker Alloy Inc. must be calibrated one (1) time per year.

5.0 Records

5.1 A log sheet shall be maintained listing the following:

5.1.1 Dosimeter manufacturer.

5.1.2 Dosimeter Serial Number

5.1.3 Date of Calibration.

5.1.4 Initials of person performing calibration.

QUAKER ALLOY, INC.
South Cherry & Richland Ave.
Myerstown, Pa. 17067
Phone 717/866-6511

RADIOGRAPHIC OPERATIONS

OPERATING AND EMERGENCY INSTRUCTIONS

FOR

QUAKER ALLOY INC.

MYERSTOWN, PENNSYLVANIA 17067

Copy No.: _____

Issued to: _____

Date; _____

Issued by: _____

RADIOGRAPHIC DEPARTMENT

OPERATING AND EMERGENCY INSTRUCTIONS

BOOK NO.	
1	Nuclear Regulatory Commission
2	Nuclear Regulatory Commission
3	D. Callihan
4	D. Edwards
5	Safety Director
6	M. Landis
7	J. Kimmel
8	R. Tobias
9	C. Kinloch
10	Maintenance Department Head
11	S. Klick
12	G. Frantz
13	Bulletin Board
14	Bulletin Board
15	K. Krammes
16	L. Krum
17	L. Steiner
18	K. Culbert
19	W. Zimmerman
20	C. Sanger
21	G. Peiffer
22	E. Swergert

OPERATING AND EMERGENCY INSTRUCTIONS MANUAL

TABLE OF CONTENTS

1.0 PURPOSE

To define, in writing, procedures and operations implemented by Quaker Alloy Inc. in regard to the radiation safety program.

2.0 SCOPE

This procedure shall govern all radiographic activities performed by Quaker Alloy Inc. employees. The company and each individual must assume a high degree of responsibility to assure total safety for the public and company personnel in an operation of this nature.

A program for performance which will assure safety has been outlined within this report for the operating procedure.

Any employee that willfully violates the requirements of this procedure or State and Federal Rules and Regulations shall be subject to dismissal

3.0 Emergency Procedures

3.1 Contacts for Routine and Emergency Operations

Quality Control Manager

Donald L. Edwards

Business: Quaker Alloy Inc.

Phone: (717)-866-6511 Ext. 289

Home: RD#1 Box 1730

Jonestown, Pa. 17038

Phone: (717)-865-5535

Senior Interpreter and Radiation Safety Officer

Joseph Kimmel

Business: Quaker Alloy Inc.

Phone: (717)866-6511 Ext. 237

Home: 616 Smith Ave.

Lebanon, Pa. 17042

Phone: (717) 272-2151

Shift Supervisors

Charles Kinloch
Ray Tobias

3.1 Contacts for Routine and Emergency Operations.

Company Safety Director

Terry Wetzel

Business: Quaker Alloy Inc

Phone: (717) 866-6511 Ext.211

Home: RD#1 Box 267
Newmanstown, Pa. 17073

Phone: (717) 949-2254

3.2 Procedure to be followed in the Event of an ACCIDENT.

3.2.1 In the event of an accident to a source or exposure device, the following steps shall be taken:

a) Return source to the shielded position and perform a survey to assure that the source is in the full shielded position.

b) Notify your Shift Supervisor IMMEDIATELY. Your Shift Supervisor is responsible to notify the Radiation Safety Officer of the incident.

c) The Radiation Safety Officer will inspect the device and make disposition on the course of action before further radiography is permitted.

3.2.2 In the event that the source cannot be returned to the shielded position, the following steps shall be taken:

a) Immediately secure the cell containing the exposed isotope.

Use survey meter to assure that no radiation areas exist that are not controlled.

3.2.2 (cont'd)

b) Notify your Shift Supervisor. Your Shift Supervisor is responsible to notify the Radiation Safety Officer of the incident.

c) Maintain surveillance of area until Radiation Safety Officer determines course of action.

NOTE: "DO NOT ATTEMPT TO RETURN SOURCE TO CONTAINER WITHOUT QUALIFIED ASSISTANCE".

3.2.3 a) The Radiation Safety Officer shall immediately make a radiation survey and evaluate the situation with full cognizance of every known safety precaution to verify that the affected area is secured and properly marked "High Radiation Area" or "Caution Radioactive Material" as appropriate.

b) The Radiation Safety Officer shall notify the Company Safety Director who will determine the effectiveness of the safety precautions to assure that company property and all personnel are adequately safeguarded and that Company policy for Health and Safety is complied with.

c) Radiation Safety Officer shall notify the appropriate N.R.C. Office as required by paragraph 20.403 of Part 20 Standards for Protection Against Radiation.

3.2.3 cont'd

d) Continued monitoring of the secured area shall be required and reported to assure no further deterioration of existing radiation problem. Full safety measures will be invoked as determined necessary to prevent exposure.

e) Qualified assistance shall be secured from the manufacturer of the device, or radiation consultant prior to any extraordinary action or attempt to secure the damaged source and/or device.

f) Routine problems (4.1.3.3) must be approved by the Radiation Safety Officer in accordance with the Maintenance Manual, before any action is taken by anyone.

3.2.4 Accident Response Form (Exposure to radiation by any individual)

Form in Appendix F

4.0 Records

4.1 Radiographers shall maintain the following records:

4.1.1 Daily Dosimeter Dose Report

All operating personnel shall report daily dosimeter dose readings to the Shift Supervisor on the Source Utilization Log.

4.1.2 Source Utilization Log, Daily

A utilization log is maintained at each source and the radiographer shall complete the log. The log contains the following information: The radiographer's name or initials, the date, the number of films exposed and exposures made, the name of the person who surveyed and secured the source, and the amount of radiation observed.

4.1.3 Daily Exposure Device Inspection

4.1.3.1 Each radiographer shall check his equipment and its operation at least one time, each shift that it is used, prior to performing any radiographic operations.

4.1.3.2 The Radiographer shall indicate that the required daily inspection was performed in the Exposure Device Inspection Log.

4.1.3.3 If the Radiographer finds any problem with the equipment, he shall report the problem to his Supervisor so that repair may be made as soon as possible. The Supervisor is responsible to report the problem to the Radiation Safety Officer.

Under no circumstances shall an exposure device with defective or poorly operating components essential to safe operation be used until repairs can be made as directed by the Radiation Safety Officer [3.2.3(f)].

5.0 OPERATING PROCEDURE

5.1 Storage of Sealed Sources

5.1.1. All portable sources shall be stored in the exposure containers when not in use. The cables must be disconnected and plugs shall be in place. The containers shall be locked and the keys kept in the office of the Department Head. The containers shall remain in Radiographic cells and the cell door locked. The doors shall be posted with "Caution Radioactive Material" signs.

5.1.2 All non-portable sources shall be retracted into the safe position. The key removed from the console and a survey of the exposure device shall be conducted prior to securing the cell. The radiographic cell doors must be locked and the keys placed in the office of the Department Head. The doors shall be posted with "Caution Radioactive Material signs".

5.2 Utilization of Sealed Sources

5.2.1 The following information shall be entered in the utilization log daily.

a) Source type and activity

b) Container model and serial number

c) Radiographer's signature and date.

d) Radiation level prior to beginning operation and after securing source, when measured as follows:

5.2.1.1 The portable exposure devices shall have no radiation level in excess of 50 milliroentgens per hour (50mr/hr) at six (6) inches from any exterior surface of the device, when a radiographic exposure device measures less than four (4) inches from the sealed storage position to any exterior surface of the device. The sealed source shall be in the "OFF" position when measured.

5.2.1.2 The non-portable radiographic exposure devices which measure 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 (200 mr/hr) at any exterior surface, and ten (10) milliroentgens per hour (10 mr/hr) at one meter from any exterior surface. The sealed source shall be in the "OFF" position when measured.

5.3 Daily Exposure Device Inspection for Portable & Non-Portable Sources

5.3.1 Each Radiographer shall check his equipment and its operation at least one time each day that it is used prior to performing any radiographic operations.

a) Portable Source - Radionics Model 192 and Technical Operations Model 660 shall have the following items checked.

1. Damage which could impair operation.
2. Changes in the operating characteristics
3. Damage of wear to the source and drive cable tubes including the connecting device.
4. Proper operating of the locking device.
5. Dirt or obstructions, including permanent bends, in the source tube.
6. Proper labeling of the source container.
7. Proper operation of door lock.

b) Nonportable sources - The following items shall be checked on the nonportable sources. Namely, Radionics Model 60-2000 and Picker Cyclops Model 500C.

1. Damage which could impair operation.
2. Changes in the operating characteristics.
3. Proper operation of the locking device.
4. Proper labeling of the source container.
5. Proper operation of door lock.

5.3.2 The radiographer shall indicate that the required inspection was performed in the Exposure Device Inspection Log.

5.3.3 If the Radiographer finds and problem with the equipment he shall report the problem to his Supervisor so that repair may be made as soon as possible. The Supervisor is responsible to report the problem to the Radiation Safety Officer. Under no circumstances shall an exposure device with defective or poorly operating components essential to safe operation by used until repairs can be made, as directed by the Radiation Safety Officer.

5.4 Exposure

5.4.1 After making the radiographic set-up, and prior to making the exposure, the Radiographer must visually check to assure that the exposure cell is clear of all other personnel, then close and lock the doors.

NOTE: If any person becomes locked inside the cell, he may exit by turning the knob in either direction. The door locking device is so constructed that the doors may be opened from the inside, even though the outside is locked. This precaution shall be verified daily by the Radiographer.

5.4.2 Manipulate the source to exposed position by remote control either by crank or activating the console. Keep the source in the exposed position for the required time.

5.4.3 Immediately conduct radiation survey at the exterior surface of the doors of the cell being used. The level must be less than 5 mr/hr. Should the level exceed 5 mr/hr, the exposure must be terminated (5.4.4 to 5.4.6) and the source position changed to lower the level outside the door.

5.4.4 Retract the source by crank or console to the shielded position when the exposure time has expired.

5.4.5 Unlock the doors and enter the cell with an operating survey meter. Positively observe both the meter and gamma alarms to assure the source is in the shielded position.

5.4.6 Survey portable source container and guide tube of the Radionics Model 192, or Technical Operations Model 660, as applicable, to assure that the source is in the shielded position. The radiation level should not exceed 50mr/hr at six (6) inches from any exterior surface of the device.

5.4.7 The portable exposure devices should be locked upon conclusion of radiographic operations, after the survey has determined that the source is in the safe position.

5.4.8 Survey nonportable source containers of the Radionics 60-2000 or Picker Cyclops, as applicable, to assure that the source is in the shielded position.

5.4.8 The radiation level should not exceed 200 mr/hr at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface.

5.5 Conclusion of Radiographic Operations

5.5.1 Survey the exposure device to assure that the source is in the shielded position.

5.5.1.1 Portable sources: See 5.4.6

5.5.1.2 Nonportable sources: See 5.4.8

5.5.2 Disconnect cable and source tube and replace both plugs.

5.5.3 Lock container or console and remove key.

5.5.4 Close and lock doors to cell.

5.5.5 Record required information in Utilization Log.

5.5.6 Return keys to key board in office of Department Head.

5.6 Radiographic Sources, Cameras and Building

5.6.1 Remote control console - operated nonportable equipment.

5.6.1.1 The nonportable sources of Cobalt 60 are used in the exposure cells, B and C. Cell B permanently houses the Radionics 60-2000 Gammatron. Cell C permanently houses one Picker Cyclops 6115020. The Radionics 60-2000 Gammatron is equipped with solenoid lock switches and electrical interlocks which activate audible, as well as visual warning signals.

5.6.1.1 The lock switch is tied into a solenoid system wherein the key, which operates the entrance door to the maze cannot be turned off and removed from the console until the source is in the shielded position. The key may now be removed from the console and the exposure room may be entered. Positively carry and observe an operating survey meter.

5.6.1.2 Each exposure room has its own lock and key. Keys are not interchangeable. Only one (1) key which operates both the panel console and entrance door to the maze is allowed. This key is carried by the operating radiographer. Duplicate keys are kept locked under the custody of the Manager of Radiographer, and or Radiation Safety Officer.

5.6.1.3 The solenoid switch will remain the locked position during a power failure and it is impossible to remove the key from the console. Upon resumption of electrical power, the source is returned to the shielded position electrically.

5.6.1.4 In the event of a mechanical malfunction, the key cannot be removed from the console until the source is returned to the shielded position.

5.6.1.5 The nonportable Picker Cyclops listed previously is used in exposure Cell C. This source is controlled by a geared motor shutter drive through a magnetic clutch from the "off" to the "on" position, winding up a heavy clock spring as it goes. In the "ON" position, the motor keeps running against the force of the coiled up clock spring. If the electrical power is interrupted or turned off from the control, the spring returns the source to its "OFF" position. The source is equipped with electrical interlocks which activate audible as well as visual warning signals. The console lock key and entrance door key are riveted together acting as one key. Only one key to operate the panel console and entrance door to this maze is allowed. Entrance to the maze must be made only after the key is removed from the console. If console key is removed before exposure is completed, the source will return to its shielded position and noted above. When the exposure is completed, the source will return to the shielded position, the key may now be removed from the console and the exposure room may be entered.

5.6.1.5 POSITIVELY CARRY AND OBSERVE AN OPERATING SURVEY METER. This key is carried by the operating radiographer. Duplicate keys are kept locked under custody of the Radiation Safety Officer or Asst. Radiation Safety Officer.

5.6.1.6 If either the gamma alarm or the survey meter indicates that the source has not returned to the "safe" position, call your Shift Supervisor. Under no circumstances may any radiographer or other person enter an exposure room to make any unauthorized repairs. See 3.2 for instructions.

5.6.1.7 Operating Limitations

5.6.1.7.1 The centerline of cameras in Cell B and C must be pointed to the south wall and to the east wall only. Never should the centerline of the cameras in Cell B and C be pointed west of crane supports on south wall or towards maze wall as indicated in Figure 1.

5.6.2 Remote Control Cable Operating Portable Equipment

5.6.2.1 The portable sources will normally be operated in the exposure cells located in the radiographic building.

5.6.2.1 Access to these radiation areas can only be made through a locked door with a key. Each door lock is different. Keys are not interchangeable. The door lock is electrically interlocked with warning devices, both audible and visual, in both the cell and control area. Before any source may be used for making an exposure it must be plugged into the alarm system. Electrical contact is broken when the remote control cable indicates the source is within its storage container. Entrance to the exposure room can than be made. Positively carry an operating survey meter. If either the gamma alarm or survey meter indicates that the source has not returned to the "safe" position, call your shift supervisor at once. Under no circumstances may any person enter an exposure room to make any unauthorized repairs. See 3.2. for instructions.

5.6.2.2 There may be an occasion to use one or more of the portable sources on a temporary radiographic site. Sources will not be transferred to field locations other than Quaker Alloy property.

5.6.2.2 The following steps must be followed prior to removal on nonportable source from an operating exposure room.

(a) Survey the exposure device to assure that the source is in the shielded position. Radiation level at 6 inches from the container surface should not exceed 50 mr/hr.

(b) Disconnect cable and source tube and replace both plugs.

(c) Lock the exposure device and remove the key.

(d) Record the required information in the Source Utilization Log.

(e) Transportation of the portable sealed sources to remote, Quaker field areas shall be directed by the Radiation Safety Officer, assisted by the Plant Safety Director, following the foregoing prerequisiter for preventing damage, undue exposure, and proper monitoring during movement, field exposure and return of the device to the appropriate cell.

NOTE: Since 1959 the portable sources have been used on a temporary site only one time.

5.6.2.3 Radiography in a temporary site must be roped off and posted with the Radiographer in attendance at all times.

5.6.2.3.1 The area bounded by the 100 mr/hr line (High Radiation Area) must be posted with signs reading "Caution High Radiation Area".

5.6.2.3.2 The area bounded by the 2 mr/hr line (Radiation Area) must be posted with signs reading "Caution Radiation Area".

5.6.2.3.3 The portable source of Iridium 192 and Cobalt 60 may be used interchangeably in any cell. The movement of the portable sources is dictated by the work load.

5.6.2.3.4 The movement of portable sources must be documented in the Source Utilization Log.

5.6.2.3.5 The entrance doors to the Radiographic buildings must be kept locked when not in use, such as over the week-ends or periods of shut-down. All source containers and cells must also be locked and the keys removed.

5.6.2.3.5 Each radiation cell is clearly marked as to the contents on the entrance door. Source containers are plainly marked as to contents and display warning symbols.

5.6.3 Operating Limitations

5.6.3.1 Iridium 192 - When operating with Iridium 192, the source, if in open air, must be shielded with either a lead shield or a lead collimator in order to maintain radiation levels outside the exposure rooms at 2 mr/hr or less.

a) Lead Collimator - The source, when used with a lead collimator, shall be placed within the collimator. (See Figure 2).

b) Lead Shield - The lead shield, when used, shall be 3 ft. square and 1/4 inch thick suspended not over 12 inches from the source. (See Figure 3).

5.7 Operating Instructions

5.7.1 Operating instructions for all sources and cameras are included for immediate reference in Appendix B, C, D.

5.8 Clearance of Exposure Cells

5.8.1 OPERATORS MUST OBSERVE THE GAMMA ALARMS AS WELL AS CARRY AND OBSERVE AN OPERABLE SURVEY INSTRUMENT UPON ENTERING A HIGH RADIATION AREA IN ORDER TO ASCERTAIN

5.8.1 THAT THE SOURCE HAS RETURNED TO ITS SHIELDED POSITION.

5.8.2 After making the radiographic set-up and prior to making the exposure, the Radiographer must visually check to be sure the cell is clear of all other personnel.

5.9 Survey Meter Operation

5.9.1 Check calibration sticker for current calibration.

5.9.1.1 Turn survey meter to "ON" and allow sufficient time for the meter to stabilize.

5.9.1.2 Set range selector to the 0-1 mr/hr range for initial readings. Change to other scale if necessary for accurate reading.

5.9.1.3 Use Source check at beginning of each shift; and verify on Utilization Log.

5.10 Personnel Monitoring

5.10.1 All Radiographic personnel shall wear, during radiographic operations, a film badge and an operable pocket dosimeter.

5.10.1.1 Film Badge

5.10.1.1.1 The film badge shall be changed weekly and film badge report will be filed with each employee's radiation record. Each employee will be assigned a film badge

5.10.1.1.1 which cannot be worn by any other person. Badges are stored in the control area during radiographers off shifts.

5.10.1.2 Dosimeter

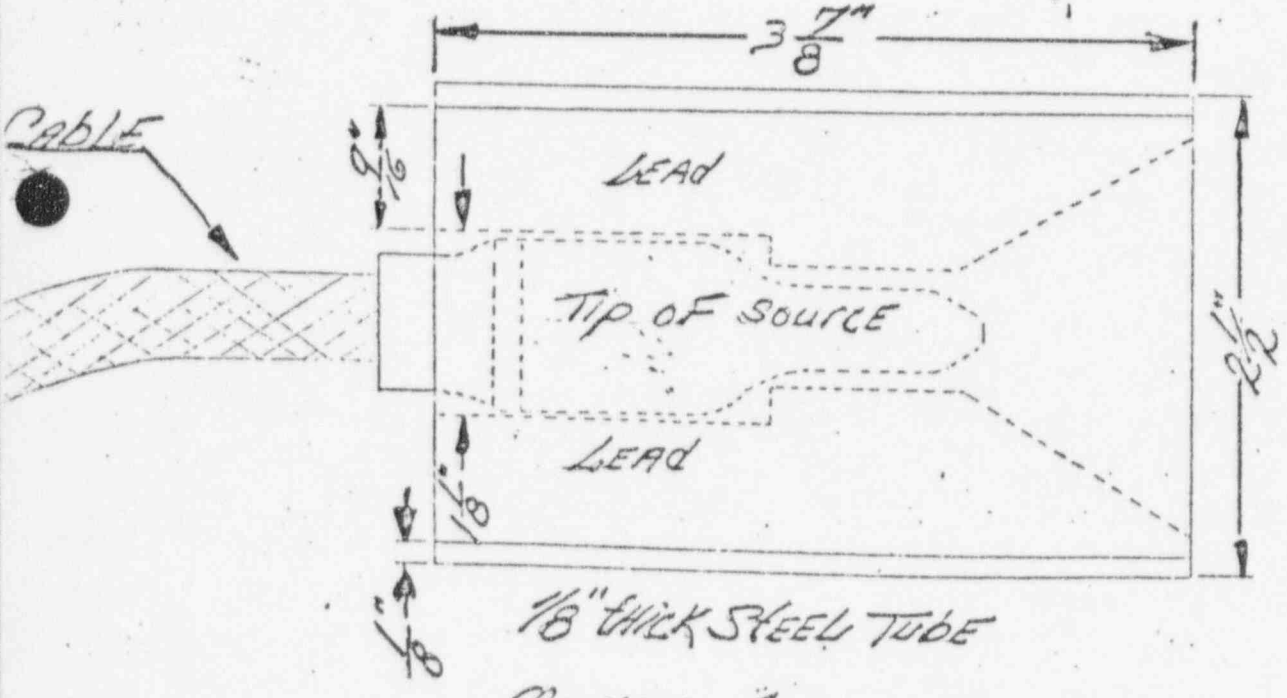
5.10.1.2.1 Each Radiographer shall enter his dosimeter reading in the Source Utilization Log at the beginning and end of each shift. The dosimeter shall be recharged each shift prior to performance of any radiographic operations.

5.10.1.2.2 Dosimeters shall be checked periodically during shift. If during radiographic operation, and employee finds his dosimeter has gone off scale, he immediately shall terminate his radiographic operation, secure the cell and report to his supervisor who is responsible to notify the Radiation Safety Officer of the incident.

5.10.1.2.3 The Radiation Safety Officer shall determine the extent of exposure by having the Radiographer's film badge processed as soon as possible.

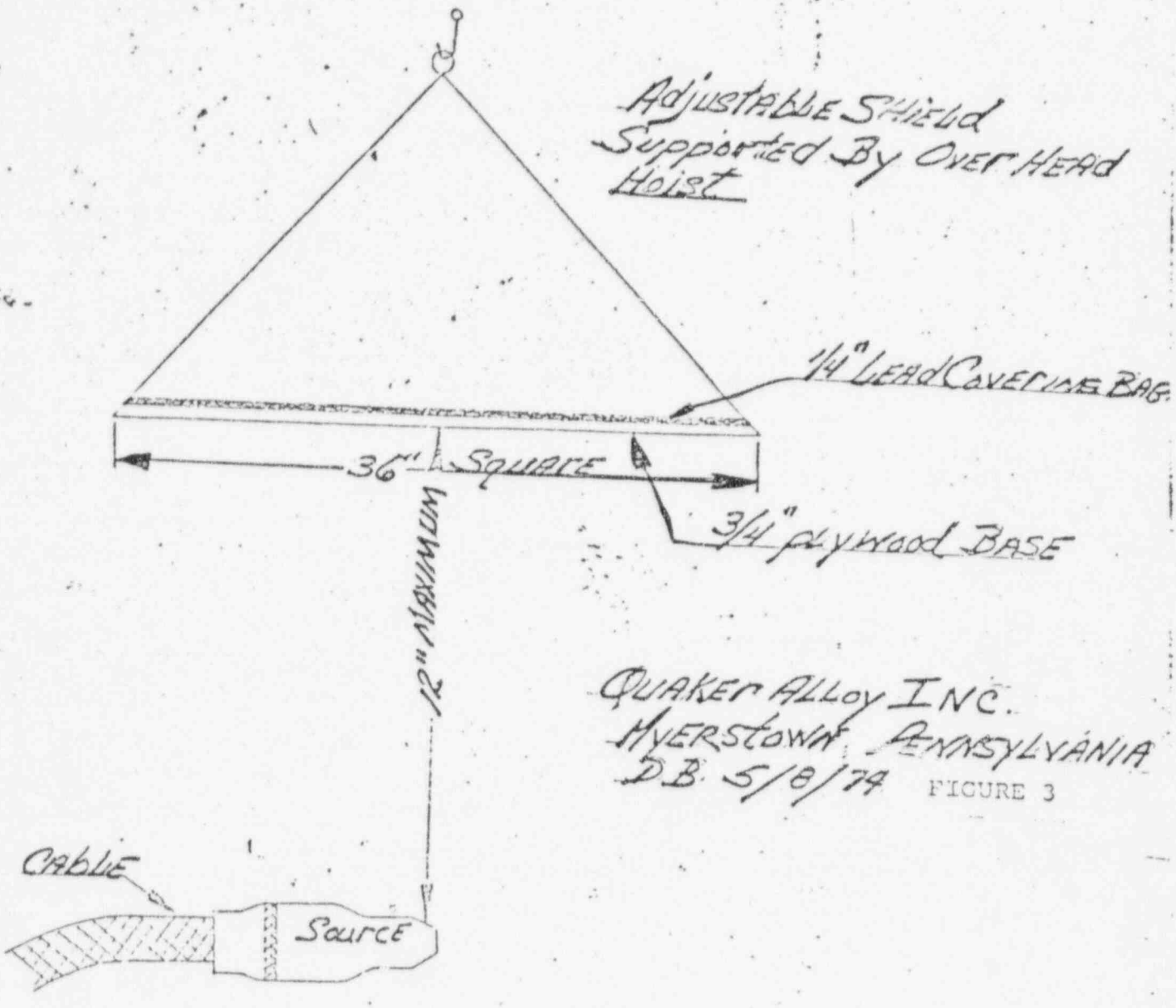
5.10.1.2.3 He will determine whether the individual may continue to work in radiographic operations, and will report the incident to the appropriate Nuclear Regulatory Commission Director as required by para. 20.403 of Part 20, Standards for Protection Against Radiation.

COLLIMATOR



QUAKER ALLOY INC.
MYERSTOWN, PENNSYLVANIA
LEAD COLLIMATOR
D.B. 5/8/74

FIGURE 2



QUAKER ALLOY INC.
HYERSTOWN PENNSYLVANIA
DB 5/8/79

FIGURE 3

UTILIZATION LOG OF CELL _____

Radiographer_____ Badge # _____ Shift _____ Date _____

Source Type_____ Strength_____ Curies-Model # _____ Serial # _____

Radiation Level at Container Beginning of Shift _____

Radiation Level at Container End of Shift _____

Container S/N _____ Camera Model # _____

CUSTOMER	PATTERN NUMBER	SERIAL NUMBER	VIEWS	TIME				SURVEYED BY AM'T OBSERVED
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								
13.								
14.								

Source Secured and

Surveyed by _____

DOSIMETER READING BEGINNING OF SHIFT _____

DOSIMETER READING END OF SHIFT _____

TOTAL GOOD SHOTS _____

DOWN TIME _____

GEIGER COUNTER CHECKED _____

Form 288 - 8/79

DAILY CHECK LIST OF PORTABLE RADIOACTIVE SOURCES

The following check list must be completed prior to performing any radiographic exposures:

1. Inspect cables for cuts, breaks and broken fittings.
2. Inspect source tubes for cuts, crushed and broken fittings.
3. Survey for excessive radiation levels.
4. Inspect source container for damage to fittings, lock, fasteners and labels.
5. Inspect crank for damage and loose hardware.
6. Check operation of control for freedom of source movement.
7. Check operation of interlock and gamma alarm systems.
8. Check the door lock and proper labeling of door.

Defective equipment must be corrected prior to use.

Figure 5

DAILY CHECK LIST OF NONPORTABLE RADIOACTIVE SOURCES

The following check list must be completed prior to performing any radiographic exposures:

1. Check for excessive radiation levels.
2. Check shutter, opening and closing time.
3. Check operation of interlock and gamma alarm systems.
4. Check the door lock and proper labeling of door.
5. Check for damage to device which may impair its operation.
6. Check electrical cables for wear, abrasion and excessive kinking, particularly at head.
7. Check all limit and safety switches and make sure they are functioning properly.

Defective equipment must be corrected prior to use.

Figure 6

Appendix A

CONTROL UNIT

The Control Unit contains all elements necessary to control and monitor the radiation. These elements are:

a) Main switch of the toggle type controls all electrical power to the equipment.

b) Shutter "OPEN" switch with key lock. This is a momentary contact switch which opens the shutter when operated if the timer reset buttons have been set.

c) Exposure emergency bar closes the shutter in emergencies where it is desired to stop the exposure before the preset time has expired. This bar functions with pushed from any angle, yet takes a definite "push" to actuate.

d) Timer permits selection of exposure times up to twelve (12) hours and thirty (30) minutes; terminates the exposure at the end of the preset time, and automatically resets.

e) Shutter indicator lights symbolically show position of shutter cylinder. When the source is in the safe or "OFF" position, the green shutter "CLOSED" and the red "OPEN" lamps light, and the shutter wheel begins to turn. At the end of about nine (9) seconds the shutter if fully open and the green "CLOSED" lamp goes out. If for any reason the shutter should stick in a partially open position, both indicator lights will remain on.

HEAD AND SHUTTER

The source capsule is housed inside the head in a cylinder made of lead, and depleted uranium. The cylinder is mounted in the head with its shaft extending out into the shutter drive on the front of the head. The shaft of the cylinder is below center in the head; i.e., it is nearer the collimator side of the head than it is to the rounded top of the head. When the radiation beam is turned "OFF" the cylinder is rotated until the source is brought to the exact center of the head where it is completely surrounded by lead and tungsten, except in the direction of the aperture in the head. In this direction the radiation is blocked by a solid tungsten rod which is a part of the shutter cylinder. To turn the radiation "ON" the cylinder is rotated 180 degrees from its "OFF" position bringing the source adjacent to the aperture in the bottom of the head. The radiation is then free to pass through this opening out into the collimator.

The cylinder is turned by a geared motor shutter drive through a magnetic clutch from the "OFF" to the "ON" position, winding up a heavy clock spring as it goes. In the "ON" position, the motor keeps running against the force of the coiled-up clock spring. If the electrical power is interrupted or turned off from the control, the spring returns the cylinder to its "OFF" position. It takes several seconds for the cylinder to turn 180 degrees, but only during 20 degrees is any significant amount of radiation coming out. Thus the sum of the effective shutter opening and closing times is only a little over three (3) seconds.

BEAM COLLIMATOR

The collimation of cobalt radiation presents a difficult problem because of its high energy, and because of the relatively large area of the face of the source. Futhermore, making the field size adjustable usually means that the collimator will be bulky. The collimator used on the Picker Cobalt 60 unit has been so designed that it in large measure overcomes the above problems. The system of articulating stainless steel faced lead plates, some of which are edged with tungsten, yields more than adequate attention of the beam outside the desired field (about 1.3 percent of primary beam is transmitted 6 cm. outside a 10x10 cm field, (by measurement) and at the same time permits the overall size of the collimator to be conveniently small. The last collimating edge is 2.5 cm from the source. Additional mechanical structure extends beyond this for 2 to 27 cm. When the collimator adjusting knob is turned, all of the lead plates move as if they were pivoted about the corresponding edges of the source. In this way all of the plates act to define the beam regardless of field size, and a very small over-all size is achieved, particularly for small fields.

INSTRUCTIONAL MANUAL

MODEL 60-2000 GAMMATRON

Radiation Engineered Services
Lafayette and Water Streets
Norristown, Pa.

INTRODUCTION

The Automatic Gamma Camera "Gammatron" has been designed to allow the radiographer to use very large sources of cobalt 60 with complete safety. Sources of 1000 curies of cobalt or more may be used, reducing exposure times to minutes rather than hours on heavy sections. Steel sections ranging in thickness from 3/4" to 12" or more can be accurately radiographed, allowing even the small shop, the advantages of high voltage radiography at a fraction of the cost of comparable X-ray equipment.

The Gammatron affords maximum safety to operating personnel through the use of safety interlocks and a fail safe device to operate in the vent of plant power failure. Accurately timed exposures are obtainable over a wide range of time intervals. The Gammatron features automatic run out and retraction at the end of the timing cycle thereby requiring a minimum of attention on the part of the operator.

EQUIPMENT

The Gammatron consists of two basic units, the drive unit together with the camera and the control console. The drive unit is mounted directly on the Gammatron head and contains the drive motor, clutch, and drive mechanism, together with relays and associated circuitry. The control console contains main switches, detector power supplies, timer and test circuitry. A fifty foot cable connects the console to the camera head. Main power, 110-115v A.C. 60 cycles is supplied to the console through a lock mechanism to prevent operation by unauthorized personnel.

FEATURES

In addition to standard equipment, the Gammatron has the following features:

1. Auxillary warning lights. An AC receptacle is provided on the lower rear of the console for this purpose. Additional warning devices (not to exceed 15 AMP current drain) may be plugged into this receptacle and will operate in conjunction with the red warning light on the console.
2. Door interlock switch. If the unit is to be operated in a special room, the user may wish an interlock feature to prevent entry of unauthorized personnel. The Gammatron is easily adapted at the factory for this purpose.
3. Elapsed time indicator is provided on the timer to indicate the time remaining on an exposure. When the timer is set e.g. one hour the red arrow will be seen to travel back to zero.
4. Audible alarms are provided to indicate the presence of radiation should AC power fail.
5. Collimators of different cone angle are easily installed on the Gammatron or a continuously variable collimator can be installed. (Collimators are optional items at additional cost).

OPERATION :

The Gammatron may be connected to any 115v 60 cycle outlet. A line cord is provided for this purpose on the back of the control console. To operate, a sequence of operations should be followed to insure safe trouble-free operation.

1. Connect console power cable to 110v, 60 cycle source.
2. If there is a door giving access to the room in which the machine is kept it must be closed and locked. The key provided for this purpose is the same key used to unlock the source control switch.
3. The operator then selects the time he wishes to have the source exposed. This is done by loosening the knob on the timer and positioning the pointer to the desired time. The knob locking the pointer in place may then be tightened.
4. Unlock the lock switch and turn to the "ON" position. this applies power to the system. Depressing the "RESET" button will start the source moving to the exposed position.
5. A light circuit, actuated mechanically, indicates the position of the source.
6. Upon reaching the exposed position the red light should be lit.
7. At the end of the predetermined time interval, the motor will reverse and the source will automatically retract to safe position. A green light will indicate this condition.
8. The operator may repeat the same exposure simply be pushing the "RESET" button located on the console.
   The time setting may be changed at any time the source is not being exposed.
9. The operator may wish, at any time, to interrupt an exposure. This may be accomplished by turning the lock switch to the OFF position.
   Provisions have been made to insure the safety of personnel. A solenoid lock switch is equipped with electrical interlocks which activate audible as well as visual

OPERATION

warning signals. The lock switch is tied into a solenoid system wherein, the key cannot be turned off an removed from the console until the source is in the shielded position. Should the source be exposed at the time of AC power failure, audible alarm bells will indicate the unsafe condition until the source is returned to the safe position. If the cause of the power failure is easily rectified, the solenoid operator may wish to continue to exposure. By subtracting the reading on the elapsed time indicator from the desired time, he will then have the new time setting necessary to complete the exposure.

CAUTION:

In designing the Gammatron every foreseeable circumstance has been provided for. However, as an added precaution ONE SHOULD NEVER ENTER INTO CLOSE PROXIMITY OF THE RADIOACTIVE MATERIAL WITHOUT A PORTABLE SURVEY METER.

INSTRUCTION MANUAL

MODEL P192-100 Radionics

Appendix C

OPERATION

Do not attempt to operate this machine without an operating gamma survey meter. This meter should be of the ion-chamber type with a full scale range of at least 1,000 mr/hr. Geiger counters are not suited for high level radiation measurement.

The operator of the machine should be familiar with the properties of radiation and the distance or shielding necessary to protect personnel. In addition, proper warning signs, etc. must be posted before the source is expose.

1. After these precautions have been taken, the control cable may be connected to the machine. This is done by removing the shipping plug from the rear (lock box) assembly and pulling the source disconnect out of the machine. The source disconnect is then mated to the control cable disconnect and the cables threaded into the machine. Note that the machine is not unlocked until after the controls have been connected, and that the source assembly cannot be pulled all the way out as long as the camera is locked.

When the controls are disconnected the shipping plug must be returned to its position in the lock box. The shipping plug has a magnetic permitting it to be attached to the camera when not in use.

NOTE: The disconnects must be turned 90° with respect to each other in order to connect and disconnect. Once connected they may be locked by rotating from the 90° angle until they are in line.

OPERATION

The disconnect attached to the "pigtail" (or source capsule assembly) must be right side-up with the longer flat next to the cable disconnect - before connecting, or the cables cannot be rotated 90° into line.

2. Place the end of the source tube conveniently near the piece to be radiographed. The source tube is made up of three (3) units; a section of conduit with male swivel fittings on both ends (Model 10 Source Tube Unit), a section of conduit with a male swivel fitting at one end and a female fitting at the other (Model 11 Source Tube Unit) and a threaded end cap (Model 12 Source Tube Unit). A seven foot source tube may be constructed by using only model 10 and model 12 units - or a 14 foot source tube may be constructed using all three (3) units. (NOTE: a 21 foot source tube may be constructed for use with 25 foot control assemblies by using one model 10, two (2) model 11 and one (1) model 12 units). If possible, stretch the cables their full length to take advantage of the protection afforded by distance.

3. The source is exposed and moved to the end of the source tube by rotating the crank handle on the control cable. Under no circumstances try to force this crank.

4. At the end of the exposure, the source can be retracted by reversing the direction of crank rotation.

CAUTION!! Never enter into close proximity of radioactive material without a survey meter. When the machine is not in use it should be locked to prevent its use by unauthorized personnel.

MAINTENANCE

As with any mechanical device, gamma radiographic equipment requires periodic maintenance. This may consist of inspecting control cables and source tube for cuts or crushed segments, checking threaded parts for worn or cross-threading etc.

If if becomes difficult to turn the crank when exposing or retracting the source, the spiral cable in the control assembly should be removed. Clean the cable with a clean cloth and Trichlorethylene or similar solvent and dust very lightly with Powdered graphite.

CAUTION!! Do not use flake graphite.

APPENDIX D

INSTRUCTION MANUAL

TECHNICAL OPERATIONS MODEL 660 SERIES

Assemble the system for use and operate the system only in areas monitored with appropriate radiation measuring equipment.

1.0 Preparation For Use

1.1 Guide Tube Assembly

1.1.1 At the radiographic focal point, position and secure the snout of the master guide tube using swivel clamps.

1.1.2 Remove the plastic dust caps and attach additional extender guide tubes, as necessary to the master guide tube.

1.1.2.1 Never operate the system with more than three(3) guide tube sections, including the master guide tube.

1.1.3 Lay out the guide tubes as straight as possible. Bending the radius smaller than twenty inches may restrict the movement of the control cable.

1.1.4 Remove the shipping plug from the projector connector and attach the last guide tube to the projector.

1.2 Control Unit

1.2.1 Lay out the control cable as straight as possible. Bending the radius less than three (3) feet may restrict the movement of the control cable.

1.2.2 Attach the control cable to the projector in the following sequence.

Control Unit

1.2.2.1 Unlock the projector with key and turn the connector selector ring from the lock position to the connect position. When the ring is in the connect position, the storage cover can be removed.

1.2.2.2 Slide the control cable collar back and open the jaws of the control cable connector. This exposes the male position of the swivel connector.

1.2.2.3 Engage the male and female portions of the swivel connector by depressing the spring-loaded locking pin toward the projector with thumbnail. Release the locking pin and test that the connection has been properly made.

1.2.2.4 Close the jaws of the control cable connector over the swivel-type connector. Slide the control cable collar over the connector jaws.

1.2.2.5 Hold the control cable collar flush against the projector connector and rotate the selector ring from the connect to the lock position.

2.0 OPERATION

2.1 Check cable connections and the position of master guide tube snout.

OPERATION

2.2 Unlock the projector connector and rotate the selector ring to the operate position. The source is not free to move.

2.3 At the control unit (shielded area) rapidly rotate the hand crank in the expose (counterclockwise) direction until the source reaches the snout, which serves as a mechanical stop for the source.

2.3.1 If cranking becomes difficult at any time during this step, reverse the direction of cranking to return source to the stored position in the projector. Monitor the area with survey meter, then check control and guide tubes for excessively small bend radius and repeat the step.

2.4 After exposure, rapidly turn hand crank in the retract (clockwise) direction to return source to the stored position.

2.5 After exposure, the area and projector should be monitored with a survey meter.

2.6 When not in use, rotate the connector selector from operate position to the lock position and secure with the projector lock.