

BRANCH RADIOGRAPHIC LABORATORIES, INC.
RADIOGRAPHIC INSPECTIONS AND SERVICES

28 SOUTH AVENUE W.
CRANFORD, N.J.
272-5743

BR 70-12-1
Rev. 2
3-30-84

34-529L

29-03405-02

PROCEDURE FOR THE USE, STORAGE AND
HANDLING OF IRIIDIUM 192 AND COBALT 60

8506180114 850522
REG1 LIC30
29-03405-02 PDR

02469

"OFFICIAL RECORD COPY"

ML10

MAY 30 1984

BR 70-12-1
Rev. 2
3-30-84

ORGANIZATIONAL STRUCTURE

William H. Branch Sr.

Chairman of the Board and Director of Operations of Branch Radiographic Labs., Inc. Radiation Safety Officer and Auditor.

William H. Branch Jr.

Vice President in charge of major projects such as Nuclear Power Plants instituting and controlling radiographic operations. Radiation Safety Officer and Auditor. Qualification of personnel.

Peter J. Branch

Vice President in charge of personnel training and qualification. Liaison officer with the Nuclear Regulatory Commission on license matters. Responsible for maintaining records of radiographic operations. Radiation Safety Officer and Auditor.

BR 70-12-1
Rev. 2
3-30-84

PROCEDURE FOR THE USE, STORAGE AND
HANDLING OF IRIIDIUM 192 AND COBALT 60

INDEX

SECTION 1

PURPOSE	1
SCOPE	1
DELEGATED USERS	2
USE	3
PERSONNEL MONITORING EQUIPMENT	4
EQUIPMENT	5
MAINTENANCE AND CALIBRATION OF EQUIPMENT	8
RECORDS	9
SURVEYS	11
STORAGE AND SECURITY OF RADIOACTIVE SOURCES	12
SOURCE CHANGING AND DISPOSAL	13
TRANSPORTATION	14
REPORTING REQUIREMENTS	15
REVIEW	17
LICENSE RENEWAL	18
INTERNAL INSPECTION	19
POSTING REQUIREMENTS	21
LEAK TESTING	22

BR 70-12-1
Rev. 2
3-30-84

INDEX (CONT'D)

SECTION 2

PROTECTION OF RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANTS	1
PURPOSE	2
PROTECTION OF WORKERS ON THE JOBSITE	3
RULES	4
OPERATING PROCEDURE FOR REMOTE CONTROL RADIOGRAPHIC DEVICES	7
EMERGENCIES	10
RADIATION LEVEL/DISTANCE CHART "A" (IR-192)	12
RADIATION LEVEL/DISTANCE CHART "B" (Co-60).	13

SECTION 3

INSPECTION AND MAINTENANCE OF EQUIPMENT	1
INSPECTION AND MAINTENANCE PROCEDURES	4

SECTION 4

PROCEDURE FOR THE USE AND STORAGE OF THE T.O. MODEL 520 Co 60 EXPOSURE DEVICE IN CONJUNCTION WITH T.O. MODEL 657 EXPOSURE CONTROL	1
PURPOSE	1
EQUIPMENT	1
EXPOSURE CONTROL (NOMENCLATURE)	2
OPERATING PROCEDURE FOR T.O. 520 EXPOSURE DEVICE	3
MAINTENANCE OF T.O. MODEL 520 EXPOSURE DEVICE AND MODEL 627 AUTOMATIC EXPOSURE CONTROL	6
OPERATION OF SAFETY INTERLOCK SYSTEM	9
DETERMINATION OF EXPECTED RADIATION LEVELS OUTSIDE OF EXPOSURE ROOM	11

BR 70-12-1
Rev. 2
3-30-84

INDEX (CONT'D)

APPENDICES

QUALIFIED RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANTS	A
CALIBRATION OF SURVEY METERS	B
TRAINING OF PERSONNEL	C
TRANSPORTATION OF RADIOGRAPHIC DEVICES	D
STORAGE OF SOURCES AT TEMPORARY JOB SITES	E
STORAGE OF PERSONNEL MONITORING EQUIPMENT	F
PROCEDURE FOR THE USE OF DOSIMETERS	G
RECORDS TO BE KEPT BY BRANCH RADIOGRAPHIC LABS. PERSONNEL	H
CLASSROOM LESSON GUIDE (INCLUDING TESTS)	I
PROCEDURE FOR USE OF TECHNICAL OPERATIONS MODEL 518 LEAK TEST KIT	J
PROCEDURE FOR THE USE OF TECHNICAL OPERATIONS MODEL 650 SOURCE CHANGER	K
PROCEDURE FOR INSPECTION AND MAINTENANCE OF MODEL 520 EXPOSURE DEVICE AND MODEL 627 AUTOMATIC EXPOSURE CONTROL	L
QUALITY ASSURANCE PROGRAM - 10 CFR PART 71 - INDUSTRIAL RADIOGRAPHY LICENSE 29-03405-02	M
CALIBRATION OF DOSIMETERS	N

Section 1

BR 70-12-1
Rev. 2
3-30-84

PURPOSE:

The purpose of this procedure is to establish a definite system for the use, storage, and handling of radioisotopes for industrial radiography. The standards are intended to comply with the rules and regulations of the Nuclear Regulatory Commission and the New Jersey State Department of Health.

SCOPE:

This procedure will cover the use of radioisotopes under the control of Branch Radiographic Labs., Inc. in various locations in New Jersey and other states under control of the NRC. Use in agreement states will be made after proper notification of the proper agency.

Section 1

BR 70-12-1
Rev. 2
3-30-84

DELEGATED USERS:

1. Radioisotopes under this procedure may be used only by the personnel listed in Appendix "A" (Radiographers) and (Radiographer's Assistants) who have been trained according to Title 10 Part 34.31.
2. All of the Radiographers and Radiographer's Assistants listed in the Appendix "A" have proved competent in the use of the radioisotope projectors and radiation survey instruments.

Section 1

BR 70-12-1

Rev. 2

3-30-84

USE:

The radioisotopes shall be used only for the purpose of exposing film for non-destructive radiographic inspection. The radioisotopes shall be used in field and shop applications and shall comply with all parts of this procedure and restrictions imposed by the NRC license and the provisions of Title 10 Part 20 and 34 of the code of Federal Regulations. The radioisotopes shall never be removed or detached from the approved container or device for use by any other method. The devices to be used shall be as listed in Section 1 "Equipment."

Section 1

BR 70-12-1
Rev. 2
3-30-84

PERSONNEL MONITORING EQUIPMENT:

1. Film Badge Service:
 - a) The supplier shall be Eberline Instruments Corp.,
Santa Fe, New Mexico--TLD badges.
 - b) Badges will be changed on a weekly basis.
2. Pocket Dosimeters:
 - a) The dosimeters to be used are:
 - 2.1) Victoreen Model 541A
 - 2.2) Landsverk Model L-50
 - 2.3) Or equivalent
 - b) The dosimeters shall be checked for operation and
recharged to the zero reading before using. All
dosimeters shall have a scale which reads from 0-200 mr
minimum.
 - c) The dosimeters shall be checked at least once every
12 months for correct response to radiation. Any
dosimeter which exceeds + or - 30 percent of a true
radiation field shall be discarded.

Section 1

BR 70-12-1
Rev. 2
3-30-84

EQUIPMENT:

The equipment used for radiography under this procedure shall include:

1. Source projectors for use with Iridium 192
 - a) Technical Operations Model 900
 - b) Technical Operations Model 660
2. Sources of Iridium 192
 - a) Sealed sources Iridium 192 #90003 (100 Curies + 10% Max)
 - b) Sealed sources Iridium 192 Technical Operations Model #A424-9 (100 Curies + 10% Max)
3. Source projectors for use with CO 60
 - a) Technical Operations Model 680
 - b) Technical Operations Model 520
4. Sources of Cobalt 60
 - a) Sealed sources CO 60 Technical Operations Model #A424-14 (100 Curies + 10%)
 - b) Sealed sources CO 60 Technical Operations Model #A453-5 (250 Curies + 10%)
5. Source Transfer Containers:
 - a) Iridium 192
 - 5.1a Technical Operations Model 414
 - 5.2a Technical Operations Model 650
 - 5.3a Technical Operations Model 850

BRANCH RADIOGRAPHIC LABORATORIES, INC.

RADIOGRAPHIC INSPECTIONS AND SERVICES

28 SOUTH AVENUE W.

CRANFORD, N.J.

272-5743

Section 1

BR 70-12-1

Rev. 2

3-30-84

b) Cobalt 60

5.1b Technical Operations Model 770

5.2b Technical Operations Model 771

5.3b Technical Operations Model 488

6. Radiation Detection Instruments:

- a) Victoreen Model 592 Gamma Survey Meter
- b) Victoreen Model 592 B Gamma Survey Meter
- c) Eberline Model E 120 G
- d) Eberline Model E 510 G
- e) Eberline Model E 130 G
- f) Gamma Industries Model 250 B
- g) Eberline Model E 130 A
- h) Or equivalent

7. Dosimeters:

- a) Victoreen Model 541 A, direct reading
- b) D. C. A. 862
- c) Or equivalent

7.1 Dosimeters are pocket type direct reading, with a range of 0-200 mr minimum

Section 1

BR 70-12-1
Rev. 2
3-30-84

b) Cobalt 60

5.1b Technical Operations Model 770

5.2b Technical Operations Model 771

5.3b Technical Operations Model 488

6. Radiation Detection Instruments:

- a) Victoreen Model 592 Gamma Survey Meter
- b) Victoreen Model 592 B Gamma Survey Meter
- c) Eberline Model E 120 G
- d) Eberline Model E 510 G
- e) Eberline Model E 130 G
- f) Gamma Industries Model 250 B
- g) Eberline Model E 170 A
- h) Or equivalent

6.1 Scales on meters read 0-100; 0-1000 mr/hr

7. Dosimeters:

- a) Victoreen Model 541 A, direct reading
- b) Landsverk 150, direct reading
- c) Or equivalent

7.1 Dosimeters are pocket type direct reading, with a
range of 0-200 mr minimum

BRANCH RADIOGRAPHIC LABORATORIES, INC.

RADIOGRAPHIC INSPECTIONS AND SERVICES

28 SOUTH AVENUE W.

CRANFORD, N.J.

272-5743

Section 1

BR 70-12-1

Rev. 2

3-30-84

8. Dosimeter Chargers:
 - a) Victoreen Model 561 Standard Charger
 - b) Landsverk 2000A
 - c) Dosimeter Corp. Model 910
 - d) Or equivalent
9. TLD Badge Service:
 - a) Eberline Instrument Corp., Sante Fe, New Mexico
10. Warning Signs:
 - a) High Radiation Warning Signs
 - b) Radiation Warning Signs
11. Rope or Tape:
 - a) Yellow colored.

Section 1

BR 70-12-1

Rev. 2

3-30-84

MAINTENANCE AND CALIBRATION OF EQUIPMENT:

1. All instruments used for survey or personnel monitoring purposes shall be kept in good operating condition at all times and checked before use for operation. All survey instruments shall be calibrated at intervals not greater than three months or when suspected of malfunction. Survey instruments shall be calibrated in accordance with Appendix "B". A record of calibration shall be kept on file at all times. All dosimeters shall be charged to zero before using and shall be calibrated once every 12 months in accordance with Appendix "N".

Section 1

BR 70-12-1
Rev. 2
3-30-84

RECORDS:

The following records shall be kept by Branch Radiographic Labs., Inc.

1. Inventory records shall show the receiving and disposal data of radioactive material. This record shall include:

- a) The location, activity, type and capsule # of source
- b) Date of receipt or shipment of source
- c) The shipping point, destination and carrier of the source when shipping.
- d) Any other pertinent information available.

2. Records in the radiography field log books which includes:

- a) The date and location of use.
- b) The activity and type of source.
- c) The individuals in attendance and their dosimeter readings.
- d) The time, position, and location of the source for each exposure.
- e) A sketch to show the approximate location of rope or tape and signs and the maximum readings at these locations.
- f) The results of the survey when securing the source for the day.

Section 1

BR 70-12-1
Rev. 2
3-30-84

3. Radiation exposure records for all individuals involved with radiography. These records are to include all exposures from all the sources on the job and shall include:

- a) The daily pocket dosimeter reading transferred from the field log book.
- b) The weekly TLD badge total.
- c) The thirteen-week TLD badge total.

4. The TLD badge reports from outside laboratories shall be kept on file.

5. Records of survey instrument calibrations shall be maintained for 2 years after the date of calibration.

6. Occupational External Radiation Exposure forms shall be kept for all concerned persons (NRC Forms 4+5 equal)

7. Leak test records shall be kept on file for six months after the next required leak test is performed.

Copies of these forms are included as part of this procedure. These records are the responsibility of the persons named on the NRC license. Copies of Radiation Exposure records shall be available to all individuals involved with radiography upon request. (see 10 C.F.R. 20.409)

Section 1

BR 70-12-1

Rev. 2

3-30-84

SURVEYS:

A survey is the evaluation of the radiation hazards incident to the use, storage and handling of radioactive sources under a specific set of conditions. A survey shall be made whenever necessary to comply with the NRC regulations. A physical survey shall be made and the radiation measured in the following cases:

- a) When receiving or returning a source in a shipping container.
- b) When exchanging sources in the radiographic unit.
- c) When storing a source
- d) When leaving or approaching the source storage area.
- e) When making each radiographic set up.
- f) When approaching the projector each time during use.
 - 1. Before and after each exposure to ensure the source is in a safe stored position. The above conditions are the minimum requirements.

Section 1

BR 70-12-1
Rev. 2
3-30-84

STORAGE AND SECURITY OF RADIOACTIVE SOURCES:

Radioisotopes shall be stored in the transfer container or projector unit. The container shall be labeled with data indicating the quantities, kind of material, and date of measurement. These devices shall be stored in a locked storage enclosure when not being used. The enclosure shall be obviously marked with "Radioactive Material" warning signs. The radiation level outside of the enclosure shall be less than 2 mr/hr. All keys to the locks involved shall remain in the possession of the radiographer on duty listed in Appendix "A". The locked storage enclosure shall be regularly inspected for evidence of tampering or damage. Any suspicion of such will be reported to William H. Branch Sr. or in his absence Peter J. Branch or William H. Branch Jr. The device in which the radioisotopes are stored will be locked at all times when the unit is not in use.

Section 1

BR 70-12-1

Rev. 2

3-30-84

SOURCE CHANGING AND DISPOSAL:

Sources may be exchanged by shipment of the radiographic unit to a licensed source vendor or exchanged on the site by using the Technical Operations Inc. Model #414, #650 or #850 Iridium Source Changer. The source changing on the job shall be done by a licensed operator in accordance with the following:

1. The location for the exchange shall be chosen so that the operator or other personnel will not be exposed to unsafe radiation levels.
2. The source changing operations shall be in accordance with the operating instructions described in Appendix "K".
3. Safety precautions identical to those used in making radiographic exposures will be observed when exchanging sources.
4. Source changing of CO 60 Units will be done by Technical Operations or their authorized representative.

A rigid system of accounting for all radioactive materials is to be enforced. All deteriorated sources shall be returned to a vendor or agency licensed for the disposal of radioactive material. The shielded shipping container shall be the Technical Operations, Inc. Model #414, #650 or #850 for Iridium 192, or Type #488, #770 or #771 for Cobalt 60, Source Changers. This container will be closed, bolted, sealed and labeled in accordance with Department of Transportation Regulations.

Section 1

BR 70-12-1
Rev. 2
3-30-84

TRANSPORATION:

When transporting radioactive material, all shipments shall conform to the Department of Transportation regulations. In all cases the source is to be in a shielded device, the radiation level at the unit surface is not to exceed 200 mr/hr or 10 mr/hr at one meter from the source. Sources shall be shipped by Rail or Air Freight, Rail Express, or Motor Vehicles. The source transfer container shall be closed, bolted, sealed, and marked and labeled as required by regulations. If the radiographic unit is to carry the source, the unit shall also be packed and locked.

A "Radioactive Materials" proper labeling shall be properly filled out and applied to the part of the container bearing the consignee's name and address. If a shipping case is used, it must state on the outside "Radioactive Material Inside" container complies with the prescribed specifications.

The consignee shall be notified of:

1. The shipment date.
2. The expected delivery date.
3. The method of transportation and the carrier's name or names.
4. The shipment identifying number.
5. The material description and type of container.

Section 1

BR 70-12-1

Rev. 2

3-30-84

REPORTING REQUIREMENTS:

Report shall be made in the following cases:

1. Reports of theft or loss of licensed material. The licensee shall report by telephone to : NRC 215-337-5000 any loss or theft of licensed material immediately after its occurrence becomes known to the licensee.
2. Reports of incidents.

The licensee shall report:

- a) Immediately by telephone and telegraph to the Manager, Region 1 Division of Compliance, any incident involving licensed material which may have caused or threatens to cause exposure to any individual to 25 rems or more of radiation.
- b) Within 24 hours by telephone and telegraph to the Manager, Region 1 Division of Compliance, the exposure of any individual to 5 rems or more of radiation.
- c) Within 30 days by letter to:
Director of Materials Licensing
United States Nuclear Regulatory Commission
Washington, D. C. 20555
- d) In addition to reports as mentioned in cases a), b), and c), a copy will also be sent to the Manager,

Section 1

BR 70-12-1

Rev. 2

3-30-84

Region 1 Division of Compliance, of each incident involving licensed material which appears to have resulted in the excessive exposure of an individual to radiation, or to have resulted in levels of radiation in excess of any applicable limits set forth in the regulations or in the licensee's license. Each report shall describe the nature of the incident, the extent of exposure of persons to radiation, the levels of radiation involved, the cause and corrective steps taken or planned to assure against a recurrence of the incident.

Section 1

BR 70-12-1

Rev. 2

3-30-84

REVIEW:

This procedure will be reviewed periodically and made to conform to the latest NRC requirements. Any changes will be written into the procedure, which will be forwarded for approval along with the application to the NRC for license renewal. Any additions or changes are to be effective only after their acceptance by the commission.

The "Materials Branch, Division of Materials Licensing", shall be informed of major changes in the operating instructions, changes of responsible personnel, additional radiation protection equipment and facilities.

Section 1

BR 70-12-1
Rev. 2
3-30-84

LICENSE RENEWAL:

Application for license renewal shall be made in triplicate on Form NRC-313R and titled, "Application for Byproduct Material License". This application shall be filed with the

Materials Branch
Division of Materials Licensing
United States Nuclear Regulatory Commission
Washington, D. C. 20555

at least 30 days before the existing license expiration date. Exemptions from the rules and regulations of the NRC may be applied for by writing to the Commission. These exemptions will not be applicable until written permission is received from the Commission. If the license is not to be renewed, a Certification of Status of Radioisotopes (Byproduct Material) Program under the United States NRC Byproduct Material License No. 29-3405-3, shall be filled out and returned to the United States Nuclear Regulatory Commission, Materials Branch, Division of Materials Licensing.

Section 1

BR 70-12-1

Rev. 2

3-30-84

INTERNAL INSPECTION:

1. Internal inspections shall be made by William H. Branch Sr., Peter J. Branch, or William H. Branch Jr. A record of these inspections shall be recorded and placed on file for reference in order to provide information and data on areas which may need improvement.
2. A complete audit of inventory records, documents, radiation records, and radiographers' audits shall be performed on a yearly basis.
3. Audits of radiographers shall be performed on a quarterly basis or more often as deemed necessary by William H. Branch Sr., Peter J. Branch, William H. Branch Jr., or Daniel F. Dodd. These audits shall be done on an unannounced basis. Results of audits shall be recorded on a radiographic audit form and reported to William H. Branch Sr. Deviations, noted by auditors, of operating and emergency procedures by personnel will be immediately brought to the attention of the radiographer and corrected.
4. A yearly review of all audits made during the year shall be made by William H. Branch Sr., Peter J. Branch, or William H. Branch Jr. This review shall also take into account any new literature or regulations issued by the Nuclear Regulatory Commission for compliance.
5. Quarterly audits will be recorded on a Radiographic Operations Quarterly Audit Form. (See page 20).

Section 1

BRANCH RADIOGRAPHIC LABORATORIES, INC.
RADIOGRAPHIC INSPECTIONS AND SERVICES

BR 70-12-1
Rev. 2
3-30-84
28 SOUTH AVENUE W.
CRANFORD, N. J.
272-5743

RADIOGRAPHIC OPERATIONS QUARTERLY AUDIT

RADIOGRAPHER _____ LOCATION _____ DATE _____

1. The "Radiographer" will be audited unannounced during a normal radiographic assignment. The following points will be checked during the audit:

Did the "Radiographer"	YES	NO
a. Wear the proper T.L.D. Badge?	_____	_____
b. Check dosimeter after each exposure?	_____	_____
c. Check survey meter prior to and after exposing radiographic device?	_____	_____
d. Upon removal of exposure device from storage, take reading at (1) meter from exposure device?	_____	_____
e. Make entry in Source Survey and Utilization Record?	_____	_____
f. Erect rope barriers and post radiation signs?	_____	_____
g. Position source tube, make source tube and control cable connections prior to unlocking exposure devices?	_____	_____
h. Watch survey meter as source was being cranked into exposure position?	_____	_____
i. Take radiation survey of exposure area, fill out "Radiation Survey Chart" form and draw sketch showing area and radiation levels at area boundaries?	_____	_____
j. Watch the survey meter as source is being cranked from its unshielded position into exposure device?	_____	_____
k. Approach exposure device slowly using survey meter, check source tube from tip to camera, then proceed along camera surface?	_____	_____
l. Lock camera?	_____	_____
m. Disconnect source tube and insert safety plugs and disconnect control cable?	_____	_____
n. Return exposure device to storage area?	_____	_____
o. Survey exposure device surface?	_____	_____
p. Turn off radiation survey meter?	_____	_____
q. Remove radiation area boundary ropes and signs?	_____	_____
r. Make correct entry in Source Survey and utilization record?	_____	_____
s. Check dosimeter and record readings?	_____	_____

Section 1

BR 70-12-1
Rev. 2
3-30-84

POSTING REQUIREMENTS:

Form NRC-3, "Notice to Employees", shall be conspicuously posted in a sufficient number of places to permit the employees to observe them.

Copies of procedures, current copies of pertinent regulations, and a copy of the NRC license are to be available for reference and the radiographers and their assistants shall become familiar with them.

Reports of personnel radiation exposure shall be available to all employees upon request.

BRANCH RADIOGRAPHIC LABORATORIES, INC.

RADIOGRAPHIC INSPECTIONS AND SERVICES

28 SOUTH AVENUE W.

CRANFORD, N.J.

272-5743

Section 1

BR 70-12-1

Rev. 2

3-30-84

LEAK TESTING:

Leak tests will be performed by a radiographer at six (6) month intervals using a Technical Operation Test Kit Number 518 per Appendix "J". The assay will be performed by Technical Operations, Burlington, Massachusetts. The record of which will be kept for NRC review in Branch Radiographic Labs., Inc. files.

Section 2

BR 70-12-1
Rev. 2
3-30-84

PROTECTION OF RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANTS:

Trained personnel handling radioisotope projectors shall be equipped with pocket dosimeters and TID badges. A working radiation survey meter shall accompany a source projector whenever it is removed from storage. Every effort shall be made by the individuals to keep their radiation doses to a minimum. All radiographic set-ups shall be considered with respect to the fundamentals of time, distance, and shielding to develop facilities and procedures which will keep personnel exposures to a minimum.

Occupational radiation doses received from both licensed and unlicensed material are not to exceed 1250 mrem for a 13-week period. The total lifetime accumulated occupational dose shall average not more than five rems per year for each year after the age of eighteen. Any individual receiving a greater dose for these periods, as determined from the personnel monitoring equipment, shall be limited to exposure as described in the Code of Federal Regulations Title 10, Part 20.

Section 2

BR 70-12-1
Rev. 2
3-30-84

PURPOSE:

The purpose of these instructions is to establish definite, safe and uniform operating and emergency instructions for the personnel handling and using Iridium 192 and Cobalt 60 sources. The operators shall abide by these instructions and will also become familiar with the formal administrative, standard operating and emergency procedures.

Section 2

BR 70-12-1

Rev. 2

3-30-84

PROTECTION OF WORKERS ON THE JOBSITE

Whenever possible radioisotopes shall be used on nights, weekends, or other times when personnel on the jobsite are at a minimum. In any event, the following precautions shall be taken to protect personnel from radiation:

1. A radiographer shall be in constant attendance and in control of the restricted radiation area when such an area exists.
2. The extent of a restricted (roped off) area shall be determined by the use of the Inverse Square Law or radiation level/distance charts (Pages 12 & 13 of this section).
3. At each set-up (before and after each exposure), a radiation survey shall be made. Gamma survey meters shall be used to aid in this evaluation.
4. "High Radiation Area" signs shall be posted at any approach where the radiation could cause any person or persons to receive more than 100 mr in any one hour. No one shall be allowed to enter this area without personnel monitoring equipment.
5. "Radiation Area" signs shall be posted at any approach where the radiation could cause any person or persons to receive more than 2 mr in any one hour.
6. The signs used shall conform to the NRC regulations.
7. The radiation in uncontrolled areas shall not exceed 2 mr in any one hour.
8. No person under eighteen years of age is to be permitted in the radiation areas.

Section 2

BR 70-12-1

Rev. 2

3-30-84

RULES:

1. The source shall never be removed or detached from their radiographic devices.
2. At all times the first consideration shall be to protect all personnel from exposure to radiation.
3. Each person handling and using radioactive sources shall wear at least an Eberline TLD badge and a pocket dosimeter.
4. No one shall be permitted to enter the radiation area without personnel monitoring equipment.
5. All personnel monitoring equipment shall be returned to the controlled storage area at the end of each work period.
6. The operators will be kept aware of their exposures.
7. A gamma ray survey meter used for the purpose of making radiation surveys must accompany all radiographic units when they are removed from storage.
8. Survey meter shall be checked for operation before being used to assure that it is in proper working condition.
9. Whenever approaching the source, a survey shall be made of the radiation area to determine the outer safe limits, at no time shall anyone approach the source before this survey is made. At no time shall the radiation level exceed 200 mr/hr at the surface of the source projector.

Section 2

BR 70-12-1
Rev. 2
3-30-84

10. The radiographic unit shall be locked and plugged at all times when not in use. Any evidence of tampering is to be reported to Wm. H Branch Sr., P. J Branch, Wm. H Branch Jr. or Shift Supervisor.
11. A time record shall be kept of the unit's removal from and return to storage.
12. The radiographic unit shall be transported in a safe manner, with care taken to prevent any possible accidents. Transportation of radiographic units shall be in accordance with Appendix "D".
13. Absorption by the human body cells of gamma radiation can result in their damage or possible destruction. The body can apparently tolerate a certain amount of radiation justifying a maximum permissible dose. Exposures over the maximum permissible dose shall not be tolerated as excessive exposures may cause bodily injury. This maximum dose shall be used as a guide only because any exposure is actually excessive. Therefore, every effort shall be made to keep personnel exposure to a minimum by making the best use of the following:
 - a) Distance from the source
 - b) Protective shielding
 - c) Time in the radiation area
14. When radiographs are being made, an area larger than the expected restricted area shall be cleared of all unauthorized persons, and steps taken to prevent re-entry. A survey is to be made immediately after the source is in the "ON" exposure position. The restricted area must then be adjusted to include any area which could result in a person receiving a dose in excess of 2 mr in any one hour.

Section 2

BR 70-12-1

Rev. 2

3-30-84

15. Radiation Area signs are to be posted at the approaches to the restricted area. High radiation area signs shall be posted at any approach where the radiation level exceeds 100 mr in any one hour.
16. When the source is in the "ON" exposure position, the radiographers or radiographer's assistant shall keep a constant vigil of the restricted area to prevent persons from entering.
17. Sufficient data to describe the location of the work area, position of the source, position of the restricted area barriers and the film exposure time shall be kept in the radiographer's field log.
18. The radiographic unit shall be stored in the locked storage area when not in use.
19. A survey shall be made of the storage area to assure the safety of this area.

Section 2

BR 70-12-1
Rev. 2
3-30-84

OPERATING PROCEDURE FOR REMOTE CONTROL RADIOGRAPHIC DEVICES

1. General Instructions:

- a) Each radiographic device shall be checked with a radiation survey meter before it is moved or put into operation.
- b) No radiographic device shall be moved unless it is locked and plugged.

2. Instructions for making an exposure:

- a) Position source tube and place film in position.
- b) Position and straighten control cable placing the hand crank in a position which will afford the radiographer the best possible protection.
- c) Bring radiographic device with survey meter into position.
- d) Unlock storage cover on back of radiographic device with key and rotate selector lever to the "CONNECT" position to release the cover.
- e) Remove storage cover from control cable connector.
- f) Connect the drive cable to the connector.
- g) Manually pull both parts of the connector to be sure the connection has been properly made.
- h) Place selector lever in "LOCK" position.
- i) Establish and post restricted areas.

Section 2

BR 70-12-1
Rev. 2
3-30-84

- j) Remove safety plug from the front of the radiographic exposure device and thread in source guide tube. Once the safety plug has been removed, the person making the connection will not allow himself to be distracted until the source guide tube is threaded into place.
 - k) Check and make sure there are no unauthorized personnel in the restricted area.
 - l) Place selector lever in "OPERATE" position.
 - m) Crank out source and check level of radiation at lines of restricted area.
 - n) Make adjustments at all lines that do not restrict an area which could result in a person receiving a dose in excess of 2 mr in any one hour.
 - o) After exposure, crank source back into the radiographic device.
 - p) Make radiation survey of area and radiographic device including source guide tubes or collimator, whichever is applicable, to make sure the source is in the safe stored position.
 - q) Place selector lever in "LOCK" position.
 - r) Enter exposure in log on Branch Radiographic Equipment Exposure Log.
3. Instructions for sealing and placing radiographic device in storage area. After final exposure has been made and survey of the radiographic device and work area is made to assure the source is in the safe stored position:

Section 2

BR 70-12-1

Rev. 2

3-30-84

- a) Place selector in the "LOCK" position.
- b) Disconnect source guide tube and replace safety plug.
- c) Turn selector lever to "CONNECT" position.
- d) Disconnect source from control cable.
- e) Replace end protector on selector lever and turn to "LOCK" position.
- f) Push down lock and remove key.
- g) Replace end protector on end of control cable.
- h) Take final reading on exposure device and place in storage area.
- i) Log date and time of return to vault in Equipment Exposure Log.
- j) Turn off survey meter.

Section 2

BR 70-12-1

Rev. 2

3-30-84

EMERGENCIES:

1. An emergency exists when the source cannot be returned to the normal safe condition in the radiographic device. No attempt shall be made to approach the source or change the conditions. A barricade shall be erected to prevent unauthorized persons from entering the radiation area. This area shall be guarded at all times until the condition is rectified.
2. If the pocket dosimeter of the radiographer is reading off scale, the radiographic operation shall be terminated and the source secured in the radiographic device.

In all cases of emergencies one of the persons mentioned below shall be immediately notified, who in turn will take necessary action:

- | | | |
|----|-----------------------|---------------------------------|
| a) | William H. Branch Sr. | Branch Radiographic Labs., Inc. |
| | Home Phone: | (201) 232-4963 |
| | Business Phone: | (201) 272-5743 |
| b) | Peter J. Branch | Branch Radiographic Labs., Inc. |
| | Home Phone: | (201) 755-1028 |
| | Business Phone: | (201) 272-5743 |
| c) | William H. Branch Jr. | Branch Radiographic Labs., Inc. |
| | Home Phone: | (201) 225-2721 |
| | Business Phone: | (201) 272-5743 |

Section 2

BR 70-12-1
Rev. 2
3-30-84

- d) Daniel F. Dodd NDT Supervisor
Home Phone: (609) 935-5682
Business Phone: (609) 935-1437
- e) Technical Operations
Burlington, Mass. (617) 272-2000

Any theft or evidence of tampering with the equipment and material used for radiography shall be reported to William H. Branch Sr., immediately upon discovery. A complete report of any unusual circumstances shall be made to the licensee.

RADIATION LEVEL/DISTANCE CHART A

Iridium-192 (unshielded)

5 curies		10 curies		15 curies		20 curies	
feet	mR/hr	feet	mR/hr	feet	mR/hr	feet	mR/hr
1.0	29500	1.0	59000	1.0	88500	1.0	118000
16.0	100	24.3	100	29.7	100	34.4	100
*35.0	24.1	*35.0	48.2	*35.0	72.2	*35.0	96.3
76.8	5	108.6	5	133.0	5	153.6	5
121.5	2	171.8	2	210.4	2	242.9	2

25 curies		30 curies		35 curies		40 curies	
feet	mR/hr	feet	mR/hr	feet	mR/hr	feet	mR/hr
1.0	147500	1.0	177000	1.0	206500	1.0	236000
*35.0	120.4	*35.0	144.5	*35.0	168.6	*35.0	192.6
38.4	100	42.0	100	45.4	100	48.6	100
171.7	5	188.1	5	203.2	5	217.2	5
271.6	2	297.5	2	321.3	2	343.5	2

45 curies		50 curies		55 curies		60 curies	
feet	mR/hr	feet	mR/hr	feet	mR/hr	feet	mR/hr
1.0	265500	1.0	295000	1.0	324500	1.0	354000
*35.0	216.7	*35.0	240.8	*35.0	264.7	*35.0	289.0
51.5	100	54.3	100	57.0	100	59.5	100
230.4	5	242.8	5	254.7	5	266.1	5
364.3	2	384.0	2	402.8	2	420.7	2

65 curies		70 curies		75 curies		80 curies	
feet	mR/hr	feet	mR/hr	feet	mR/hr	feet	mR/hr
1.0	383500	1.0	413000	1.0	442500	1.0	472000
*35.0	313.1	*35.0	337.1	*35.0	361.2	*35.0	385.3
61.9	100	64.3	100	66.5	100	68.7	100
276.9	5	287.4	5	297.5	5	307.2	5
437.9	2	454.4	2	470.4	2	485.8	2

85 curies		90 curies		95 curies		100 curies	
feet	mR/hr	feet	mR/hr	feet	mR/hr	feet	mR/hr
1.0	501500	1.0	531000	1.0	560500	1.0	590000
*35.0	409.4	*35.0	433.5	*35.0	457.5	*35.0	481.6
70.8	100	72.8	100	74.9	100	76.8	100
316.7	5	325.9	5	334.8	5	343.5	5
500.7	2	515.3	2	529.4	2	543.1	2

105 curies		110 curies		115 curies		120 curies	
feet	mR/hr	feet	mR/hr	feet	mR/hr	feet	mR/hr
1.0	619500	1.0	649000	1.0	678500	1.0	708000
*35.0	505.7	*35.0	529.8	*35.0	553.9	*35.0	557.9
78.7	100	80.6	100	82.4	100	84.1	100
352.0	5	360.3	5	368.4	5	376.3	5
556.5	2	569.6	2	582.4	2	595.0	2

* Average cranking distance (control box to free end of guide tube)

RADIATION LEVEL/DISTANCE CHART B

Cobalt-60 (unshielded)

5 curies		10 curies		20 curies		30 curies	
feet	mR/hr	feet	mR/hr	feet	mR/hr	feet	mR/hr
1.0	72000	1.0	144000	1.0	288000	1.0	432000
26.8	100	37.9	100	*40.0	180	*40.0	270
*40.0	45	*40.0	90	53.7	100	65.7	100
120.0	5	169.7	5	240.0	5	293.9	5
189.7	2	268.3	2	379.5	2	464.7	2

40 curies		50 curies		60 curies		70 curies	
feet	mR/hr	feet	mR/hr	feet	mR/hr	feet	mR/hr
1.0	576000	1.0	720000	1.0	864000	1.0	1008000
*40.0	360	*40.0	450	*40.0	540	*40.0	630
75.9	100	84.5	100	92.9	100	100.4	100
339.4	5	379.4	5	415.7	5	449.1	5
536.6	2	600.0	2	657.3	2	709.9	2

80 curies		90 curies		100 curies		110 curies	
feet	mR/hr	feet	mR/hr	feet	mR/hr	feet	mR/hr
1.0	1152000	1.0	1296000	1.0	1440000	1.0	1584000
*40.0	720	*40.0	810	*40.0	900	*40.0	990
107.3	100	113.8	100	120.0	100	125.8	100
480.0	5	509.1	5	536.6	5	562.8	5
758.9	2	805.0	2	848.5	2	890.7	2

* Average cranking distance (control box to free end of guide tube)

Section 3

BR 70-12-1

Rev. 2

3-30-84

INSPECTION AND MAINTENANCE OF EQUIPMENT:

All equipment shall be cleaned and/or repaired in accordance with the manufacturer's maintenance instructions.

Any major repairs that have to do with the source shield shall be made by Technical Operations

Inspection of radiographic devices shall be made before each use and at (3) month intervals and/or at source changes or at any occasion the radiographer notices any change in the operating characteristics.

The form which constitutes page 3 of this section shall be filled out before the use of each machine and at the time of periodic inspections.

The following items shall be checked and a record kept of any necessary repairs:

1. Changes in the operating characteristics of the device.
2. Proper operation of the crank mechanism.
3. Proper operation of source position indicator mechanism.
 - a) Light indicators
 - b) Odometer indicator
4. Proper operation of the locking mechanism.
5. Source and drive-cable wear or damage.
6. Damaged or worn source and drive-cable tube.
7. Connector wear or damage (this item shall be checked before each use of the radiographic device.)

Section 3

BR 70-12-1

Rev. 2

3-30-84

8. Rust, dirt or sludge buildup in the source guide tubes.
9. Shifting of the shield inside the projector housing.
10. Proper connection of all mating components.
11. Cable drive gear-box damage and wear.
12. Proper positioning of source inside the shield.
13. Proper labeling.
14. Miscellaneous (screws, safety caps, legs)

Any damage to any radiographic device which may impair its operation shall be reported immediately and rectified before the device is put back into operation. All damage of this nature will be reported immediately to William H. Branch Sr. or in his absence, Peter J. Branch or William H. Branch Jr., who shall take the proper steps to see that the condition is rectified.

Section 3

MAINTENANCE REPORT

BR 70-12-1

Rev. 2

3-30-84

Machine Serial #	Crank Serial #	Date Inspected	Date Due
Inspection			Comments
1. Changes in operating characteristics of the device			
2. Proper operation of the crank mechanism			
3. Proper operation of source position indicator mechanism			
4. Proper operation of the locking mechanism			
5. Source and drive-cable wear or damage			
6. Damaged or worn source and drive cable tube			
7. Connector wear or damage (to be checked before and after each use of the radiographic device)			
8. Rust, dirt or sludge build up in the source guide tubes			
9. Shifting of the shield inside the projector housing			
10. Proper connection of all mating components			
11. Cable drive gear-box damage and wear			
12. Proper positioning of source inside shield unit			
13. Proper labeling			
14. Miscellaneous (Loose screws, safety caps, legs, etc.)			

Any damage to radiographic equipment which may impair its operation will be reported immediately to William Branch, Peter J. Branch, or William H. Branch, Jr.

Inspected By _____

Approved By _____

Section 3

BR 70-12-1

Rev. 2

3-30-84

INSPECTION AND MAINTENANCE PROCEDURES:

- A. Daily inspection of radiographic devices shall be performed by the radiographer before each use. The results of this inspection shall be logged on Branch Radiographic's "Maintenance Report".

The following order shall be used in performing the above maintenance:

1. Unwind the crank mechanism.
2. Feel the outside surface of the cable for any cuts, bruises, excessive roundness or flat configurations.
3. Check the outside surface of the crank mechanism for loose bolts and position of the odometer and or light mechanism. Check the nuts on the ends of the outside cable of drive cable to be sure they are tight.
4. Remove the end protector of the drive cable. Take the Technical Operations 550 connector gage and check the cable for excessive wear. Wind approximately 2 feet of drive cable out of its protective casing and inspect for dirt and frays.
5. Take radiation survey of camera to be used to check for any sign of abnormal radiation leakage (anything over 200 mr/hr for a new source of maximum capacity at the surface of the camera).

Section 3

BR 70-12-1

Rev. 2

3-30-84

6. Unlock locking mechanism on back of camera. Turn connector selector ring to connect, take the Technical Operations 550 connector gage and check the female connector on the back of the camera.
7. Leaving the safety plug in the camera, connect the control cable to the source. Feel the tension on the spring loaded locking pin. Be sure there is no dirt buildup and the locking pin does have tension on it. Look at connector for chipped edges. Tug lightly at connection to be sure connectors are properly mated.
8. Take the control cable collar and hold it flush against the projector connector and rotate the selector ring from the "CONNECT" position to the "LOCK" position.
9. Turn selector ring to operate and then turn back to lock and connect. Make sure the selector ring turns easily and the control cable connector springs back when the selector ring comes to connect.
10. Disconnect the control cable from back of camera.
11. Replace protective cover on control cable.
12. Replace protective cover on back of camera and turn selector ring to lock. Lock Camera.
13. Remove safety plug and look at threads for any possible dirt buildup. Do not look directly into front of camera or stand in front of camera with safety plug removed. Replace safety plug.

Section 3

BR 70-12-1
Rev. 2
3-30-84

14. Take a survey of camera at 1 meter and log it in the Radiographic Equipment Exposure Log.
15. Check all tags and markings on camera.
16. Take source guide tubes and check all mating ends for metal burrs and stripped threads or dirt buildup.
17. Run hands on outside surface of the guide tubes to check for flat spots, out of round, or twists and cuts in outer casings.
18. Pull slightly on all swedged fittings to make sure they are secure.

B. Quarterly maintenance shall be performed by radiographers and their assistants on all radiographic devices at intervals not to exceed three months. The results and the required repairs shall be logged on Branch Radiographics "Maintenance Report". The following shall be inspected and serviced in the manner prescribed below:

1. Unwind control cable and remove the end protector. Check the male end connector of the drive cable with Technical Operation 550 connector gage.
2. Take isotope projector from storage vault and make radiation survey.

Section 3

BR 70-12-1

Rev. 2

3-30-84

3. Hook up projector (IR-192 Units Only) as specified in procedure for source changer.
 - 3a) Co 60 sources will not be removed from projector for maintenance purposes by Branch personnel. If it becomes necessary in the opinion of Peter J. Branch that the source has to be removed, Technical Operations will be called in or their representative.
4. Crank source into changer, take radiation survey and disconnect source from control cable.
5. Retract source drive cable.
6. Check projector with survey meter.
7. Check source changer with survey meter.
8. Disconnect control cable from back of isotope projector.
9. Crank the control cable out of the control cable housing into a bucket, with a small amount of solvent in it, by turning the control handle in the exposed direction. Wind cable in a circular motion so it forms a circle on the bottom of the bucket.
10. When cable releases itself from the crank, pull it out of the control cable housing by hand. Maintain the circular motion on the cable so the control cable still forms a circle on the bottom of the bucket.
11. Let cable soak in bucket of degreasing solvent until all foreign matter which may be accumulated is removed.

Section 3

BR 70-12-1
Rev. 2
3-30-84

12. Remove control cable housing from crank and control cable cover by loosening the fittings. Take some degreasing solvent and pour it through the cable housing until the fluid coming through is free of impurities.
13. Dry cable inside and out by using compressed air or air stream from a vacuum cleaner. Under no circumstances should air pressure exceed fifteen pounds.
14. Pour off solvent from control cable and replace with fresh, make sure cable is clean. Remove all solvent from bucket and let cable air dry for approximately fifteen minutes.
15. Remove cover from gear mechanism on crank, remove gear and check for chipped or excessively worn gear teeth. Remove all grease from inside of housing. While doing this, check for metal chips which may be a part of the gear or drive cable, check for score marks on inside of housing.
16. Wipe inside of housing clean with solvent and dry off.
17. Check for any dirt and grime. When you are satisfied housing is clean take some Texaco Unitemp grease and put a light coat on the gear teeth and a small amount on the inside surface of the gear housing on the edge where the drive cable will pass over.
18. Reassemble the gear mechanism.
19. Reassemble the drive cable housing mechanism.

Section 3

BR 70-12-1
Rev. 2
3-30-84

20. Take terminated end of the drive cable and start feeding the cable into the drive cable housing. While doing this take a small amount of Texaco Unitemp grease and apply it to the cable. Give the cable a careful visual inspection while feeding the drive cable into the housing.
21. When the drive cable reaches the gear mechanism have the assistant radiographer turn the crank slowly in the retract direction while you continue the greasing and inspection of the drive cable.
22. With the cable in the fully retracted position, reset the odometer or check the light mechanisms whichever is applicable.
23. Replace end protector.
24. Log all necessary repairs and maintenance performed on Branch Radiographics "Maintenance Log".
25. Look into exitport and check for alignment of shield source tube with female connector on the front end of the projector. Warning: Do not look into or stand in front of the projector with a source in it. If the tube is misaligned notify William H. Branch Sr., Peter J. Branch or William H. Branch Jr. immediately in order to make arrangements with Technical Operations to have the necessary adjustments made.

Section 3

BR 70-12-1
Rev. 2
3-30-84

26. Check the locking mechanism for any dirt buildup and clean if necessary.
27. Pour a small amount of solvent through the front of the projector. Do this over a clean pan. Check the solvent coming out for any metallic pieces. If any are found, do not touch these with your hands. Notify William Branch Sr., Peter Branch or William Branch Jr. immediately. They will make the necessary checks and evaluation to ascertain they are not radioactive, (part of the shield assembly).
Pour solvent through tube until it is clean.
28. Dry out mechanism with forced warm air.
29. Hook up cranking mechanism.
30. Hook up dummy source in camera.
31. Put on maximum length of cleaned out source guide tubes with blank end or signal whichever is applicable.
32. Expose dummy source and retract several times to make sure machine feels mechanically proper and source position indicator is proper.
33. Odometer is working properly.
34. Check for loose screws.
35. Check labeling on machine.
36. Remove dummy source from camera.

Section 3

BR 70-12-1

Rev. 2

3-30-84

37. Reload projector with the source. Take survey for radiation levels. Disconnect source guide tubes and replace safety plug.
38. Disconnect crank mechanism.
39. Check the male end of the source drive cable and the female end of the source connector using Technical Operations 550 connector gage.
40. Replace end protector on drive cable and put into storage.
41. Replace end protector on projector and lock mechanism.
42. Take radiation survey and put projector into storage.
43. Log necessary repairs that were made on Branch Radiographic Maintenance Report.
44. Take source guide tubes and check ends for burrs and crushed threads.
45. Feel cables for flat spots twists and deep cuts.
46. Place a small amount of solvent into cables and shake, empty cable of solvent. Repeat this process until solvent comes out clean.
47. Blow clean warm dry air through the source tubes until they are dry.
48. Connect the male and female end of each individual hose together and hang up.
49. Take guide hose with source switch or snub end and replace protective cover on the male end.
50. Replace source guide tubes in storage area.

Section 4

BR 70-12-1
Rev. 2
3-30-84

PROCEDURE FOR THE USE AND STORAGE OF THE T. O. MODEL 520
CO 60 EXPOSURE DEVICE IN CONJUNCTION WITH T. O. MODEL 657

EXPOSURE CONTROL

PURPOSE:

The purpose of this procedure is to establish safe uniform operational conditions to prevent unnecessary over exposure to personnel.

EQUIPMENT:

Exposure Device

The exposure device consists of a lead filled steel shell which contains the radioactive source. This device is trunnion mounted to allow it to be properly positioned for the purpose of taking radiographs. The face of this exposure device has a 60° conical beam limiting device. In the center of this device is positioned the locking safety shipping plug. A face plate with an electrical contact is provided with this unit in order to limit the source travel to the base of the 60° conical beam limiting device. Another adjustable beam limiting device (manually operated) is attached to the front of the shield to permit the limiting of radiation to the desired exposure area. The unit may also be used with guide hoses. However, the use of this procedure is prohibited except for the purpose of placing the source in a source changer if necessary. This procedure will be performed by Technical Operations or their authorized representative only.

Section 4

BR 70-12-1
Rev. 2
3-30-84

Exposure Control

The exposure control used on this device is the Technical Operations Automatic Exposure device Model 657 it is connected to the shielding device by the source drive cable and the electrical control cable. The drive cable is activated by a 115VAC reversible electric motor, built into a large metal box housing all control elements and indicators. The following items are located on the face of the control box:

1. Power lock with key.
2. Power "ON" indicator.
3. "Door Open" indicator
4. "Set Timer" indicator
5. Timer
6. "Stored" indicator
7. "Transit" indicator
8. "Exposing" indicator
9. Expose switch
10. Retract switch
11. Excess torque indicator

On the side of the control box is located a manual crank arrangement in case of a power failure.

Section 4

BR 70-12-1
Rev. 2
3-30-84

OPERATING PROCEDURE FOR T. O. 520 EXPOSURE DEVICE

1. General Instructions

- a) Check radiographic exposure device with survey instrument at all times when in exposure room.

2. Instructions For Operation

- a) Make a survey of radiographic exposure device.
- b) Position object to be radiographed.
- c) Remove locking safety plug and replace with face plate that creates the 60° conical beam limiting device. Once locking safety plug is removed the person making the connection will not allow himself to be distracted until the face plate is installed.
- d) Check area gamma alarms to see if they are operational.
(Is green light lit?)
- e) Remove all personnel from area.
- f) Close gate with safety interlock system.
- g) Insert key in power lock and turn clockwise activating control panel. Stored indicator should be lit.
- h) Set Timer
- i) Press Expose Switch.

The control panel shall show the following sequence:

"Stored" indicator shall change to "Transit" and finally to

Section 4

BR 70-12-1
Rev. 2
3-30-84

"Exposing" when the source arrives at the switch. The Stored and Transit lights shall be extinguished when Exposing light is illuminated. The timer shall then start to function.

- j) Make a survey of area.
- k) Upon completion of the exposure time, the source will retract to the stored position and the "Stored" indicator shall be illuminated.
- l) Turn off power key and pocket it.
- m) Open gate with survey meter in hand and survey area as approaching exposure device and finally survey exposure device itself.
- n) If the "Excess Torque" indicator lights and the "Transit" indicator is illuminated before the "Exposing" indicator is illuminated push the "Retract" button and return the source to the "Stored" position. Exposure device is malfunctioning. Before proceeding enter room with survey meter and survey area. If area is safe check exposure device and control cables for the cause of the malfunction - i. e. too sharp a bend of the control cables. When cause of malfunction is corrected return to paragraph (d) of procedure and proceed.

Section 4

BR 70-12-1

Rev. 2

3-30-84

3. Storage Of Unit

After final exposure and source is in stored position:

- a) Turn off power key and pocket it.
- b) Open gate with survey meter in hand and survey area as approaching exposure device and finally survey exposure device itself.
- c) Remove the 60° conical beam limiting device and replace the locking safety plug.
- d) Leave exposure room and secure gate.

Section 4

BR 70-12-1
Rev. 2
3-30-84

MAINTENANCE OF T. O. MODEL 520 EXPOSURE DEVICE AND MODEL
627 AUTOMATIC EXPOSURE CONTROL

This equipment shall be cleaned internally yearly by Technical Operations and repaired as required by Technical Operations.

Inspection of this equipment shall be made before each use, at three month intervals, and at any occasion the radiographer notices any change in the operating characteristics.

The form which constitutes page 8 of this procedure shall be filled out before each use of this machine and at the time of periodic inspections.

Source drive cable, source connections, and internal working devices of the shield shall be checked and cleaned on a yearly basis by Technical Operations.

The following items shall be checked and a record kept of any necessary repairs:

1. Changes in the operating characteristics of the device.
2. Proper operation of the drive mechanism.
3. Proper operation of the source position indicator mechanisms.
4. Proper operation of lock mechanism.

Section 4

BR 70-12-1

Rev. 2

3-30-84

5. Source and drive-cable wear or damage
(yearly by Technical Operations)
6. Damaged or worn drive cable tube (Outer casing
daily) (Inner yearly by Technical Operations)
7. Source and drive cable connectors
(yearly by Technical Operations)
8. Proper connection of all mating components.
9. Cable drive gear-box damage and wear
(check for damage daily and wear quarterly)
10. Proper positioning of source inside shield.
11. Proper labelling
12. Miscellaneous (screws, bolts)

Any damage to this radiographic device which may impair its operation shall be reported immediately and rectified before the device is put back into operation. All damage of this nature will be reported immediately to William H. Branch Sr., or in his absence Peter J. Branch, or William H. Branch Jr., who shall take the proper steps to see that the condition is rectified.

BRANCH RADIOGRAPHIC LABORATORIES, INC.

RADIOGRAPHIC INSPECTIONS AND SERVICES

Section 4

28 SOUTH AVENUE W.

CRANFORD, N.J.

272-5743

MAINTENANCE REPORT

BR 70-12-1

Rev. 2

3-30-84

MACHINE SERIAL #

CRANK SERIAL #

DATE INSPECTED

DATE DUE

INSPECTION	COMMENTS
1. Changes in operating characteristics of the device	
2. Proper operation of the drive mechanism	
3. Proper operation of source position indicator mechanisms	
4. Proper operation of the lock mechanism	
5. Source and drive-cable wear or damage (yearly by Technical Operations)	
6. Damaged or worn source and drive cable tube outer casing daily (Inner yearly by Technical Operations)	
7. Source and drive cable connectors (yearly by Technical Operations)	
8. Proper connection of all mating components	
9. Cable drive gear-box damage and wear (Checked for damage daily and wear quarterly)	
10. Proper positioning of source inside shield	
11. Proper labelling	
12. Miscellaneous (Loose screws)	

Any damage to radiographic equipment which may impair its operation will be reported immediately to William H. Branch Sr., Peter J. Branch, or William H. Branch Jr.

INSPECTED BY

APPROVED BY

Section 4

BR 70-12-1
Rev. 2
3-30-84

OPERATION OF SAFETY INTERLOCK SYSTEM

The safety interlock system combines a Techops model 492 gammalarm and a safety interlock control similar to Technical Operations model 748.

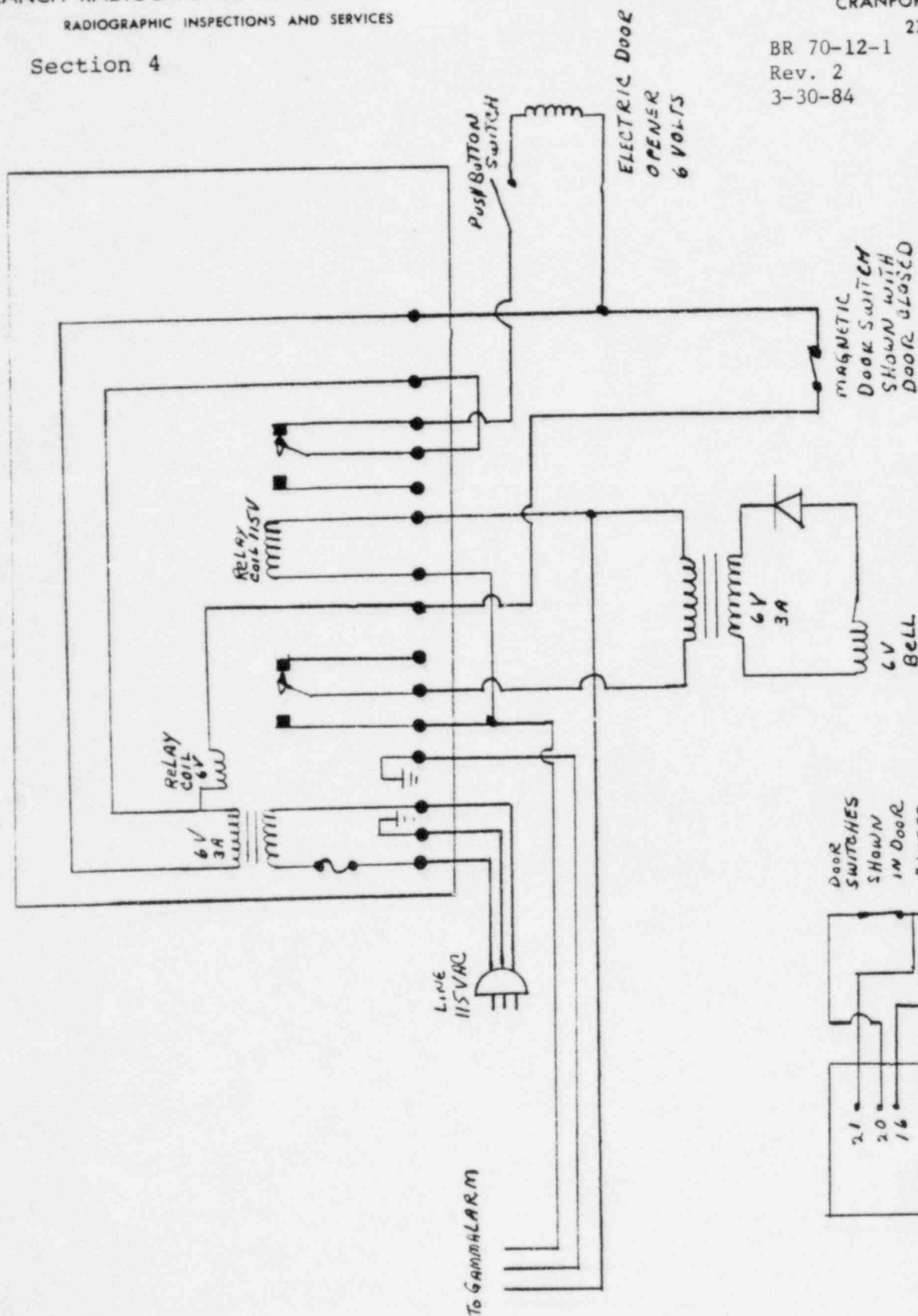
When the exposure room door is open and no radiation is present, the alarm bell is quiet and the Technical Operations model 657 control will not operate. When the exposure room door is closed and no radiation is present the alarm bell is quiet, the 657 control can be operated, and the exposure room door can be opened with the push button. When the exposure room door is closed and radiation is present (source exposed) the alarm bell will ring if door is opened and the 657 control will retract the source. In this condition the exposure room door cannot be opened with the push button but can be opened from the inside at anytime.

BRANCH RADIOGRAPHIC LABORATORIES, INC.
RADIOGRAPHIC INSPECTIONS AND SERVICES

28 SOUTH AVENUE W.
CRANFORD, N. J. 07016
272-5743

Section 4

BR 70-12-1
Rev. 2
3-30-84



SAFETY INTER LOCK SYSTEM

Section 4

BR 70-12-1
Rev. 2
3-30-84

DETERMINATION OF EXPECTED RADIATION
LEVELS OUTSIDE OF EXPOSURE ROOM

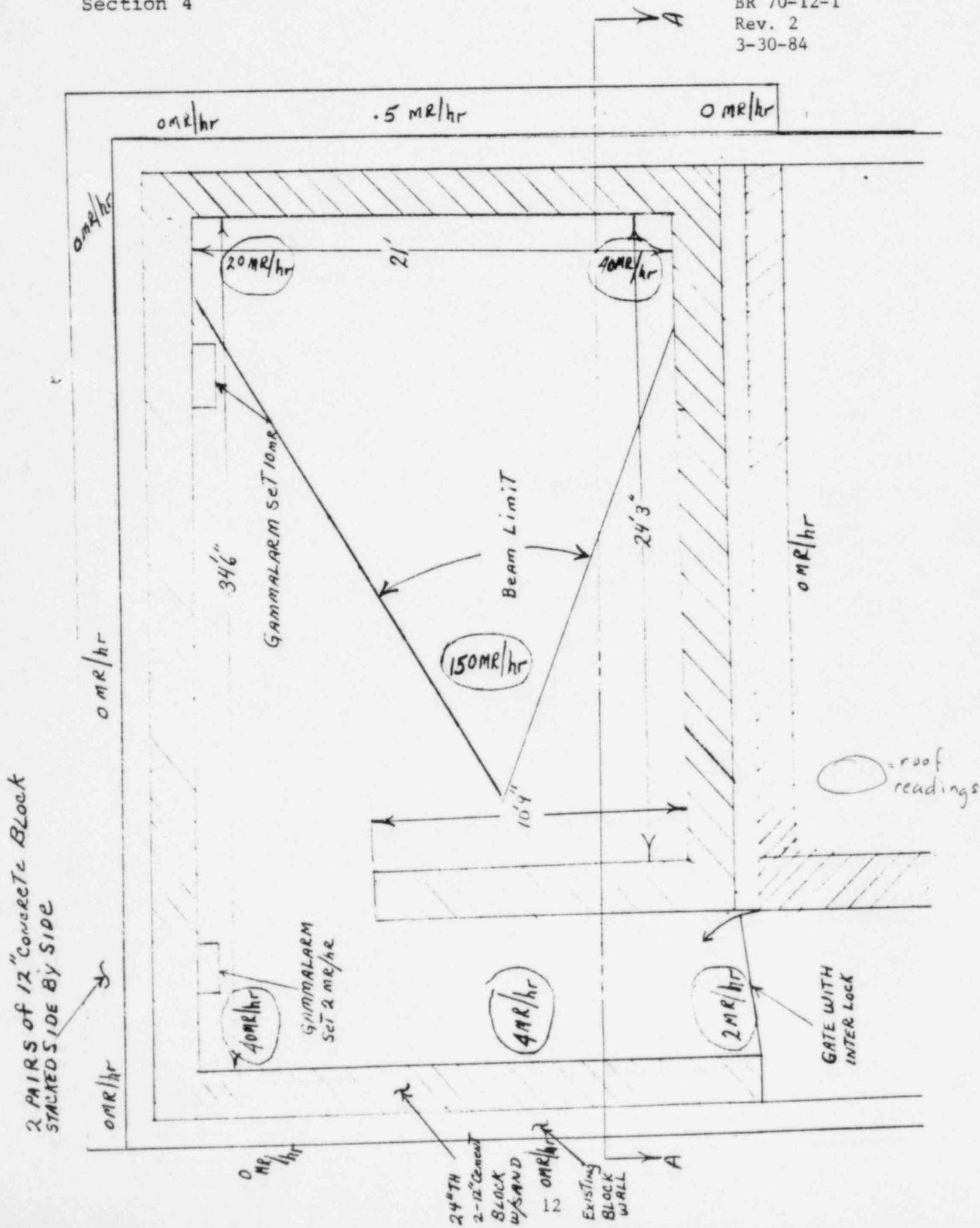
Radiation readings were taken using 100ci of Co 60 exposed using a Technical Operations model 719 depleted uranium collimator with a lead forward throw insert at a height of 80" pointed at the floor. Radiation readings taken outside the exposure room indicated a maximum reading of 4 mr/hr at an outside wall. Multiplying this reading by 2.5 to compensate for a 250ci Co 60 source gives an estimated 10 mr/hr at this outside wall. By adding an additional two pallets of concrete block to the outside walls as shown in the attached drawing the expected radiation levels will be down to .3 mr/hr. Once the 250ci Co 60 source is installed additional readings will be taken and the shielding modified to comply with NRC limits.

BRANCH RADIOGRAPHIC LABORATORIES, INC.
RADIOGRAPHIC INSPECTIONS AND SERVICES

28 SOUTH AVENUE W.
CRANFORD, N. J. 07016
272-5743

Section 4

BR 70-12-1
Rev. 2
3-30-84



BRANCH RADIOGRAPHIC LABORATORIES, INC.

RADIOGRAPHIC INSPECTIONS AND SERVICES

Section 4

28 SOUTH AVENUE W.

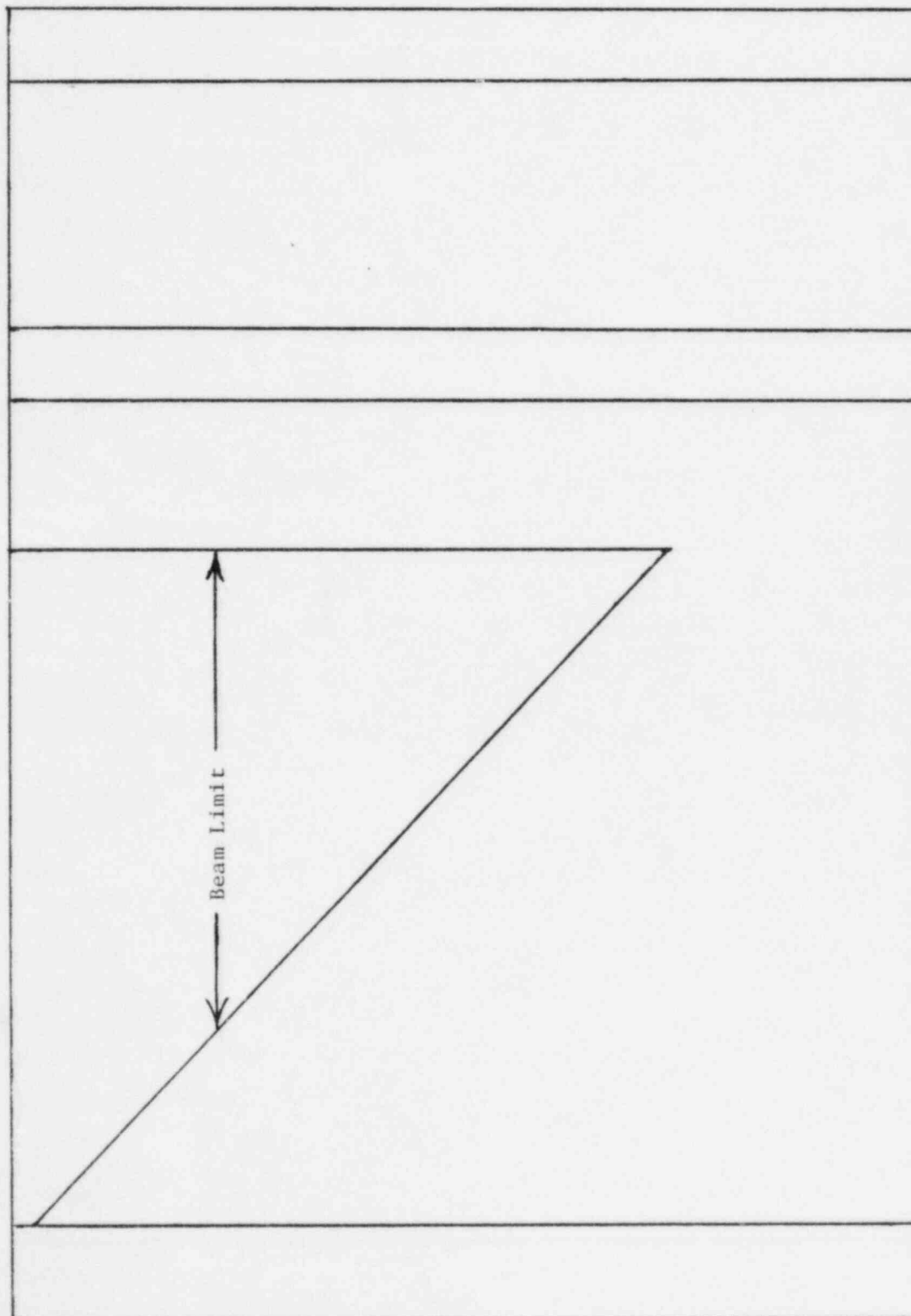
CRANFORD, N.J.

272-5743

BR 70-12-1

Rev. 2

3-30-84



Roof

Section A

APPENDIX "A"

<u>RADIOGRAPHERS:</u>	<u>SOCIAL SECURITY NO.</u>	<u>DATE OF BIRTH</u>
William H. Branch	158-01-8330	03-05-19
William H. Branch Jr.	149-28-3258	06-09-38
Peter J. Branch	144-30-6812	05-12-41
Jeffrey Benson	222-46-0304	12-13-57
Gary Biddle	158-52-2534	08-08-58
Daniel Dodd	022-28-8760	12-14-39
Butch Ehmann	145-23-4295	07-13-44
Mark Koch	155-38-8166	02-13-58
Robert LoCorriere	153-46-8778	05-30-55
John Marti	156-48-3722	03-03-54
Michael Oliveri	353-50-8158	09-28-58
Brent Wallace	149-50-6644	09-07-54
Michael Wish	223-68-0053	01-11-46
David Mora	156-60-6875	10-20-61
Jerry Banger	143-46-2138	04-11-58
Steven Gorman	141-50-1674	08-20-53
<u>RADIOGRAPHERS ASSISTANTS:</u>		
William P. Branch	153-58-2515	07-18-63
Gary Dohanish	148-35-3550	05-08-45
James DiMarzio	135-60-3811	07-22-60
Michael DeLuca	147-54-1670	06-24-59
Ronald Evans	146-52-7541	07-12-56
Scott Beckman	156-62-2703	09-29-59
Joseph McFadden	151-68-4619	06-10-64
Steven Uhrick	221-30-9003	03-10-58

APPENDIX "B"

CALIBRATION OF SURVEY METERS

- A. Calibration of survey meters shall be performed at intervals of not greater than (3) months.

Meters shall be calibrated by an authorized outside laboratory such as:

Technical Operations, Burlington, Massachusetts

Eberline Instrument Corporation, Santa Fe, New Mexico

or by the use of Technical Operations Model 571 Calibration Kit.

Calibration of survey meters at Branch Radiographic Labs., Inc. shall be performed by the following Branch personnel only:

Peter J. Branch

William H. Branch Jr.

William H. Branch Sr.

It shall be performed in accordance with the instructions in subsection B of Appendix "B".

Each meter shall be checked at two points on each scale. Adjustments shall be made when necessary so that the meter shall read within a range of plus or minus 20%.

Survey meters which cannot be calibrated shall be returned to the manufacturer for repair.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "B"

A record shall be kept of the calibration of each meter and a tag fastened to the meter with the date of calibration and due date for calibration.

B. Procedure for the calibration of survey meters.

1. Set Technical Operations Model 571 calibration unit on calibration board.
2. Take readings off dose/distance calibrator mounted on the side of the unit for distance which will produce meter readings at the following points: 750 mr, 250 mr, 75 mr, 25 mr, 7.5 mr, 2.5 mr
3. Using the roll up rule mounted on the side of the unit, set proper distance for calibrator to meter.
4. Stand behind calibrator and unlock unit.
5. Move carrying handle from over the control rod and raise to expose meter. (Meter should be exposed a minimum of 15 seconds).
6. Take meter reading. (If it is within 20% of expected value, no adjustment is necessary. If meter reads out of this range, secure calibration rod in the "SAFE" position and adjust meter until it reads properly).
7. Record reading on Meter Calibration Sheet (See page 4 of this appendix).
8. Repeat procedure steps (3) thru (7) for each reading on each scale of survey meter.
9. After calibration is complete, replace carrying handle over source rod and lock into place securing the Technical Operations 571 unit in its safe stored position.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "B"

10. Replace Technical Operation 571 calibration unit in its storage place. (Isotope Vault)

APPENDIX "B"

BR 70-12-1
Rev. 2
3-30-84

METER CALIBRATION CERTIFICATE

CUSTOMER _____

ADDRESS _____

MODEL NO. _____ SERIAL NO. _____

CALIBRATION DATE _____

	<u>TRUE FIELD</u>	<u>RESPONSE</u>	<u>% ERROR</u>
RANGE X	2.5 mr/hr	_____	_____
	7.5 mr/hr	_____	_____
RANGE X	25 mr/hr	_____	_____
	75 mr/hr	_____	_____
RANGE X	250 mr/hr	_____	_____
	750 mr/hr	_____	_____

The above instrument was calibrated with a Cobalt 60 source. Nuclear Regulatory Commission regulations require that it be re-calibrated within three (3) months.

BRANCH RADIOGRAPHIC LABS., INC.

BY: _____

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "C"

TRAINING OF PERSONNEL:

A. Training of personnel at Branch Radiographic Laboratories shall be given in accordance with Appendix "I" Table 1 of BR 70-12-1 for assistant radiographers and Appendix "I" Table 2 for radiographers.

Candidates to become assistant radiographers shall be given a written examination consisting of thirty (30) questions taken from the list of questions submitted as Appendix "I" Article 1. Five (5) questions shall be taken from each major category I thru VI of Article 1. A minimum grade of 80% shall be maintained to qualify as an assistant radiographer. No more than two (2) questions may be missed in any one category. If it is recognized by the examiner that a candidate who has missed qualifying as an assistant radiographer by one question because of misunderstanding, he shall be allowed the option of asking the question of the candidate orally and upgrading his examination if he answers it successfully. Upon successful completion of the examination the candidate's name shall be placed in Appendix "A" of BR 70-12-1.

If the candidate has been unsuccessful in the examination, he shall be instructed in the areas of weakness and allowed to be re-examined after a period of thirty (30) days. If successful, his name shall be placed in Appendix "A" of BR 70-12-1. If unsuccessful on the second examination, the candidate will be considered as incapable and not allowed to perform as an assistant radiographer or radiographer.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "C"

B. Upon successful completion of examination to become an assistant radiographer, the candidate shall serve an apprenticeship of a minimum of three (3) months. During this period they shall have on-the-job training in which they will learn the procedures set forth in BR 70-12-1 and the requirements of Part 20 and 34 of the Code of Federal Regulations. After the minimum of three (3) months, the assistant radiographer will be given classroom review for a minimum of sixteen (16) hours as given in Appendix "I" Table 2.

Testing of radiographers shall be accomplished as follows:

1. The candidate will be given a written examination consisting of fifty (50) questions from Article 1 category I thru VI. The minimum percentile grade for qualification shall be 80%. There will be no oral upgrading involved with this examination.

2. The candidate will be given a practical examination consisting of check points as defined in Appendix "I" Article 2. A percentile grade of 90% must be obtained for qualification as a radiographer.

3. If the candidate is unsuccessful, he will receive an additional training period of not less than thirty days and further instruction in the areas of his weakness before re-examination.

It has been recognized by Branch Radiographic Labs., Inc. that candidates, although they can pass a written examination, do not fully understand the responsibilities set forth upon them when they become radiographers. It has therefore been found desirable to examine each candidate individually in an informal atmosphere to gain an insight to the candidate's knowledge and attitude.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "C"

This examination shall take place without the candidate's knowledge. This examination and all others shall be given by William H. Branch Sr., Peter J. Branch, or William H. Branch Jr. and shall cover the candidate's knowledge and attitude concerning Federal Regulations and Procedures set forth in BR 70-12-1.

Upon successful completion of the above examination, the candidate's name shall be placed in Appendix "A" of BR 70-12-1 as a radiographer.

C. Personnel who become a part of the Branch Radiographic group from another laboratory, which has had previous training, will receive additional training as outlined in Table 1 of Appendix "I". He will then be given a written examination consisting of fifty (50) questions taken from the list of questions submitted in Appendix "I" Article 1 and a practical per Article 2. A minimum grade of 80% shall be maintained to qualify as a radiographer. If it is recognized by the examiner that a candidate who has missed qualifying as a radiographer by one question because of a misunderstanding, he shall be allowed the option of asking the question of the candidate orally and upgrading his examination if he answers it successfully. Upon successful completion of the examination, the candidate's name shall be placed in Appendix "A" of BR 70-12-1.

If the candidate has been unsuccessful in the examination, he shall be instructed in the areas of weakness and allowed to be re-examined after a period of thirty (30) days. If successful, his name shall be placed in Appendix "A" of BR 70-12-1.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "C"

D. Periodic and refresher training shall take place on a quarterly basis. Subjects covered during this period shall be a review of radiation safety practices, problems which occur at different jobs and their resolution, and changes in regulations which may concern the radiographer and radiographer's assistant.

APPENDIX "C"

REFRESHER TRAINING PROGRAM
FOR PERSONNEL EMPLOYED BY
BRANCH RADIOGRAPHIC LABORATORIES, INC.

SCOPE: The purpose of this program is to insure that personnel performing radiographic inspection are informed of any changes in operating procedures and are consistently maintaining safe practices in the use of radiographic exposure devices.

1. Part "A" consists of a list of subjects which are pertinent aspects of radiation safety.
2. Part "B" consists of a training form which shows the date the training session was held, subjects covered, personnel attendance, and instructor. This form will be maintained as a permanent record.

BR 70-12-1
Rev. 2
3-30-84

Page 2 of 3

APPENDIX "C"

PART "A"

REFRESHER TRAINING (SUBJECTS):

Refresher training sessions shall include, but not be restricted to, the following subjects:

1. Protection of radiographers and radiographers' assistants.
CFR Title 10 Part 20.
2. Protection of workers on the job site.
3. Operating procedure for remote control radiographic devices.
4. Emergencies.
5. Inspection and maintenance of R.T. equipment (daily use).
6. Inspection and maintenance of R.T. equipment (quarterly).
7. Calibration of survey meters.
8. Transportation of radiographic devices.
9. Storage of sources.
10. Storage of personnel monitoring equipment.
11. Procedure for the use of dosimeters.
12. NRC record requirements.
13. Procedure for use of T.O. Model 518 Leak Test Kit.
14. Procedure for use of T.O. Model 650 Source Changer.

BRANCH RADIOGRAPHIC LABORATORIES, INC.
RADIOGRAPHIC INSPECTIONS AND SERVICES

28 SOUTH AVENUE W.
CRANFORD, N. J.

272-5743

APPENDIX "C"

BR 70-12-1

Rev. 2

3-30-84

PART "B"

REFRESHER TRAINING REPORT

DATE: _____

SUBJECT: _____

ATTENDANCE:

INSTRUCTOR:

REVIEWED BY:

(BRLI MANAGEMENT)

APPENDIX "D"

TRANSPORTATION OF RADIOGRAPHIC DEVICES:

1. When transporting radiographic devices, the following rules shall be followed in order to ensure safety in transportation.

a) Devices shall be checked with a survey meter to ensure radiation levels are at a normal level for the source contained in the device.

b) Devices shall be locked and all safety plugs in place before any movement is accomplished.

c) The device shall be placed in an area in the transporting vehicle that will restrict its movement so that excessive bouncing or possible damage will be avoided.

d) A survey shall be taken on the outside extremities and of the passenger compartments to assure that safe radiation levels for unrestricted areas are being observed. Radiation levels shall not exceed 1 mr/hr at any point on the outside surface or in the passenger compartment.

e) The front, back and sides of the transporting vehicle shall be placarded with the appropriate signs as specified in the Department of Transportation regulations in 49 CFR 170-178. The placards shall be of white background with black letters reading "Radioactive".

f) A survey meter will be carried in the front of the vehicle with the radiographer or his assistant while transporting the device.

g) In case of any accident involving the vehicle transporting by-product material (radiographic device), the persons listed in Section 2 under the paragraph "EMERGENCIES" shall be immediately notified.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "E"

STORAGE OF SOURCES AT TEMPORARY JOB SITES:

1. Storage of sources at temporary job sites shall be accomplished in the following manner.

a) Sources shall be stored in a locked container when stored in the vehicle in which they are transported. The key for this storage container shall be in the possession of the radiographer and his assistant. The vehicle shall be locked and the keys in the possession of the radiographer and his assistant. The outside of the vehicle shall be placarded with signs reading "Danger" or "Caution Radioactive Materials". All efforts are to be made to isolate the vehicle from public access. A radiation survey meter shall be maintained in the vehicle.

b) Storage at sites where a room or closet is available shall be accomplished in the following manner. Signs reading "Caution Radiation Materials" shall be posted on all entrances. "High Radiation Area" signs shall be posted inside the enclosure. The key for this enclosure shall be maintained by the radiographer, his assistant, and the shift supervisor of the plant after he has been briefed by the radiographer on what to do in case of fire or other emergency conditions. A radiation survey meter shall also be kept in this enclosure. No other personnel other than the persons mentioned above shall be allowed to enter this room without the direct supervision of the radiographer or his assistant.

BR 70-12-1

Rev. 2

3-30-84

APPENDIX "E"

c) Storage of sources at major job sites, such as Nuclear Power Plants, may be accomplished by storage in a concrete vault with a lock and hasp on it or a lead lined vault in the operations trailer. The concrete vault shall be maintained as close to the operations trailer as possible. Either kind of vault shall be placarded with "Caution Radioactive Material" signs. Keys for the vault and survey meters shall be kept in the operations trailer.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "F"

STORAGE OF PERSONNEL MONITORING EQUIPMENT:

1. The storage of personnel monitoring equipment at job sites shall be accomplished in the following manner.

a) Storage of the TLD badges and dosimeters at job sites shall be accomplished by placing the TLD badges and dosimeters in a small lead lined box away from any known radiation. A separate dosimeter shall be placed in the box to act as a control on the storage area.

b) Storage of the TLD badges and dosimeters at major job sites, such as Nuclear Power Plants, shall be accomplished by placing badges and dosimeters in the operations trailer with a separate control badge to account for any radiation which the badges may accidentally be exposed to in shipment.

APPENDIX "G"

PROCEDURE FOR THE USE OF DOSIMETERS:

1. Dosimeters shall be worn by all personnel during working hours.
Dosimeters shall be charged at the beginning of each work shift.
2. During production hours or when the radiographers and assistants are working with Gamma and/or X-rays, they are to take readings at frequent intervals during the work shift. Readings are to be taken before the first exposure and after the first exposure, after which readings should be taken between 15 minutes and $\frac{1}{2}$ hour intervals.
3. If a dosimeter goes off scale, report it at once to the supervisor who will in turn take the necessary steps to determine whether the dosimeter is faulty and ship the TLD badge for processing.
4. Log dosimeter readings at the end of each work shift on the Radiographic Equipment Exposure Log. (See page 2 of this appendix).
5. Dosimeters are delicate instruments. If you drop your dosimeter, read it immediately to be sure it did not go off scale. If you receive an electric shock, read it immediately to be sure it did not go off scale. High humidity may also effect your dosimeter and cause abnormal readings. If at any time the dosimeter becomes suspect of being faulty, notify the supervisor who will take the appropriate steps.
6. Store dosimeters with TLD badges.

APPENDIX "G"
RADIOGRAPHIC EQUIPMENT EXPOSURE LOG

BR 70-12-1
Rev. 2
3-30-84

DATE AND TIME OF USE	RADIOGRAPHIC UNIT USED
CUSTOMER	X-RAY
LOCATION OF WORK	MACHINE MODEL #
TIME WORK STARTED	MACHINE SERIAL #
NUMBER OF EXPOSURES	CAPSULE SERIAL #
EXPOSURE TIME (Each Picture)	MACHINE CONDITION
SURVEY METER READING (Meter from Exp. Device)	
DATE AND TIME IN SAFE	VEHICLE USED
PROTECTION USED	
RADIATION LEVEL AT BOUNDARY BARRIER (Not To Exceed 2mr)	
OPERATOR	DOSIMETER READING
HELPER	DOSIMETER READING
SURVEYS: ON OFF STORAGE	
REMARKS:	

SURVEY SKETCH

WEEKLY AUDIT
FINDINGS

DATE: _____

SIGNED: _____

BRANCH RADIOGRAPHIC LABORATORIES, INC.

RADIOGRAPHIC INSPECTIONS AND SERVICES

28 SOUTH AVENUE W.

CRANFORD, N.J.

272-5743

BR 70-12-1

Rev. 2

3-30-84

Page 1 of 3

APPENDIX "H"

RECORDS TO BE KEPT BY BRANCH RADIOGRAPHIC LABS.' PERSONNEL:

1. It shall be the duty of the radiographer to fill out the Maintenance Report and Radiographic Equipment Exposure Log which makes up pages 2 and 3 of this appendix.

APPENDIX "H"
MAINTENANCE REPORT

BR 70-12-1

Rev. 2

3-30-84

Machine Serial # _____

Crank Serial # _____

Date Inspected _____

Date Due _____

Inspection	Comments
1. Changes in operating characteristics of the device	
2. Proper operation of the crank mechanism	
3. Proper operation of source position indicator mechanism	
4. Proper operation of the locking mechanism	
5. Source and drive-cable wear or damage	
6. Damaged or worn source and drive cable tube	
7. Connector wear or damage (to be checked before and after each use of the radiographic device)	
8. Rust, dirt or sludge build up in the source guide tubes	
9. Shifting of the shield inside the projector housing	
10. Proper connection of all mating components	
11. Cable drive gear-box damage and wear	
12. Proper positioning of source inside shield unit	
13. Proper labeling	
14. Miscellaneous (Loose screws, safety caps, legs, etc.)	

Any damage to radiographic equipment which may impair its operation will be reported immediately to William Branch, Peter J. Branch, or William H. Branch, Jr.

Inspected By _____

Approved By _____

APPENDIX "H"
RADIOGRAPHIC EQUIPMENT EXPOSURE LOG

BR 70-12-1
Rev. 2
3-30-84

DATE AND TIME OF USE	RADIOGRAPHIC UNIT USED
CUSTOMER	X-RAY
LOCATION OF WORK	MACHINE MODEL #
TIME WORK STARTED	MACHINE SERIAL #
NUMBER OF EXPOSURES	CAPSULE SERIAL #
EXPOSURE TIME (Each Picture)	MACHINE CONDITION
SURVEY METER READING (Meter from Exp. Device)	
DATE AND TIME IN SAFE	VEHICLE USED
PROTECTION USED	
RADIATION LEVEL AT BOUNDARY BARRIER (Not To Exceed 2mr)	
OPERATOR	DOSIMETER READING
HELPER	DOSIMETER READING
SURVEYS: ON OFF	STORAGE
REMARKS:	

SURVEY SKETCH

WEEKLY AUDIT
FINDINGS

DATE: _____

SIGNED: _____

BR 70-12-1
Rev. 2
3-30-84

Page 1
Lesson 1

APPENDIX "I"

CLASSROOM LESSON GUIDE
THE STRUCTURE OF MATTER AND RADIATION

I. The structure of matter

- A. The atom and subatomic particles
- B. The atom compared to the solar system
- C. Elements are composed of atoms
- D. Compounds
- E. Atomic weight and isotopes

II. Radiation

- A. Excess energy possessed by unstable radioisotopes is emitted
in the form of radiation
- B. Two types of radiation particulate and electromagnetic
 - 1. Particulate radiation
 - 2. Electromagnetic radiation

Lesson 2

NUCLEAR REACTIONS AND RADIOISOTOPES

I. Nuclear reactions

- A. Nuclear fission
- B. Chain reactions
- C. Fission products

APPENDIX "I"

II. Activation of isotopes

- A. Early production methods
- B. Radioisotopes produced in nuclear reactors

III. Decay of radioactivity

- A. Excess energy of nuclei of radioactive atoms emitted as radiation.
 - 1. Radiation is usually alpha and beta particles and gamma rays
- B. Radioactive decay
 - 1. Rate of decay
 - 2. The radioactive half-life of an element
- C. The curie
- D. Plotting radioactive decay

Lesson 3

THE NATURE AND CONSEQUENCES OF RADIATION EXPOSURE

I. Radiation hazard in proper perspective

- A. Philosophy of risk evaluation
- B. "Background" radiation as it occurs in nature
- C. Man-made sources
- D. Sources of information about radiation's effect on man
- E. Radiation risk to radiographers

BR 70-12-1
Rev. 2
3-30-84

Page 3

APPENDIX "I"

II. Measurement units of radiation doses

A. Measurement terms

1. Roentgen
2. Rem
3. Rad
4. RBE

III. Nature of Radiation Health Problems

- A. External radiation
- B. Internal radiation

IV. Levels and Symptoms of Radiation Injury

- A. Classification of doses of radiation
- B. Common terms used to describe gross effects of radiation injury

V. Personnel monitoring

- A. Permissible Exposure
- B. Radiation "Banking" Concept
- C. Unusual exposure
- D. Instrumentation
- E. Contamination
 1. Contamination hazards
 2. Safety precautions

APPENDIX "I"

RADIATION ATTENUATION

- I. Time as a factor in radiation exposure
 - A. Roentgen
 - B. The rem
- II. Distance and the attenuation of radiation
 - A. The inverse square law
 - B. Finding radiation intensity when distances are known
 - C. Finding the intensity of radiation at a specified distance from a known source
 - D. Finding the distance from a specified source at which radiation will be attenuated to some desired value

Lesson 5

ABSORPTION OF RADIATION

- I. The absorption of radiation
 - A. Alpha and beta rays
 - B. Gamma and X-Rays
- II. Half-value layers
 - A. Definition of Half-value Layers

BR 70-12-1
Rev. 2
3-30-84

Page 5

APPENDIX "I"

III. Reduction Factor

IV. Principles of Radiation Safety

- A. Personnel dosage, time
- B. Personnel dosage, distance
- C. Personnel dosage, shielding

Lesson 6

RADIATION DETECTION AND MEASUREMENT

I. Detection and measurement of radiation

- A. Definition of detection
- B. Measurement
- C. Total dose exposure
- D. Dose-rate of exposure

II. Dosimeters

- A. Pocket dosimeter
- B. Film badges
- C. TLD badges

III. Survey meters

- A. Ionization chamber instruments
- B. Geiger counter

IV. Instrument Characteristics and Calibration

- A. Characteristics of radiation measuring instruments

BR 70-12-1
Rev. 2
3-30-84

Page 6

APPENDIX "I"

B. Radiographer and calibration of instruments

V. Source Calibration

Lesson 7

THE EFFECT OF RADIATION ON THE ORGANS AND TISSUES OF THE BODY

I. Radiation effects on living matter

- A. Bodies of living organisms and varying tolerances
- B. Radiation and its affects on the living organ

II. Radiosensitivity

- A. Definition

III. The effect of radiation on various tissues and organs of the body

- A. The blood and bone marrow
- B. The lymphatic system
- C. Skin and hair follicles
- D. The digestive system
- E. The liver and gall bladder
- F. The endocrine system
- G. The respiratory system
- H. The urinary system
- I. The bones
- J. The eyes

BR 70-12-1
Rev. 2
3-30-84

Page 7

APPENDIX "I"

IV. Other effects of radiation

- A. Effect of radiation on the life span
- B. Genetic effects of radiation

Lesson 8

NRC RULES AND REGULATIONS WHICH
CONCERN THE RADIOGRAPHIC PERSONNEL

I. Pertinent Federal Regulations

- A. 10 CFR 19
- B. 10 CFR 20
- C. 10 CFR 30
- D. 10 CFR 34
- E. 10 CFR 71

Lesson 9

PROCEDURE FOR THE USE, STORAGE
AND HANDLING OF IRIIDIUM 192 AND COBALT 60 BR-70-12-1

I. Protection of Workers on Job Site

II. Rules

III. Operating Procedure for Remote Control Radiographic Devices

BR 70-12-1
Rev. 2
3-30-84

Page 8

APPENDIX "I"

- IV. Emergency Procedure
- V. Inspection and Maintenance of Equipment
- VI. Calibration and Workings of Survey Meters
- VII. Transportation of Radiographic Devices
- VIII. Storage of Sources at Temporary Job Sites
- IX. Use of Model 414 and 650 Source Changers
- X. Storage and Handling of Personnel Monitoring Equipment
- XI. Preparing of Maintenance and Exposure Logs

Time: Total 40 Hours

BR 70-12-1

Rev. 2

3-30-84

LAB #1

INVERSE SQUARE LAW, SHIELDING, TIME

SURVEY METER CALIBRATION

NOTE: This Lab will be conducted by P. J. Branch. Students will observe results.

PURPOSE:

To demonstrate the three methods (Time, Distance, Shielding) of controlling radiation exposure.

EQUIPMENT:

- 1) Technical Operations model 571 calibration kit
- 2) Eberline model E510G, E120G, and/or E130G survey meter
- 3) Dosimeters
- 4) Various thicknesses of lead, steel and concrete

PROCEDURE:

Part A: Inverse Square Law and Survey Meter Calibration

- 1) Calculate the distances from the model 571 Calibration kit needed to obtain radiation intensities of 2 mr/hr, 8 mr/hr, 20 mr/hr, 80 mr/hr, 200 mr/hr, and 800 mr/hr.
- 2) Record all distances as calculated
- 3) Place a survey meter at these distances and record readings.

BR 70-12-1
Rev. 2
3-30-84

LAB #1

Part B: Time

- 1) At the distances calculated in part A determine how long it would take to accumulate a dose of 10mREM
- 2) Record the time for each distance
- 3) Place a dosimeter at these distances and expose it for the calculated times
- 4) Record the results

Part C: Shielding

- 1) Place a survey meter at the distance calculated in "A" for 20 mr/hr.
- 2) Expose survey meter and record reading.
- 3) Place various thicknesses of lead steel and concrete between source and survey meter
- 4) Record reading

BR 70-12-1
Rev. 2
3-30-84

LAB #2

RADIOGRAPHIC EQUIPMENT OPERATION

PURPOSE:

The purpose of this lab is to familiarize candidates with the operation of exposure equipment used at Branch Radiographic Labs.

EQUIPMENT:

- 1) Technical Operations Model 660 Projector loaded with a dummy source
- 2) Drive Cables
- 3) Source guide tubes (3)
- 4) Collimator

PROCEDURE:

Students will be shown the procedure involved in operating Branch Radiographic Labs! Operating and Emergency Procedure BR-70-12-1 Section 2 Operating Procedure for Remote Control Radiographic devices, and Section 3 Inspection and Maintenance Of Equipment.

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8:00	LESSON #1 STRUCTURE OF MATTER	LESSON #6 PERSONNEL MONITORING	QUIZ	LESSON #11 OPERATING AND EMERGENCY PROCEDURES	FINAL WRITTEN EXAMINATION
9:00	LESSON #2 RADIATION NUCLEAR REACTIONS AND RADIO-ISOTOPES	LESSON #7 METHODS OF CONTROLLING RADIATION DOSE. (TIME, DISTANCE, AND SHIELDING)	LESSON #9 RADIOGRAPHIC EQUIPMENT FAMILIARIZATION		
11:00	LESSON #3 MEASUREMENT UNITS OF RADIATION DOSES.		LAB. #2 RADIOGRAPHIC EQUIPMENT OPERATION	LAB. #3 OPERATING AND EMERGENCY PROCEDURES.	
12:30	LESSON #4 THE NATURE AND CONSEQUENCES OF RADIATION EXPOSURE.	LESSON #8 RADIATION DETECTION INSTRUMENTATION.	LESSON #10 FEDERAL REGULATIONS		
1:30	THE NATURE OF RADIATION HEALTH PROBLEMS AND LEVELS AND SYMPTOMS OF RADIATION INJURY.				
2:30	LESSON #5 EFFECTS OF RADIATION ON THE ORGANS AND TISSUES OF THE BODY.	LAB. #1 INVERSE SQUARE LAW, SHIELDING TIME, SURVEY METER CALIBRATION		REVIEW	ORAL EVALUATION
3:30					

TABLE 1

	MONDAY	TUESDAY
8:00	STRUCTURE OF MATTER-RADIATION, NUCLEAR REACTIONS AND RADIOISOTOPES-MEASUREMENT UNITS OF RADIATION DOSES	WRITTEN EXAMINATION
9:00	THE NATURE AND CONSEQUENCES OF RADIATION EXPOSURE-THE NATURE OF RADIATION HEALTH PROBLEMS AND LEVELS AND SYMPTOMS OF RADIATION INJURY-EFFECTS OF RADIATION ON THE ORGANS AND TISSUES OF THE BODY	
10:00	PERSONNEL MONITORING-METHODS OF CONTROLLING RADIATION DOSE-RADIATION DETECTION INSTRUMENTATION,	
11:00	FEDERAL REGULATIONS	PRACTICAL EXAMINATION
12:30		
1:30		
2:30	OPERATING AND EMERGENCY PROCEDURES	
3:30		

TABLE 2

BR 70-12-1
Rev. 2

I DEFINITIONS

Match the following words to the appropriate definitions listed below.

- | | | | |
|-----------------------|-------|---------------|-------|
| 1. Byproduct Material | _____ | 6. Isotope | _____ |
| 2. Rem | _____ | 7. Curie | _____ |
| 3. Milliroentgen | _____ | 8. Roentgen | _____ |
| 4. Millicurie | _____ | 9. Dose | _____ |
| 5. Radioactivity | _____ | 10. Half-life | _____ |

- A. The radiation emitted by atoms which are energetically unstable and are decaying to a stable condition.
- B. The amount of ionizing radiation energy absorbed per unit mass of irradiated material at a specific location.
- C. $\frac{1}{1000}$ of a roentgen.
- D. A unit of absorbed radiation dose in biological matter.
- E. Any radioactive material (except source of fissionable material) obtained in the process of producing or using source of fissionable material.
- F. One thousandth of a curie or $\frac{1}{1000}$ of a curie.
- G. A unit of exposure dose of ionizing radiation.
- H. The time in which half the activity in a radioactive substance disintegrates.
- I. An atom with the same atomic number but different atomic weights (or) an atom whose nuclei has the same number of protons but different mass numbers.
- J. The basic unit used to describe the intensity of radioactivity in a sample of material, 3.7×10^{10} disintegrations per second.

Match the following words to the appropriate definitions listed below.

- | | |
|------------------------------|--|
| 1. High Radiation Area _____ | 6. Radiography _____ |
| 2. Sealed Source _____ | 7. Radiographer's Assistant _____ |
| 3. Unrestricted Area _____ | 8. Inverse Square Law _____ |
| 4. Radiographer _____ | 9. Radiation Area _____ |
| 5. Restricted Area _____ | 10. Radiographic Exposure Device _____ |
- A. Any byproduct material that is encased in a capsule to prevent its leakage or escape.
- B. Any area to which access is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials.
- C. Any individual who performs or who, in attendance at the site where the sealed source or sources are being used, personally supervises radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of NRC regulations and the conditions of the license.
- D. The intensity of radiation (from a point source) varies as the inverse square of the distance from the source.
- E. Any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem or in any 5 consecutive days a dose in excess of 100 millirems.
- F. Any instrument containing a sealed source contained therein, in which the sealed source or shielding thereof may be moved or changed from a shielded to unshielded position for purposes of making a radiographic exposure.
- G. Any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.
- H. Any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools, or survey instruments in radiography.
- I. The examination of materials by utilizing sealed sources of byproduct material and other sources of ionizing radiation.
- J. Any area into which entry is not controlled by the licensee.

APPENDIX "I"

ARTICLE 1

Page 1

II FUNDAMENTALS OF RADIATION SAFETY

A-- Characteristics of Gamma Radiation

1. Of the three types of radiation, namely, Alpha, Beta, and Gamma, which is the most penetrating?

A. Alpha	B. Beta	C. Gamma
----------	---------	----------
2. Of the three types of radiation, namely, Alpha, Beta, and Gamma, which type is likely to be emitted from a sealed source used for Industrial Radiography?

A. Alpha	B. Beta	C. Gamma
----------	---------	----------
3. What types of radiation can be detected by any of the physical senses?

A. Beta	C. Gamma
B. Alpha	D. None of the above
4. What types of radiation damages body tissues?

A. Alpha	C. Gamma
B. Beta	D. B and C above
5. What provisions can be used for protection?

A. Shielding	C. Distance
B. Time	D. All of the above
6. What origins of gamma radiation must the radiographer plan against in his exposure setup?

A. Direct exposure	C. Both A and B
B. Scatter Radiation	D. Neither A or B

APPENDIX "I"

Page 2

ARTICLE 1

II FUNDAMENTALS OF RADIATION SAFETY

B--Units of Radiation Dose (mrem) and

Quantity of Radioactivity (curie)

1. What are the permissible dosage limits from radioactive material for any individual in restricted areas in any period of one calendar quarter?

A. 1.25 rem
B. 5 rem

C. 1.25 mrem
D. 100 mrem

II FUNDAMENTALS OF RADIATION SAFETY

C--Hazards of Excessive Exposure of Radiation

1. A whole body dose increased above 25 Rems will show immediately. Observable effects increase in severity with dose, beginning with barely detectable changes to biological signs, clearly indicating damage or death at levels of a few hundred Rem.

True _____

or

False _____

II FUNDAMENTALS OF RADIATION SAFETY

D--Levels of Radiation from Licensed Material

1. What is the maximum permissible radiation level in distance, in time and milliroentgens of radiographic exposure devices which measure less than 4 inches from the sealed storage position to any exterior surface of the device?

No radiation level in excess of :

A. 5 r/hr at 1 meter
B. 25 mr/hr at surface

C. 50 mr/hr at 6 inches
D. 10 mr/hr at 4 inches

APPENDIX "I"

Article 1

Page 3

2. What is the maximum permissible radiation level in distance, in time and milliroentgens of radiographic exposure devices measuring a minimum of 4 inches from the sealed storage position to any exterior surface of the device?
 - A. No radiation level in excess of 200 mr/hr at any exterior surface and 10 mr/hr at 1 meter from any exterior surface.
 - B. No radiation level in excess of 25 mr/hr at any exterior surface or 5 mr/hr at 1 meter from any exterior surface.
 - C. No radiation level in excess of 100 mr/hr at any exterior surface or 20 mr/hr at 1 meter from any exterior surface.

II FUNDAMENTALS OF RADIATION SAFETY

E--Methods of Controlling Radiation Dose,
Working Time, Working Distances, Shielding

INVERSE SQUARE LAW PROBLEM

PROBLEMS IN INTENSITY

1. If a T. O. Model 660 projector with 100 curies of IR-192 with the source in the "ON" position produces 9.2 mr/hr per curie at 25 feet from the end of the source guide tube, what is the intensity 46 feet away at the source control box?

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

$$\frac{9.2}{X} = \frac{2116^2}{625}$$

$$2116X = 625 \times 920$$

$$2116X = 575000$$

$$X = 271.1$$

INVERSE SQUARE LAW PROBLEM

PROBLEMS IN DISTANCE

2. Given 200 mr/hr radiation level from 800 mc source of Cobalt 60, what is the distance from the source?

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

$$\frac{14.4}{.0144} = \frac{D_2^2}{1^2}$$

$$11.32 \text{ R/ 800 mc at 1 ft.}$$

$$\frac{200}{11,500} = \frac{12}{X^2}$$

$$200 X^2 = 11520$$

$$X^2 = 57.6$$

$$X = 7.58 (7.59) (7.6)$$

APPENDIX "I"

Page 4

ARTICLE 1

II FUNDAMENTALS OF RADIATION SAFETY

E--Methods of Controlling Radiation Dose

Working Time, Working Distances, Shielding

1. What is the fundamental principle in radiation protection with respect to the use of shielding?
 - A. Time in radiation area
 - B. Absorption
 - C. Time is not a factor when shielding is used.
 - D. Keep distance to a minimum by use of shielding
2. Pick three principal materials used in shielding against radiation?
 - A. Wood
 - B. Lead
 - C. Water
 - D. Concrete
 - E. Steel
 - F. Dirt
3. Of the three principle materials, which absorbs radiation to the greatest degree?
 - A. Water
 - B. Steel
 - C. Concrete
 - D. Wood
 - E. Dirt
 - F. Lead
4. In shielding what is meant by half value layer (hvl) of thickness?
 - A. That amount of material which reduces the intensity of radiation to half of its unshielded intensity.
 - B. $\frac{1}{2}$ inch of shielding material
 - C. Reducing the shielding thickness by one half.
 - D. Half value layer (hvl) does not pertain to thickness.
5. What is meant by the term tenth value layer?
 - A. Multiplying shielding thickness ten times.
 - B. Utilizing one tenth (1/10) of original shielding thickness.
 - C. That amount of materials which reduces the intensity of radiation to one-tenth of its unshielded intensity.
 - D. None of the above.
6. What is the fundamental principle in radiation protection with respect to distance?
 - A. Distance is not a factor.
 - B. Distance is directly proportional to intensity
 - C. Distance is inversely proportional to time.
 - D. The inverse square law.

7. What is the formula for determining exposure rate in working distances?

A. $\frac{I_1}{I_2} = \frac{D_2^2}{D_1^2}$

B. $\frac{I_1}{I_2} = \frac{D_1^2}{D_2^2}$

C. $\frac{I_1}{D_1^2} = \frac{I_2^2}{D_2}$

8. The formula for working distance in words is,

The intensity of radiation (from a point source) is inversely proportional to the square of the distance.

True _____

or

False _____

9. Name three fundamental principles which a radiographer or assistant must exercise in controlling exposure of the body to gamma radiation from external sources? (circle correct answers)

- A. Time- Time radiographer is exposed to radiation
- B. Intensity- The number of curies when exposed to an inert situation that fundamentally filters stray or reflected radiation
- C. Shielding- How much shielding is needed to make the area in which he stayed safe.
- D. Distance- The distance he must go to be out of the radiation area

10. The fundamental principle in radiation protection with respect to time is that,

The intensity of radiation is proportional to the time of exposure.

True _____

or

False _____

11. How is intensity of gamma radiation expressed?

A. ci/hr or millici/hr

C. mc/hr

B. r/hr or mr/hr

D. Intensity/Distance

12. The dose rate of gamma radiation reaching a point at some distance from a source with no shield divided by the dose rate reaching the same point with some shield interposed is the Reduction Factor in shielding.

True _____

or

False _____

13. How much lead is required to reduce Cobalt 60 radiation with an intensity of 3000 mr/hr to 20 mr/hr.

A. 3'

C. 3½"

B. 6"

D. 1 meter

III RADIATION DETECTION INSTRUMENTATION TO BE USED

- A--Use of Radiation Survey Instrument Operation,
Calibration and Limitations
B--Survey Techniques

1. What is a survey meter?

A portable instrument which measures dose rate of exposure or radiation intensity.

True _____ or False _____

2. Why are survey meters used?

- A. In order to detect ionizing radiation
- B. To conform to NRC regulations
- C. To assist in calculating exposure times
- D. To determine if dosimeters are working and accurate

3. How often must a survey meter be calibrated?

- A. At the beginning of each shift
- B. Every three months
- C. Every hour during operations
- D. A & C above

4. Is a radiographer permitted to perform calibration of a survey meter?

- A. Yes
- B. No
- C. Only Level II or III radiographers
- D. Survey meters must be calibrated by the shift supervisor

5. Who is permitted to perform calibration of a survey meter?

- A. Radiation Safety Officer - Peter J. Branch
- B. BRLI President - William H. Branch
- C. BRLI Vice President - William H. Branch Jr.
- D. All of the above

C--Use of Personnel Monitoring Equipment

1. TLD Badges

1. A TLD badge is a thermoluminescent dosimeter. When certain materials are exposed to radiation, energy is absorbed in traps. This stored energy is released in the form of light when the material is heated and is called thermoluminescence. The amount of light released indicates total radiation exposure.

True _____ or False _____

2. How are TLD badges identified?
- A. By serial number
 - B. By name of wearer
 - C. Both A & B above
 - D. By either r badge or mr badge
3. How long is a TLD badge worn?
- A. Until it reaches 200 mr/hr
 - B. One week
 - C. One day
 - D. One calendar quarter
4. TLD badges at the end of the working shift are kept in the storage area with the control badge.
- True _____ or False _____
5. In what manner are dosages reviewed?
- A. Weekly
 - B. Monthly
 - C. Bi-weekly
 - D. Quarterly
6. How is the information reported?
- A. On Federal Form 960
 - B. On NRC Form 9A
 - C. On Eberline Instruments Occupational Radiation Exposure Report
7. Is this information available to radiographers and assistants?
- A. Yes
 - B. No
 - C. Quarterly
8. In case of accidental breakage or wetting of the TLD badge, what procedure must be followed? (Circle correct answer or answers)
- A. Notify the Radiation Safety Officer
 - B. Notify the shift supervisor
 - C. Notify the NRC
 - D. Both A & B
9. The purpose of the control TLD badge is to account for radiation which may be received to the badge in shipment or storage.
- True _____ or False _____
10. Is the control TLD badge worn by a radiographer?
- Yes _____ or No _____

11. Where is the control TLD badge kept during the week?
- A. In the storage area with the control badge.
 - B. The TLD badge is used to monitor personnel while they are working.
 - C. The purpose of the TLD badge is to give a permanent record of occupational dose only.
 - D. The control badge monitors the other badges while they are in the storage area and during shipping.

III RADIATION DETECTION INSTRUMENTATION TO BE USED

C--Use of Personnel Monitoring Equipment

2. Pocket Dosimeters

1. What is a pocket dosimeter?
- A. It is an instrument for cumulatively measuring the amount of X-ray and gamma radiation received by the wearer.
 - B. It is an instrument for measuring and accumulating radiographic data.
 - C. It is an ionization bar graph.
 - D. It is a portable radiation detection instrument used in lieu of survey meters.
2. What is the graduated scale of the pocket dosimeter employed by Branch Radiographic Labs., Inc.? (Circle all that apply)
- A. 0-200 mr
 - B. 0-500 mr
 - C. 0-10 mr
 - D. 1-10 r
3. How are pocket dosimeter dosages reviewed?
- A. Hourly
 - B. Daily
 - C. Weekly
 - D. Quarterly
4. How often and by whom must a pocket dosimeter be checked?
- A. By the shift supervisor at the beginning of each work shift.
 - B. By the NRC Inspector hourly.
 - C. Every fifteen minutes when working with radioactive materials by the wearer and at the end of each work shift.
5. How often and by whom must a pocket dosimeter be charged?
- A. Daily, by the radiographer or Radiation Safety Officer.
 - B. Weekly, by the radiographer or Radiation Safety Officer.
 - C. Quarterly, by the radiographer or Radiation Safety Officer.
 - D. Hourly, by the radiographer or Radiation Safety Officer.

6. In the case of accidental breakage of a pocket dosimeter, what procedure must be followed?
- A. Must be immediately reported to the manufacturer who will delete it from his records.
 - B. Must be immediately reported to the NRC.
 - C. Must be reported after the shift.
 - D. Must be immediately reported to the Radiation Safety Officer who will replace it.

IV RADIOGRAPHIC EQUIPMENT TO BE USED
A--Remote Handling Equipment
B--Radiographic Exposure Devices
C--Storage Containers

1. Why are the projectors utilized by Branch Labs. said to be "Remote Handling"?

- A. They are portable projectors that can be taken to remote areas such as power plants, refineries, and fabrication shops.
- B. All source projectors are controlled electronically so as to minimize exposure to personnel.
- C. All sources are handled by mechanical devices which allows the radiographer to handle the sources safely.

2. Describe how typical handling equipment at Branch Labs. is utilized.

- A. Used for the purpose of taking radiographs of objects in order to determine its acceptability to a specific criteria.
- B. All handling equipment at Branch Labs. is used under the direct supervision of an NRC Inspector.
- C. Typical handling equipment is used to remove sources from the projectors into shipping containers only by Level III radiographic personnel.

3. Why are the projectors called "Radiographic Exposure Devices"?

They contain a sealed source which may be moved to an unshielded position for the purpose of taking radiographs.

True _____

or

False _____

4. What are projector "locking safety plugs"?

- A. Plugs used on source guide tubes to prevent dirt from entering the tubes.
- B. Plugs used to secure the selector in the lock position.
- C. A threaded bolt with a piece of cable on the end. Its purpose is to prevent the source from moving to an unshielded position.

5. Why are the information tags attached to the projectors in addition to the yellow caution sign?

- A. To allow the radiographic technician to know what source is contained in the device and its strength at a given period of time.
- B. So that during audits each source can be easily located.
- C. So they won't get lost.

BRANCH RADIOGRAPHIC LABORATORIES, INC.

RADIOGRAPHIC INSPECTIONS AND SERVICES

APPENDIX "I"

BR 70-12-1 Rev. 2

3-30-84

ARTICLE 1

28 SOUTH AVENUE W.
CRANFORD, N. J.

272-8743

Page 2

6. Why does the projector have a label "Caution Radioactive Material"?
 - A. To discourage theft of radiographic equipment.
 - B. Because the shielding material inside the projector is uranium with low background radiation.
 - C. To warn personnel that the unit contains radioactive material.
7. Why must the source tubing attached to a projector always be of no greater length than the control cable?
 - A. If the source tubing is longer the control cable will slip off of the control gear and the source will not be able to be retracted without difficulty or in the normal manner of operation.
 - B. Any length greater than the control cable length will cause an excessively large radiation area.
 - C. The length of the source tubing does not matter.
 - D. None of the above is a correct answer.

APPENDIX "I"

Page 1

ARTICLE 1

V THE REQUIREMENTS OF PERTINENT FEDERAL REGULATIONS

1. How often shall a licensee conduct a physical inventory of sealed sources received and possessed under his license?
 - A. Daily inventory is mandatory per NRC regulations
 - B. At the beginning of each quarter
 - C. Monthly as per CFR-10, Part 30
2. What records must be maintained? (circle all that apply)

A. Source inventory	D. Machine maintenance records
B. Leak Test results	E. Source disposal receipts
C. Survey meter calibration	F. Exposure Logs
3. What are the limitations placed upon the license by the NRC before licensee can permit a person to act as a radiographer or radiographer's assistant? (match correct answer)
 - (a) Use of radiographic sources, tools, and related equipment?
 - (b) Instructions?
 - (c) Publications and literature requirements?
 - (1) Use, Storage, and Handling of IR-1 2 and CO 60 BR 70-12-1
 - (2) Trained in accordance with Appendix A of 10 CFR 34
 - (3) 10 CFR 19, 20, 30, and 34
4. What is the maximum allowable body dosage for a person 18 years of age or over in a calendar quarter of a 12 week, 13 week, and 14 week quarters?

A. 200 mr	C. 125 r
B. 5 r	D. 1.25 r
5. Your son, age 17, wishes to be an assistant radiographer during his summer vacation--what factor among others makes this difficult?
 - A. No one under 18 years of age is allowed to work with radiation
 - B. Accumulated dose is calculated on a full 12 month year
 - C. The maximum radiation allowed a person under 18 years of age per year is 1/10th of the normal allowable dose or 500 mr
6. In working with the Model 660 Projector on a Friday afternoon, you survey the Accounting Dept., a reading beside John Doe shows 3 millirems/hr. What must you do and why?
 - A. Remove John Doe from the area and restrict area from all personnel. Restricted area defined as 2 mr/hr and over.
 - B. Secure operations and notify the NRC of the incident with 24 hrs.
 - C. Issue a dosimeter and a TLD badge to John Doe and continue operations.

V THE REQUIREMENTS OF PERTINENT FEDERAL REGULATIONS

7. In the open shop you calculate shielding and place a warning rope and signs, etc. at 20 ft. from the projector. While making an exposure your survey meter reads $2\frac{1}{2}$ millirems/hr. at 20 ft. What must you do and why?

- A. Secure operations and make a written report to your supervisor of the excessive radiation area.
- B. Shut off machine. Move the ropes and signs back to the 2 mr/hr area.
- C. This is not important as long as all personnel in the area are equipped with TLD badges and dosimeters.

8. The maximum allowable dose permitted to be received by a person in a restricted area before he must use personnel monitoring equipment is, all radiographers and radiographer's assistants must wear personnel monitoring devices. Anyone who may receive 25% of the following limits:

Rems per calendar quarter

- 1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads.....1-1/4
- 2. Hands and forearms; feet and ankles.....18-3/4
- 3. Skin of whole body.....7-1/2

Anyone under 18 years old who may receive 5% of the above limits.

True _____ or False _____

9. What is the maximum allowable dose permitted to be received by a person under 18 years of age?

- A. 500 mr
- B. 5 rem
- C. 2 mr
- C. $1\frac{1}{4}$ rem

10. The radiation vault has posted inside a sign reading: "Caution Radioactive Materials" to warn personnel of its presence so they may take precautions to avoid or minimize exposures.

True _____ or False _____

11. Projectors have a sign reading "Caution Radioactive Materials" to alert individuals handling or using the containers in the vicinity to take precautions to avoid or minimize exposures.

True _____ or False _____

V THE REQUIREMENTS OF PERTINENT FEDERAL REGULATIONS

12. At a job site, you move the projector into a closet during your lunch period and eat your lunch in front of it, need you post a caution sign?

Yes _____ or No _____

13. At a job site you finish for the night and store the projector in the tool supply room which has a lock but to which others have also the key. You also label and post caution signs. Are you in compliance with NRC regulations?

Yes _____ or No _____

14. At a job site, another worker unknown to you has been seated for one hour next to a projector leaking 50 rems/hr. Upon learning of this you should do what?

A. Chase the man from the area C. Notify the Radiation Safety Officer
B. Say nothing D. Terminate him

15. At an open shop location during an exposure, a "Front Office" messenger manages to stand in an intensity of 60 rem/hr for five minutes. Upon learning of this, what should you do?

A. Notify the doctor
B. Notify the Radiation Safety Officer
C. Notify the Security Guard
D. Send the person home

16. You visit your doctor for an annual physical check up and you advise him of feeling poorly. The doctor upon learning your occupation requests that you obtain your exposure record for his review. May you make these available to him?

Yes _____ or No _____

17. Why is the "Safety Plug" (Storage Plug) placed in the source tubing connection hole of the projector provided with a locking device and when should it be in place?

A. To hold the radioactive capsule in the proper stored position. At all times when the projector is not in use.
B. To hold the locking mechanism in a safe position, at all times.
C. To allow the radioactive material to regenerate its energy, for times when maximum radiation is needed.

V THE REQUIREMENTS OF PERTINENT FEDERAL REGULATIONS

18. At a job site, you must leave the projector to go to the men's room. What is the first thing you must do?
- A. Notify Safety Dept.
 - B. Notify Radiation Safety Officer
 - C. Return the source to the safe stored position, make a survey of the camera and guide hoses. Lock and secure projector and post a guard
19. At a job site, you are called to the office of the construction superintendent. After placing the locking safety plug, what else must you do before leaving?
- A. Notify the NRC.
 - B. Make a radiation survey. Secure projector and post a guard.
 - C. Turn off survey meter. Put projector in closet.
20. At a job site you receive a projector which when surveyed appears to be in good order but a Leak Test Certificate is missing. Upon calling the supplier, you are told it was leak tested within the last six months and it will be sent. May you use the projector?
- Yes _____ or No _____

APPENDIX "I"

Page 1

ARTICLE 1

VI OPERATING AND EMERGENCY PROCEDURE

1. What is the purpose of Branch Radiographic Laboratories, Inc. Operating and Emergency Procedures BR 70-12-1?
 - A. To satisfy the NRC and State Environmental Dept. Requirements
 - B. To establish definite, safe and uniform operating and emergency instructions for the personnel handling and using IR-192 and Co. 60.
 - C. Both A and B
2. What are the radioisotopes licensed to Branch Radiographic Laboratories to be used for?
 - A. Irradiating material (sterilization)
 - B. Any industrial use
 - C. Industrial Radiography only.
 - D. Source inspection.
3. According to BR 70-12-1 surveys are required? (circle all that apply)
 - A. When approaching the projector each time during use.
 - B. When exchanging sources in the radiographic unit.
 - C. When making each radiographic set up.
 - D. When receiving or returning a source in a shipping container.
 - E. When leaving or approaching the source storage area.
 - F. When storing a source.
4. How will radioisotopes be stored:
 - A. Radioisotopes shall be stored in the transfer container or projector unit, these containers will be stored in a locked storage enclosure when not in use.
 - B. By use of lock and chain with a radiation sign posted.
 - C. Radioisotope storage will be done by the radiation safety officer only.
5. a) Who can change a IR-192 source at Branch Radiographic Laboratories?

A. Anyone	C. Management only
B. A Health Physicist	D. A licensed operator
6. What is the minimum number of authorized personnel permitted by BR 70-12-1 to operate a source?
 - A. One, a health physicist
 - B. Two, a radiographer and assistant
 - C. One, a radiographer
 - D. Two, a radiographer and helper

APPENDIX "I"

ARTICLE 1

Page 2

VI OPERATING AND EMERGENCY PROCEDURE

7. a) What should be done when a source cannot be returned to the safe storage position?
 - A. Immediately notify the NRC
 - B. Obtain a source changer and secure source
 - C. A barricade shall be erected to prevent unauthorized persons from entering the area. A guard shall be posted.
- b) Who shall be notified?
 - A. NRC
 - B. W.H. Branch Sr., P.J. Branch, W.H. Branch Jr., D.F. Dodd, or Technical Operations
 - C. Local Police, State Police, and Project Safety Dept.
 - D. All of the above
8. When shall radiographic devices be inspected and by whom?
 - A. Periodically by the NRC
 - B. Three month intervals by a radiographer
 - C. When receiving and/or shipping by the Radiation Safety Officer
 - D. Before each use by a radiographer
9. What records shall be kept after the device has been inspected?
 - A. Branch Maintenance Report shall be completed and kept on file for all equipment inspections.
 - B. A log of time and date of inspection
 - C. Leak Test Report
 - D. Utilization Log only
10. When and by whom are survey meters calibrated?
 - A. Before each use by the shift supervisor
 - B. Hourly by the radiographer
 - C. Every 3 months by W H. Branch Sr., W.H. Branch Jr., or P.J. Branch
11. When transporting a source to a job site. where will the survey meters be located?
 - A. With the source container
 - B. In the front seat of the vehicle
 - C. In the utility box
 - D. With the TLD badges

VI OPERATING AND EMERGENCY PROCEDURE

12. At a temporary jobsite, how is storage of the source to be accomplished? (Match 1, 2, 3 to a, b, c)
- a) The source in a locked storage container shall be stored in the vehicle in which it was transported provided the radiographer has possession of the keys to both the vehicle and storage container, the vehicle is posted with a sign reading "Danger or Caution Radioactive Material" and a survey meter is maintained in the vehicle.
 - b) In a concrete vault with a lock and hasp. The vault shall be posted with a "Caution Radioactive Material" sign.
 - c) Signs reading "Caution Radioactive Material" shall be posted at all entrances. "High Radiation Area" signs shall be posted inside the enclosure. Keys for the enclosure will be maintained by the radiographer, his assistant and the shift supervisor of the plant after he has been briefed by the radiographer.
- 1) Site with a room or closet
 - 2) Site without a room or closet
 - 3) At a major site
13. How should personnel monitoring equipment be stored at a jobsite?
- A. The TLD and dosimeter are issued weekly and are the responsibility of the personnel wearing them.
 - B. Locked in a safe place to avoid theft or loss.
 - C. The TLD and dosimeter shall be stored in a lead lined box away from any known radiation. A control dosimeter shall be placed in the box to act as a control on the storage area.
14. What records must be filled out by the radiographer?
- A. Maintenance Reports
 - B. Quarterly Inventory
 - C. Radiographic Equipment Logs
 - D. Both A and C

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "I"

ARTICLE 2

RADIOGRAPHER'S OPERATIONAL PERFORMANCE TEST

1. The radiographer will be given a gamma-ray radiographic assignment of an actual or mock-up specimen. The following points will be checked during the operational test. Did the radiographer.....

	<u>YES</u>	<u>NO</u>
a. Wear the proper TLD badge?	_____	_____
b. Charge dosimeter and record readings?	_____	_____
c. Check survey meter prior to going to source storage area?	_____	_____
d. Upon removal of exposure device from storage, take reading at the surface of the camera?	_____	_____
e. Make entry in Source Survey and Utilization Record?	_____	_____
f. Erect rope barriers and post radiation signs?	_____	_____
g. Position source tube, make source tube and control cable connections prior to unlocking exposure devices?	_____	_____
h. Watch survey meter as source was being cranked into exposure position?	_____	_____
i. Take radiation survey of exposure area, fill out "Radiation Survey Chart" form and draw sketch showing area and radiation levels at area boundaries?	_____	_____
j. Watch the survey meter as source is being cranked from its unshielded position into exposure device?	_____	_____
k. Approach exposure device slowly using survey meter, check source tube from tip to camera, then proceed along camera surface?	_____	_____
l. Lock camera?	_____	_____

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "I"

ARTICLE 2

	<u>YES</u>	<u>NO</u>
m. Disconnect source tube and insert safety plugs and disconnect control cable?	_____	_____
n. Return exposure device to storage area?	_____	_____
o. Survey exposure device surface?	_____	_____
p. Turn off radiation survey meter?	_____	_____
q. Remove radiation area boundary ropes and signs?	_____	_____
r. Make correct entry in Source Survey and Utilization Record?	_____	_____
s. Check dosimeter and record readings?	_____	_____
t. Place TLD badge and dosimeter in TLD badge rack?	_____	_____

EXAMINER _____

NAME _____

SOCIAL SECURITY # _____

DATE _____

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "J"

PROCEDURE FOR USE OF TECHNICAL OPERATIONS MODEL 518 LEAK TEST KIT:

1. Be sure source is fully retracted into projector. (Use a survey meter to be sure the radiation levels are normal).
2. Remove source tube from face of shield or remove shipping plug.
3. Wet the swab with EDTA solution. Shake off excess and insert the swab into the hole in the shield. Wipe the interior of the hole thoroughly by rotating swab holder.
4. Withdraw swab and place in plastic envelope.
5. The swab should now be monitored by turning the survey meter to its most sensitive range. Place the meter in a low background area and move the swab in its plastic envelope to the meter, not the meter to the swab.
6. If there is no indication on the meter or if the indication is no more than 0.2 mr per hour above background, put the plastic envelope with the swab in the mailing box and mail to Technical Operations, Incorporated, Burlington, Massachusetts. Be sure to fill out and return the identification sheet. (See page 2 of this appendix).
7. If the swab should show more than 0.2 mr per hour, do not mail. Contact Peter J. Branch, William H. Branch Jr., or William H. Branch Sr. for specific instructions.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "J"

NCO Systemmedia Group

ER 44783



40 NORTH AVENUE
BURLINGTON, MA. 01803
(617) 272-2000

**518
LEAK TEST**

Co. Name _____ P.O. No. _____
Street _____ NRC or _____
City, State _____ State License No. _____
Projector _____
Model No. _____ Serial No. _____
Source _____
Model No. _____ Serial No. _____ Curies _____
IR-192 _____ CO-60 _____ CS-137 _____ Other _____
Wipe _____
Performed By _____ Date _____

The United States Nuclear Regulatory Commission requires that radiographic sources be tested for evidence of leaking at the time of manufacture and thereafter at not more than six-month intervals.
The amount of removable contamination must not exceed 0.005 microcuries. If the test shows more than 0.005 microcurie of removable contamination, the source and equipment must be immediately taken out of service and be repaired or be disposed of. Please note that this source must be tested again on or before _____

FOR TECH-OPS USE ONLY

ORIGINAL

BR 70-12-1

Rev. 2

3-30-84

APPENDIX "K"

PROCEDURE FOR THE USE OF TECHNICAL OPERATIONS MODEL 650 SOURCE CHANGER:

1. All precautions used when making a radiographic exposure shall be followed during source changing operations.
2. Upon receipt of the source changer, survey the source changer to insure the source is in the proper storage position.
3. Remove projector to receive new source from storage vault. (Make survey of projector).
4. Place projector and source changer in a restricted area.
5. Connect projector and source drive cable. Place projector control in "LOCK" position.
6. Remove the cover from the source changer. Remove the source hold down cap.
7. Position source changer and camera as shown in Figure "A".
8. Connect one end of guide tube extension to projector and the other end to the fitting above the empty chamber in the source changer.
9. Close and latch the source guides.
10. Check area for unauthorized and unmonitored personnel.
11. Turn locking device to "ON" position.
12. Crank the source as if making an exposure driving the source into the source changer.
13. Approach the projector with the survey meter. Survey the guide tube and source changer. Maximum radiation level at the source changer should be less than 200 mr/hr at contact.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "K"

14. Open the source guides and disconnect the drive cable from the source assembly.
15. Disconnect the guide tube from the source changer.
16. Remove the old source tag from the projector and replace it with the new source tag.
17. Connect guide tube to the fitting above the chamber containing the new source.
18. Connect the drive cable to the source. Close and latch the source guides.
19. Crank the source from the source changer to its storage position in the projector.
20. Approach projector with the surveymeter and survey guide tube and projector. Reading should not exceed 200 mr/hr at projector surface.
21. Lock the projector and disconnect the source guide tube from the source changer and projector and plug projector.
22. Bolt the source hold down cap in place and seal with wire.
23. Attach identification plate of the old source to the male end of the source guide which contains the old source.
24. Bolt the source changer cover in place and seal with wire.
25. Survey all exterior surfaces of the source changer to insure that the radiation level does not exceed 200 mr/hr at contact.
26. Measure the radiation level 1 meter from all exterior surfaces of the source changer and insure that the radiation level is less than 10 mr/hr. The

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "K"

maximum radiation level measured at 1 meter from any exterior surface is the Transport Index. (Example: with a maximum radiation level of 2.2 mr/hr, the Transport Index is 2.2).

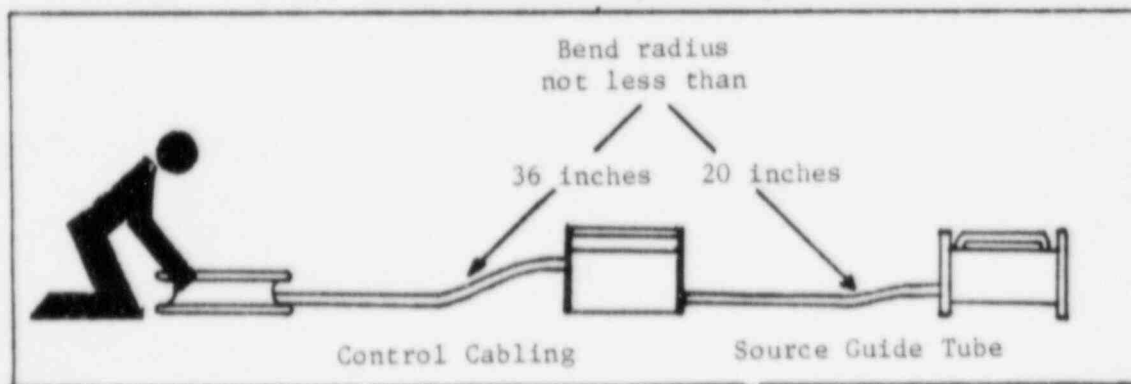
27. Complete the proper "Radioactive" shipping label. (When the maximum radiation level does not exceed 50 mr/hr at surface and 1.0 mr/hr at one meter, use a "Radioactive" Yellow II label. When maximum radiation level does not exceed 200 mr/hr at surface and 10 mr/hr at one meter, use "Radioactive" Yellow III label).

28. Apply the proper "Radioactive" shipping labels, properly completed, to two opposite sides of the container.

29. Return the container to Technical Operations, Incorporated. Make sure the proper checkin and checkout forms have been completed (see pages 4 & 5 of this appendix).

Figure "A"

Typical Source-exchange Arrangement



272-8743

BR 70-12-1

Rev. 2

3-30-84

APPENDIX "K"

BY-PRODUCT MATERIAL RECEIVING CHECKIN LIST

1. Receiving Date: _____ Time: _____
2. Type Source _____ Model No. _____
3. Serial No. _____
4. No. of Curies _____
5. Radiation Readings: Surface _____ @ 1 meter _____
6. Shipping Container Type _____
7. Condition of Container _____
8. Shipped By: _____
9. Shipped Via: _____

Received By: _____

272-8743

BR 70-12-1

Rev. 2

3-30-84

APPENDIX "K"

BY-PRODUCT MATERIAL SHIPPING CHECKOUT LIST

1. Type Source: IR-192 _____ Co-60 _____
2. Model No. _____
3. Source Serial No. _____
4. No. Curies _____
5. Type Shipping Container _____ Model No. _____
6. Shipping Container Serial No. _____
7. Label Type _____
8. Lead Seal Installed _____
9. Radiation Readings: Surface _____ @ 1 meter _____
10. Shipping Date: _____
11. Shipped To: _____
12. Shipped Via: _____

Packaged By: _____

Released For Shipment By: _____

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "L"

PROCEDURE FOR INSPECTION AND MAINTENANCE OF MODEL 520 EXPOSURE DEVICE AND
MODEL 627 AUTOMATIC EXPOSURE CONTROL:

SCOPE:

This procedure shall be used to perform inspection and maintenance checks of the Model 520 exposure device and Model 657 automatic exposure control:

1. Make survey of radiographic exposure device.
2. Remove locking safety plug and replace with face plate that creates the 60° conical beam limiting device.
3. Check area gamma alarms to see if they are operational. (Is green light lit?)
4. Check drive cable outer casing connections to be sure they are tight at the exposure device and the control panel.
5. Check outer casing for crimps by feeling and looking for flat spots.
6. Remove all personnel from exposure room.
7. Set timer as if making an exposure.
8. Activate control panel and expose source.
9. Check indicator lights at this time.
 - A. When control is activated the indicator lights should follow the following sequence:
 1. Stored light is lit.
 - B. When expose button is pressed.
 1. Transit light is lit then expose light.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "L"

- C. When source is exposing, timer is activated.
- D. With key, override electronic lock and open gate.
 - 1. Alarm sounds
 - 2. Source is automatically retracted
 - 3. Door open light is lit
- E. With gate still open, press expose button.
 - 1. Nothing should happen, button should not expose source or depress.
- 10. Store unit as instructed in Section 4, Page 5, Section 3.
- 11. At control panel remove face plate from gear drive. Check for score marks and metal chips. If any are found, report it immediately to Peter J. Branch, William H. Branch Jr., or William H. Branch Sr. They will notify Technical Operations for corrective action.
- 12. Replace face plate on gear drive.
- 13. De-activate control panel by removing plug from outlet.
- 14. Open control panel access door and visually inspect the following items for wear or loose connections respectively.
 - 1. Wires for frayed or loose ends.
 - 2. Drive belt for wear or frayed edges.
- 15. If any deviation of expected results from maintenance and inspection check occurs, report it immediately to Peter J. Branch, William H. Branch Jr., or William H. Branch Sr. who will take appropriate action to confirm results and initiate repairs.

APPENDIX "M"
QUALITY ASSURANCE PROGRAM

10 CFR PART 71

INDUSTRIAL RADIOGRAPHY LICENSE 29-03405-02

1. ORGANIZATION:

The final responsibility for the Quality Assurance Program for Part 71 requirements rests with Branch Radiographic Labs., Inc. Design and fabrication of the radioactive material shipping packages shall not be conducted under this Quality Assurance Program. The Quality Assurance Program is implemented using the following organization:

- a. Radiographer's Assistants and Radiographers are responsible to the Radiographic Supervisor. The Radiographers are responsible for handling, storage, shipping, inspection, test, operating status and record keeping.
- b. The radiographic Supervisor is responsible to the Manager of Quality Assurance. The Radiographic Supervisor is also designated the Radiation Safety Officer and is responsible for Part 71 Quality Assurance requirements. The Radiation Safety Officer is responsible for overall administration of the program, training and certification, document control, and auditing.

APPENDIX "M"

c. The Manager of Quality Assurance is responsible to the President.

2. QUALITY ASSURANCE PROGRAM:

The management of Branch Radiographic Labs., Inc. establishes and implements this Quality Assurance Program. Training for all QA functions, prior to engagement in these functions, is required according to written procedures with management approval. The QA Program will ensure that all defined QC procedures, engineering procedures, and specific provisions of the package design approval are satisfied. The QA Program will emphasize control of the characteristics of the package which are critical to safety.

The Radiation Safety Officer shall assure that all radioactive material shipping packages are designed and manufactured under a Quality Assurance Program approved by the Nuclear Regulatory Commission for all packages designed or fabricated after July 1, 1978. This requirement can be satisfied by receiving a certification to this effect from the manufacturer.

3. DOCUMENT CONTROL:

All documents related to a specific shipping package will be controlled through the use of written procedures. All document changes will be performed according to written approved by management.

The radiation Safety Officer shall insure that all QA functions are conducted in accordance with the latest applicable changes to these documents.

BR 70-12-1
Rev. 2
3-30-84

Page 3 of 4

APPENDIX "M"

4. HANDLING STORAGE AND SHIPPING:

Written safety procedures concerning the handling, storage and shipping of packages for certain special form radioactive material will be followed. Shipments will not be made unless all test, certifications, acceptances, and final inspections have been completed. Work instructions will be provided for handling, storage and shipping operations. Radiography personnel shall perform the critical handling, storage and shipping operations.

5. INSPECTION, TEST AND OPERATING STATUS:

Inspection, test and operating status of packages for certain special form radioactive material will be indicated and controlled by written procedure. Status will be indicated by tag, label, marking or log entry. Status of nonconforming parts or packages will be positively maintained by written procedures.

Radiography personnel shall perform the regulatory required inspections and tests in accordance with written procedures. The Radiation Safety Officer shall ensure that these functions are performed.

6. QUALITY ASSURANCE RECORDS:

Records of package approvals (including references and drawings), inspections, tests, operating logs, audit results, personnel training

BR 70-12-1
Rev. 2
3-30-84

Page 4 of 4

APPENDIX "M"

and qualifications and records of shipments will be maintained. Descriptions of equipment and written procedures will also be maintained.

These records will be maintained in accordance with written procedures. The records will be identifiable and retrievable. A list of these records, with their storage locations, will be maintained by the Radiation Safety Officer.

7. AUDITS:

Established schedules of audits of the Quality Assurance Program will be performed using written checklists. Results of audits will be maintained and reported to management. Audit reports will be evaluated and deficient areas corrected. Audit reports will be maintained as part of the quality assurance records. Members of the audit team shall have no responsibility in the activity being audited. Audits will be on a (3) three month frequency.

BR 70-12-1
Rev. 2
3-30-84

APPENDIX "N"

CALIBRATION OF DOSIMETERS

- A. Calibration of dosimeters shall be performed at intervals not to exceed 12 months.
1. Dosimeters shall be calibrated by the radiation safety officer or his designee.
 2. Dosimeter calibration shall be accomplished in accordance with the manufacturers instructions for the specific calibrator utilized.
 3. Typical calibrators used shall be:
 - 3a. Dosimeter Corporation
Model 3060
 - 3b. Victoreen Corporation
Model 541-205
 - 3c. Or Equivalent
 4. Dosimeters which read in excess of $\pm 30\%$ of true exposure will be discarded.