UNION CARBIDE CORPORATION
P.O. BOX 8361, SOUTH CHARLESTON, WV 25303

August 17, 2000

Mr. David Collins
USNRC, Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85.
Atlanta, GA 30303-3415

Re: License application of Bayer Corp., So. Charleston, WV 25303

Dear Mr. Collins:

This is in response to your recent request for a copy of Union Carbide Corporation, So. Charleston, WV, Technical Center's (Tech. Center) Radiological Safety Manual. The Bayer Operation being licensed is located inside the Tech. Center site. For consistency, efficiency and expediency, Bayer proposes to continue to use the radiation safety services provide by Union Carbide at the Tech Center and abide by the procedures and requirements described in this Manual, as it applies to the sources that they are licensed to possess and use.

As a result of Mr. Diaz's comments during the June 2000 inspection of our licensed operation, we have made minor revisions to the Manual. I am including a second copy that may be added to the Tech. Center's license file (#47-00260-02)

If there are further actions that need to be taken, please let me know. If you have any question on this, please call me at 304/747-5314.

Sincerely,

Michael L. Green
Radiation Safety Officer
South Charleston Technical Center
Union Carbide Corporation

Cc: William Gill, Bayer Corp.
M. N. Duvall, UCC Danbury

A-121

Withhold All EXERPT 2

UNION CARBIDE CORPORATION
SOUTH CHARLESTON TECHNICAL CENTER
RADIOLOGICAL CONTROL MANUAL
June 2000

USNRC LICENSE NO. 47-00260-02

(Functionally Used By Bayer Corporation Operations at UCC So. Charleston Technical Center Site)

August 1, 1979
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Revised May 1999
Revised June 2000

Nuclear Measurements Skill Center
Safety & Industrial Hygiene Technology
Health, Safety & Environmental Technology
Union Carbide Corporation, Inc.
South Charleston, West Virginia

minor revisions flagged by licence reviewer per notes. authors D J Collins 9/8/2000

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CHAPTER I

INTRODUCTION AND ORGANIZATION

1. PURPOSE

This Radiological Control Manual (a) outlines and prescribes the Union Carbide Corporation, So. Charleston Technical Center's Radiation Control Program and identities responsibilities for its implementation and operation; (b) identifies this manual as the official technical publication for controlling the use of radioactive materials, X-ray equipment, and other harmful electromagnetic and particulate radiation-producing sources; and (c) identifies the functions of the Radiation Safety Committee.

Preparation and maintenance of the Technical Center Radiological Control Manual will be the responsibility of the Technical Center Radiation Safety Officer. The manual will establish detailed policies, procedures, standards, and guidelines to be followed in insuring proper radiological health and safety controls, compliance with NRC Regulations, and the capability of the Technical Center to secure and retain those types of NRC licenses which provide the necessary flexibility for operational requirements. The manual will include, but not be limited to, the following subjects:

A. Special requirements and procedures for the acquisition, accountability, and control of radioactive material and radiation producing devices.

B. Functions and procedures of the Radiation Safety Committee, and Radiation Safety Officer.

C. Radiological safety procedures and radiation monitoring.

D. Procedures for securing approval of work involving the use of ionizing radiation, including user requests, licenses from USNRC, and special work permits.

2. SCOPE

This manual is applicable to all Technical Center operations, including tenant and contractor operations that involve the use of radioactive material or radiation-producing devices.

3. OBJECTIVES

The primary objectives and required uses of this manual are to:

A. Keep personnel's exposure to ionizing radiation as low as reasonably achievable (ALARA).

B. Prevent contamination of equipment, materials, and the environment with radioactive materials.

C. Ensure compliance with requirements of the Nuclear Regulatory Commission (NRC) and all other governmental agencies.

4. ORGANIZATION

The Technical Center holds Broad Scope NRC Specific License numbered 47-00260-02. This license permits authorized Technical Center personnel to evaluate, develop, install, and test gauging equipment containing encapsulated isotopes, permits use of sealed sources in shielded source holders in the field determination of process levels and densities, permits the use of radioisotopes in any form for research and development as defined in 10 CFR 30 and permits the use of neutron sources in the testing of steel vessels for carbon buildup.

5. SITE REGULATION

It is management's intent to exercise centralized control over the use of ionizing radiation sources to ensure that exposure will be adequately controlled so as to prevent adverse effects on the health and safety of employees. Persons involved in the use of ionizing radiation are responsible for ensuring compliance with NRC licensing constraints and radiation protection requirements. All proposed uses of ionizing radiation, all procurement actions for sources of such radiation, and all facility and equipment design criteria for use of such radiation shall receive the written approval of the Radioactive Safety Committee with the following exception. Use of conventional commercial level & density gauging devices and chromatograph electron capture detectors require only approval of the RSO.

6. RADIATION SAFETY OFFICER (RSO)

The RSO will coordinate and supervise the Radiation Safety Program at the Technical Center. The RSO will serve as Chairman of the Radiation Safety Committee. Radiation Protection Officer (RPO) is an acceptable alternative name for the RSO. The RSO will be responsible at all times for the status of the Radiation Safety Program. The RSO, or persons designated by him or her, will perform the following duties:

A. Maintain all records pertaining to the Radiation Safety Program.

B. Make periodic surveys (at least semi-annually) to ensure that the radiation protection required is adequate and that the provisions 10 CFR 20, "Standards for Protection Against Radiation," and the provisions of this Radiological Control Manual are being met.

C. Assist in developing operating and emergency procedures for radiological operations.

D. Review plans of proposed operations involving the use of radiation to ensure that adequate protective measures are being incorporated into the design of the operation, and make recommendations to Committee members.

E. Assist in the performance of leak tests on sealed sources, or see that they are performed by personnel trained and authorized for this task.

F. Supervise and coordinate the Radioactive Waste Disposal Program.

G. Assume responsibility for receiving, delivering, and opening all incoming shipments of radioactive material, and receiving, packaging, and shipping all radioactive material leaving the Technical Center.

H. Distribute and process personnel monitoring equipment, determine the need for and evaluation of bioassays, maintain personnel exposure and bioassay records, and notify individuals and their supervisors of exposures approaching maximum permissible amounts.

I. Conduct training program and instruct personnel in the proper procedures for the use of radioactive material prior to use, and conduct refresher training courses periodically.

J. Maintain an inventory of all radioisotopes at the Technical Center and limit the quantity of radionuclides to the amounts authorized by the license.

K. In addition to the above, the RSO has the authority to:

1) Impound radioactive material;

2) Seal off contaminated areas;

3) Require tests of potentially contaminated personnel in consultation with the Medical Department as required;

4) Approve all procurement and shipment of radioactive material and its documentation; and

5) Approve purchase requests for all radiation-producing devices.

7. USER

When an employee of the Technical Center, a Technical Center tenant or a contractor intends to use radioactive material and/or radiation-producing devices, he/she must prepare a memorandum requesting the approval of the Radiation Safety Committee. This request procedure is outlined in Chapter II.

8. RADIATION SAFETY COMMITTEE

The Radiation Safety Committee shall have ultimate authority in all issues concerning radioactive materials and radiation-producing devices. The Radiation Safety Committee will receive requests for use of radioactive as authorized by the USNRC Broad Scope License. Membership to the Radiation Safety Committee will include but not be limited to:

A. Technical Center RSO (Chairman)

B. Technical Center Radiation Safety Personnel

C. Nucleonic Applications Personnel

D. Management Representative (Group Leader)

E. Purchasing Representative

F. Site Industrial Hygienist

The Committee will be required to meet at least quarterly to review activities, and whenever necessary to evaluate new proposals for use of radioactive material. If there are no activities underway which required review by the committee or are the result of action by the committee, the quarterly meetings may be waived at the RSO's discretion. Meetings will be held annually as a minimum. A quorum, consisting of the management representative and two representatives from Radiation Protection and Nucleonic Applications, must be present at a meeting for it to be considered official. A proposal must receive a unanimous vote of all members present for it to be approved.

Proposed uses of radioactive materials shall be presented to the Radiation Safety Committee as described in Chapter II, "Procurement of Radioactive Material and Radiation-Producing Devices." Safety evaluations will include consideration to the adequacy of facilities and equipment, operating and emergency procedures, procedures for disposal of the material, and training of proposed users. Also to be considered is the total possession limit of the proposed isotope. All evaluations shall be based on total containment and control of the radioactive material or controlled release as authorized in 10 CFR 20 or as specifically authorized by the USNRC. All exposures of personnel will be kept as low as reasonably possible with zero exposure as a specific goal.

Use of sealed sources as contained in commercial level and density gauging device will not require approval of the Radiation Safety Committee. The RSO will assure the proper installation and utilization of these devices.

The Committee will maintain control of material by the following procedures:

(1) Only one "Purchasing Agent" is authorized to purchase radioactive materials. This Purchasing Agent is a member of the RSC.

(2) All purchase orders for radioactive materials must be approved by the Technical Center RSO who is Chairman of the RSC.

(3) All radioactive materials received must be checked in at the Receiving Dock by a Radiation Safety Technician who works directly for the Radiation Safety Officer. This individual is responsible for entering the material into the inventory. The received radioactive material will be surveyed tested for contamination using appropriate techniques and the survey will be documented

(4) All shipments of radioactive materials from the Technical Center must be approved by the RSO or his alternate who must verify that the recipient is authorized to receive the material.

(5) An inventory of all radioactive materials at the Technical Center will be maintained continually and will be checked by actual inspection semi-annually.

(6) Proceedings of the Radiation Safety Committee including all proposals and their evaluations shall be recorded and maintained in the files.

(7) Divestment, lease or other action which would cause the user of licensed radioactive material to be other than a UCC employee or UCC contract employee will require that the affected licensed radioactive material be legally transferred to the non-UCC entity. (MLG 6/29/00)

Review of the Radiation Protection Program as it pertains to the Radiation Safety Committee shall be conducted by the Committee annually. This review shall consist of auditing current users, inventories, and other records required to be maintained.

CHAPTER II

PROCUREMENT OF RADIOACTIVE MATERIALS AND RADIATION-PRODUCING DEVICES

1. PROCEDURES

Procurement requests for all radioactive materials will be routed through the RSO for review and approval prior to processing. The procedure is as follows:

The first step for a person who wishes to use a radioisotope is to discuss the proposed project with the Radiation Safety Officer. A formal request for the use of the materials can then be initiated if the RSO is satisfied that the Technical Center is authorized by the NRC to possess the isotope and quantity of material requested, and that the persons who will be handling the material have been adequately trained in the use of radioisotopes.

The formal request will specify what steps will be taken to ensure that the radioactive material is contained at all times and specifically what steps will be taken to prevent the spread of material in the event of an accident. Other items that must be in this request are statements of the specific procedures to be used anytime that the material is handled, procedures used to control the accessibility of this material to untrained personnel, the exact record system to be used in keeping an accounting of the radioactive material at all stages of the experiment, and the ultimate means of disposal of all material.

After the formal request has been approved by the Radiation Safety Committee, the RSO and the user's supervisor may approve the purchase request and submit it to the Purchasing Department. Only requisitions approved in this manner will be accepted by the Purchasing Department for the procurement of radioactive material or radiation-producing devices.

Requests for ionizing radiation emitting devices must be accompanied by the completed form "REQUEST FOR APPROVAL OF IONIZING RADIATION EMITTING DEVICE" from the UCC Responsible Care Programs and Guidelines Manual, Section PG 3.5.0.2

2. RECORDS OF RECEIPT, TRANSFER, AND DISPOSAL OF RADIOACTIVE MATERIAL

The user must maintain permanent records showing materials accountability for each radioisotope. The records must be available at all times and must contain:

A. The amount of radioisotope and the date received. Retain the original shipping receipt with this record.

B. The amount of radioisotope transferred to any other authorized person and the date of transfer. A signed acknowledgment of receipt must be requested when a radioisotope is transferred.

NOTE:
The regulations of the Post Office Department, Department of Transportation, International Air Transport Agency, International Atomic Energy Agency, U. S. Nuclear Regulatory Commission, and the Interstate Commerce Commission must be met when radioisotopes are shipped by U. S. Mail or common carrier.

C. The user must know the location of any radioactive materials in his possession at all times. An inventory should be performed semi-annually or more frequently where necessary, to assure that materials on hand correspond to those thought to be on hand. Procedures for keeping track of radioactive materials in an experiment are to be worked out with the RSO and included in the format request.

D. The amounts of radioisotopes disposed of and a description of the method and date of disposal. Disposal must always be done in compliance with the requirements as set forth by the NRC Regulations and Committee-approved procedures.

CHAPTER III

RECEIVING, SHIPPING, AND STORAGE OF RADIOACTIVE MATERIAL

1. GENERAL

The receiving, packaging, shipping, and storage of radioactive material must be coordinated and controlled to avoid exposing personnel whose duty assignments otherwise require no such exposure to ionizing radiation. All radioactive material transported, stored, or shipped at the Technical Center shall be properly packaged, labeled, and shielded to minimize radiation hazards.

2. APPLICABLE DIRECTIVES

A. The packaging and labeling of both incoming and outgoing shipments of radioactive material must comply with applicable regulations such as the US Department of Transportation (DOT) regulations as specified in Title 49 of the Code of Federal Regulations.

B. **THE SHIPPING AND RECEIVING OF RADIOACTIVE MATERIAL WILL BE CONTROLLED LOCALLY BY THE RADIATION SAFETY OFFICER.**

3. RESPONSIBILITIES

A. The authorized user must assure proper identification, shielding, and containment of all material to be shipped off the Technical Center site or to be transported within the Technical Center. All shipping containers must be labeled in accordance with DOT regulations.

B. The RSO is responsible for inspecting, labeling, and shipping in accordance with DOT and NRC regulations.

C. The RSO will supply technical information as required.

4. PROCEDURES

A. In-coming Shipments

1) Receipt of incoming shipments of radioactive materials will be performed by the Receiving and Shipping Department.

2) The Receiving Department will immediately notify the RSO of the arrival of a shipment by phone, giving all available information such as type of material, amount, size of package, to whom addressed, etc. The package(s) will be set aside with a minimum of handling until the RSO can inspect it.

3) The RSO or his designated agent will immediately proceed to the receiving area, inspect the shipment and perform and document any necessary contamination surveys. After assurance that the shipment is in proper order and that the addressee is authorized to receive the material, the RSO will authorize the Receiving Department supervisor to take action as appropriate.

4) Under no circumstances may these packages be opened without permission of the RSO or his designated agent whose duty it is to test for dose rates and leakage with the proper equipment.

5) The RSO or his designated agent will log the material into the radioactive materials tracking system by filling out the "Radioactive Material Data Sheet" for the source received, create a file folder for the new source, make a notation on the paper copy of the last inventory sheet and enter the data and location of the source into the computer inventory of radioactive materials.

B. Outgoing Shipments

1) Radiation Safety personnel will receive information on the radioactive material to be shipped from the person requesting shipment.

2) Radiation Safety personnel will receive documented verification from consignee that they are authorized to receive the quantity and form of material to be shipped.

3) The shipping container is appropriate for the quantity and form of material to be shipped.

4) The material is packaged in accordance with the requirements of applicable governmental regulations such as 49

CFR 173.393.

5) Adequate internal packing material or bracing is used to protect the contents and maintain required spacing under conditions normally incident to transportation.

6) All closures are properly sealed.

7) Packaging is performed in a controlled area, with appropriate surveillance and radiation monitoring.

8) A radiation survey is performed to ensure that limits specified in 49 CFR 173.393 are not exceeded and to determine the appropriate labels to be affixed to the package.

9) A contamination survey is performed to assure contamination levels are acceptable. All packages of radioactive materials must be tested for removable radioactive material surface contamination prior to shipment, except special form sources (49 CFR 173.443). Special form sources must have a current leak test if leak tests of the source are required. Packages containing normal form materials must have surface contamination levels less than 10E-5 mCi/cm2 or 22 disintegrations per minute (dpm) per cm2 or as required by the applicable governmental regulations. This includes all beta emitters, all radioisotopes with half-lives less than 10 days, natural uranium, natural thorium, U-235, U-238, Th-232, Th-228 and Th-230 when contained in ores or physical concentrates. All other alpha emitting radioisotopes have permissible contamination levels 10% of this value.

10) The following shipping papers are properly prepared and accompany the shipment:

a) Shipper's Certificate.
b) Leak Wipe Results.
c) Guidance for Carriers.
d) Instructions for Consignee.
e) Special Form Certification if applicable.

11) The following papers are properly prepared and mailed to the consignee.

a) License Responsibility Transfer.
b) Radioactive Material Shipment Record Data.

12) The package is marked and labeled as required by the USDOT.

13) Transport Index labels are completed and placed on the package (2 labels on opposite sides of package).

14) Lead or tape security seal is affixed to the package.

C. Intra-center Transportation

1) The RSO will be notified by phone when it is necessary to move radioactive material to a different location within the Technical Center.

2) Radioactive material to be transported within the Technical Center will be packaged and shielded so that the radiation level does not exceed 5.0 millirem/hr at 1 ft from the source if the shipment is accompanied by a qualified user. If not accompanied by a qualified user, DOT regulations apply.

3) Standard radiation warning stickers required by Code of Federal Regulations, Title 10, Part 20 shall be used.

4) The driver of the vehicle will be apprised of the nature of his cargo. It is highly desirable that the user accompany the driver.

5) If there is a vehicle accident, the driver must notify security personnel and the RSO immediately. Emergency personnel will render emergency services such as first aid or fire suppression as necessary to control the situation. The security personnel will keep all unnecessary persons away from the accident area until the RSO has determined that the area is free of radioactivity.

6) The RSO or his/her designated agent will note the new location of the radioactive material in the computer inventory and make a notation on the paper copy of the last inventory sheet

D. Storage

1) All radioactive materials will be stored in designated, properly identified storage areas and will be secured against unauthorized removal.

2) No material will be placed in the Bldg. 747 Radioactive Materials Storage Area without the knowledge and approval of the RSO.

3) Material placed in the storage area will be surveyed and positioned such that the radiation field at 12 inches from the perimeter of the storage area is less than or equal to 2 millirem/hour.

E. Inventory

1) A continually updated inventory of sealed sources of radioactive materials at the Technical Center will be kept in the computer. A paper copy of the last verification of the inventory will be kept in a file drawer near the computer.

2) A physical verification of this inventory shall be performed every six months. This will be done by printing out the computer's version of the inventory, checking it against changes noted on the paper copy of the last inventory and visually checking each source in the inventory by serial number verification. Sources in use will be leak tested and surveyed at that time. At the completion of the check, a new paper copy will be generated for noting change for the next six months.

3) An inventory of unencapsulated radioactive materials will be kept by the principal user of that material. An update and verification of the status of their inventory will be prepared every six months and reported to the RSO.

CHAPTER IV

DISPOSAL OF RADIOACTIVE MATERIAL

1. GENERAL

The proper methods to follow for the disposal of any item of radioactive material that becomes unserviceable or unnecessary are included in this chapter.

Some items may be returned to the supplier for repair or disposition. These procedures are applicable regardless of whether the sources require disposal or return to the manufacturer.

2. SCOPE

This chapter includes procedures for all items of radioactive material including waste that requires disposal, regardless of whether the item is controlled by the NRC.

3. PROCEDURES

A. For items requiring disposal, a memorandum requesting the disposal of radioactive material will be forwarded to the RSO. This request will include, as minimum information about the item(s) the following:

1) Isotope(s).

2) Brief description of the chemical and physical form of the items.

3) Millicuries of activity.

4) Description of container(s).

5) Any toxic or chemical hazard involved with this material.

B. In cases not covered by this instruction, or where any uncertainty exists, the RSO should be contacted for specific instructions.

C. The RSO will evaluate the material for potential future use in other UCC applications. If potentially reusable, the material may be stored in the Technical Center Radioactive Materials Storage Area.

D. Upon receipt of the memorandum, the RSO will take the appropriate action to obtain disposition instructions and to dispose of the item(s). The RSO will prepare all shipping documents and make arrangements for transportation of the item(s).

E. No authorization exists for local disposition of any byproduct material, except as specifically authorized in the Technical Center's USNRC license or as authorized in 10 CFR 20. In all cases where byproduct material or other radioactive material must be discarded, it will be handled as outlined in this chapter. In cases not covered by this chapter, the RSO shall determine the proper disposal procedure.

CHAPTER V

RADIATION PROTECTION GUIDES

1. REFERENCE

Code of Federal Regulations, Title 10, Part 20, "Standards for Protection Against Radiation."

2. GENERAL

A. Unnecessary exposure to radiation should be avoided. In setting standards for Radiation Protection Guides, two types of radiation exposure must be considered:

1) Internal exposure resulting from radioactive material taken into the body by ingestion, inhalation, and absorption through openings in the skin; and

2) External exposure resulting from the body being exposed to radiation from radioactive materials and ionizing radiation produced by machines.

B. The population is divided into two groups for determining Radiation Protection Guides:

1) Occupationally exposed persons, i.e., the small segment of the population who are exposed to radiation in the normal course of their employment. The Radiation Protection Guide is established at a maximum that is not believed to produce detectable damage to an individual during his or her lifetime.

2) All personnel not occupationally exposed that is, the general public. The Radiation Protection Guide for this major portion of the population is established at 100 millirem per year.

C. The area in which radiation fields may exist in excess of those permitted or implied in Paragraph 2.B.2) above must be under the control of the user or the supervisor responsible for the facility, and access to the area must be restricted. No person below the age of 18 can be included in Group 2.B.1).

D. Radiation Protection Guides as outlined in this section do not include doses received from natural background and from medical and dental procedures.

3. DEFINITIONS OF UNITS

Definition of units used in this chapter may be found in Appendix II. (Refer specifically to Radiation Protection Guides, dose, rad, and rem.)

4. BASIC RULES OF RADIATION PROTECTION GUIDELINES

A. Exposure of Individuals to Radiation in Restricted Areas.

1) No individual will receive in any calendar year a total effective dose equivalent of occupational exposure in excess of 5 rem as further defined in 10 CFR 20 Part C.

2) Exposures will be kept as low as reasonably achievable (ALARA).

B. Permissible Levels of Radiation in Unrestricted Areas.

1) Operations will be arranged and performed so that no individual in any unrestricted area will receive a dose in excess of 0.1 rem to the whole body in any period of one calendar year.

2) In no case will any operation be allowed to create in any unrestricted area radiation levels which, if an individual were continuously present in the area, could result in that individual receiving a dose in excess of 2 millirem in any one hour. Whenever maintenance work or scaffolding is being done within 12 feet of a gamma ray radiation source, possible exposure of personnel should be considered and the option of removing the source evaluated.

3) Concentrations of effluents in unrestricted areas shall be governed by provisions of Code of Federal Regulations, Title 10, Part 20, Subpart D and other applicable regulations of the Federal Government and the State of West Virginia.

C. Contamination Guides

Surface contamination guidelines established for restricted and unrestricted areas within the Technical Center are as follows:

(b,g) Surface Contamination

Type of Surface	removable dpm/100 cm^2	total dpm/100 cm^2
Lab benches & floors (restricted areas)	1,000	5,000
Hallways and other unrestricted areas	1,000	5,000
Skin & personal clothing	1,000	5,000

Any levels above these recommendations will require decontamination (see Section E). Every reasonable effort will be made to reduce surface contamination levels in unrestricted areas and on skin & clothing to as low a level as possible, zero contamination being the goal.

D. Radiation and Contamination Surveys

1) Unencapsulated Radioisotope Areas.
In order to assure that radiation and contamination guides are met, surveys will be made at least monthly in area where unencapsulated radioactive materials are actively being used. Records of these surveys shall remain on file in the radiation protection office at the Technical Center. In the event that glove boxes, hoods, ductwork, etc., require maintenance, contamination and/or radiation surveys will be made prior to that work.

2) Sealed source areas
Radiation surveys and leak tests will be performed upon installation of any sealed source and at 6 month intervals thereafter as described in this manual.

3) Maintenance Operations Near Radiation Sources.
Whenever maintenance work or scaffolding is being done within 12 feet of a gamma ray radiation source, possible exposure of personnel should be considered and the option of removing the source evaluated.

E. Decontamination Procedures

1) General
Contamination of personnel, plant areas, or equipment areas may present emergency conditions following an accident. Prompt measures must be taken to identify contaminated personnel and to perform required decontamination. As soon after a survey of contamination as possible, preplanned decontamination methods shall be applied to the contaminated areas and equipment. Only the RPO or his authorized delegate(s) shall decontaminate personnel or material.

2) Procedure for Decontaminating Personnel

a) All contaminated clothing or clothing suspected to be contaminated shall be removed and placed in suitable waste containers (a plastic bag within a plastic can or equivalent) for later disposal.

b) If the skin is affected, the contaminated area shall be scrubbed thoroughly for two to three minutes, soaping and rinsing repeatedly. Consideration shall be given to the chemistry of the contaminant, and an attempt shall be made to find a suitable agent for dissolving it. Any cleansing agent may be used, but synthetic detergents are preferred to soap. (Note: Prolonged decontamination may result in irritation of the skin and should be avoided.)

c) In serious cases, a physician shall be called immediately, but the decontamination shall proceed until he arrives and gives further instructions. If internal contamination is suspected, the physician must be notified so that he may take appropriate biological samples as needed for examinations.

d) Personnel engaged in contamination surveys and decontamination operations shall wear respirators, coveralls, and shoe covers, as necessary.

3) Decontamination of Tools and Materials
Under the direction of the RPO, vacuum cleaners, mops, detergents, and wetting agents should be employed on the contaminant. Care must be exercised so that these objects themselves do not become contaminated, or, if they do, that they are treated as radioactive waste. Vacuum cleaners must have high efficiency filtered exhausts.

F. Air Sampling

To assure that no workers are exposed to concentrations of radioactive material in air greater than those specified in 10 CFR 20, Appendix B, Table 1, Column 1, activity concentrations will be evaluated on a quarterly basis. Evaluations will be made using a Johnson Laboratories, Inc., TRITON 955B air monitor.

If airborne radioactive particulates are suspected, known volumes of ambient air will be passed through a paper filter. The filter will be removed and counted in the proportional alpha/beta counter in the Nuclear Measurements Laboratory. The average airborne concentration will be determined by dividing the activity on the filter by the volume of air passed through the filter.

CHAPTER VI

PERSONNEL MONITORING

1. REFERENCE
Code of Federal Regulations, Title 10, Part 20.

2. GENERAL
Paragraph 20.1502 of the above referenced Federal regulation requires that appropriate personnel monitoring equipment be applied to:

A. Each individual who is likely to receive, a dose in any calendar year in excess of 10 percent (10%) of the applicable value specified in Paragraph (A) of 20.101 [Paragraph 4.A.1) of Chapter V of this manual

B. Minors and declared pregnant women who enters a restricted area and receives, or is likely to receive, a dose in any calendar quarter in excess of 10 percent (10%) of the applicable value specified in Title 10, CFR 20.1207 & 20.1208.

D. Each individual prior to entering a high radiation area.

E. Personnel working as radiographers as specified in 10 CFR 34.33. This requirement applies to machine radiography as well as radiographers using by-product material.

F. Personnel who may not meet any of the above categories, but whom the RSO decides should wear personnel monitoring equipment.

3. SCOPE
These requirements apply to all employees of the Technical Center, its contractors, its consultants, etc.

4. DEFINITIONS
See Appendix II for definitions of technical terms used in this procedure.

5. RESPONSIBILITIES
The Radiation Safety Officer is responsible for obtaining dosimetry service at the Technical Center. The manager of each activity in which there are projects dealing with radioactive materials or equipment capable of producing or accelerating ionizing particles shall enforce these requirements. The RSO will also provide guidance and establish need for dosimetry services within the Technical Center.

6. TYPES OF DOSIMETERS

A. Film badges
B. Thermoluminescent dosimeters (TLD)
C. Pocket ion chambers (non-self-reading)
D. Pocket dosimeters (self-reading)

Film badges and TLDs (see Appendix II) are used to obtain a permanent record of the radiation dose to which the individual has been exposed. Pocket ion chambers and pocket dosimeters (see Appendix II) permit the individual to check daily on his accumulated dose. Their use is advisable whenever a person expects to be exposed to radiation fields higher than 5 mrem/hr. They are to be used to detect high doses in addition to a film badge or TLD which will be used to obtain a permanent record of the dose.

7. PROCEDURES

The procedures for using each of the above described dosimetry devices are outlined in the following paragraphs:

A. Film Badges and Thermoluminescent Dosimeters
1) General Precautions:

a) Do not tamper with the film or TLD.

b) Do not expose the film or TLD to excessive heat or moisture.

c) Do not leave the film or TLD in a location where it will be exposed to radiation except when worn by the employee.

d) Always wear the film or TLD badge when entering a radiation area (see Appendix II) or working with radiation emitting devices.

e) Wear only your own film or TLD badge.

f) Report any occupational exposure that the badge or TLD may not have recorded.

g) Wear the monitor on the area of the body most likely to receive the highest radiation exposure, with the label facing away from the body.

h) Do not wear film badge or TLD when being exposed to medical X-rays for therapeutic or diagnostic purposes.

2. How to Obtain Badges or TLDs:

a) The responsible Technical Center supervisor will, prior to using a radiation source, consult with the RSO to determine dosimetry requirements. If dosimetric service is required, the supervisor will request a film badge or TLD for each individual who does not already, have one and who may be exposed. This.request will be in the form of a memorandum to the RSO. It will include the name of the individual(s), the type of radioactive material or the radiation-producing device for which dosimetric devices are required, the date they are required, the location where the work is done, and the name of the person who will supervise the work. In addition, the following information for each individual for whom film badges are required is necessary: name, job title, normal work assignment extent of previous radiation exposure, Social Security number, and date of birth.

b) The RSO is responsible for obtaining dosimetry service when it is required. There are several vendors who provide this service for a nominal charge.

B. Pocket Dosimeters and Pocket Chambers

1) Since pocket dosimeters and pocket ion chambers permit immediate evaluation of radiation exposure, they can be used to supplement film badges. It is good practice to carry two dosimeters or pocket chambers since they are subject to leakage and accidental discharge. When using two pocket ion chambers, the lowest value is recorded. Chambers and dosimeters will be used that measure radiation dose within an accuracy of 10 percent (10%) or better in the average range encountered in the use of sources of ionizing radiation.

2) Dosimeters and pocket chambers will be charged and read by the RSO or a qualified person designated by him. The accumulated dose will be recorded. A record will be maintained for each individual exposed. Since the accumulated dose for the period is maintained, each individual can determine if he has exceeded the maximum permissible exposure. In the event an overexposure is suspected, the individual's film badge will be delivered to the RSO so that it can be evaluated immediately.

8. PERSONNEL MONITORING RECORDS

U. S. Nuclear Regulatory Commission Form 5 "Current Occupational External Radiation Exposure," or its equivalent will be included in the records of applicable individuals who are required by regulation, to be monitored. The RPO will maintain cumulative dose records on each employee required to be monitored, as required by 10 CFR 20.2106.

Records of personnel exposure will be maintained for an indefinite period of time.

CHAPTER VII

INSTALLATION, LEAK TESTING & RADIATION SURVEYING OF SEALED SOURCES

1. GENERAL

A. References
National Bureau of Standards Handbook, "Safe Design and Use of Industrial Beta Ray Sources"; Handbook 73, "Protection Against Radiations from Sealed Gamma Sources"; and CFR Title 10.

B. Definition
"Sealed Source" means radioactive material that is encased in, and is to be used in, a container in a manner intended to prevent leakage of the radioactive material.

C. Types of Sealed Sources
1) Gamma ray sources such as Co-60, Cs-137, and Ir-192 are used in industrial applications, radiography, and in medical therapy.

2) Beta sources such as Sr-90, Ni-63, Fe-55 and Pm-147 are used as density gauges, nuclear batteries, static eliminators, etc.

3) Alpha-emitting sources such as Ra-226 and Am-241 are used in alpha-neutron sources and as sources for ionizing air in devices such as smoke detectors.

D. Deterioration or Rupture of Containers
Any leakage is serious since the escaping material can contaminate surfaces that it contacts and may be inhaled or ingested into the body. Several factors may cause the container or its seal to leak or become damaged.

1) Radiation from the source itself, either direct or indirect, which accelerates corrosion either directly or by production of corrosive ozone in the air.

2) Attack by chemicals inside the source.

3) Attack by corrosive fumes, solvents, or other chemicals to which the source may be exposed.

4) Buildup of gaseous pressure inside the encapsulating material by the action of radiation or by heating, such as might occur during a fire.

5) Breakdown resulting from discharge of high electrical potentials built up by the transmission of beta particles through insulating material.

6) Vibration, shock, or other mechanical injury.

7) Stresses set up by differences in thermal expansion.

8) Deterioration inherent in the materials used for the container; e.g., loss of solvents or plasticizers from plastics.

9) Damage from high or low temperatures, humidity, low pressure experienced in shipment by air, or any other unfavorable environmental conditions that might occur.

E. Detecting Leaks

For the foregoing reasons, it is mandatory that leak tests be performed on all sealed sources upon receipt, at other specified intervals, and before shipping. The conditions detailed in NRC licenses concerning possession and use of sealed radioactive sources include requirements for performing leak tests and maintaining records of the results.

F. Standard Leak Test Kit

The Standard Leak Test Kit supplied by the UCC Technical Center specifically for performing leak test on sealed sources consists of:

1) A glass vial containing a cotton tipped wooden swab. One vial & swab is supplied for each source to be leak tested.
2) One label for each vial.
3) One vial of weak soap solution for wetting the swab.

4) One set of instructions (See Appendix VII, Standard Forms).

2. EQUIPMENT REQUIRED FOR PERFORMING LEAK TESTS

A. Long-handled forceps or tongs for handling sources.

B. An appropriate survey meter.

C. Filter paper, cotton, or cotton swabs attached to sticks for wiping the container and envelopes.

D. A sensitive counter capable of measuring 0.005 microcuries of the isotope in question.

E. Protective gloves.

F. Film badges.

G. Appropriate shielding.

3. PROCEDURES FOR LEAK TESTING SEALED SOURCES

A. General

1) Leak wipe test will be made only by the RSO or his authorized representative.

2) Personnel performing the leak tests shall wear film badges if the source being checked emits gamma rays or high energy beta particles.

3) All sources being tested will be handled as though they are leaking until proven not to be leaking.

4) This step should be followed very carefully to insure the proper identification and accuracy of the analysis. Complete the leak test kit labels as to:

a) the location of the source;
b) the date the leak test was made;
c) the identification (a serial number, property number, etc.) and
d) type of isotope that is contained within the source holder.

LOCATION: _____

DATE: _____

I.D. NO.: _____

ISOTOPE: _____

After this has been completed, remove the paper backing and attach the label to one of the sample containers.

5) The individual making the test will follow the procedures listed below:

a) Use protective gloves and accessories. In wiping special-form sources with a cotton tipped wooden applicator, gloves may hinder efficient completion of the task and prolong the individuals time in the vicinity of the radiation source. Since this type source has an extremely low probability of leaking, use of gloves is optional.

b) If the source holder is in a storage container, cautiously remove the cover of the storage container, so as not to spread contamination if the source is leaking. DO NOT ATTEMPT TO OPEN THE SOURCE HOLDER UNLESS SPECIFICALLY AUTHORIZED AND LICENSED TO DO SO.

c) Do not expose any part of your body to a direct beam from the source holder.

d) Remove cotton applicator from its container. Saturate the cotton applicator with leak wipe solvent and wipe all external seams, cracks, and openings of the source holder to achieve maximum surface material removal.

- DO NOT DISASSEMBLE THE SOURCE HOLDER.
- DO NOT PLACE THE COTTON APPLICATOR IN THE SOLVENT DURING OR AFTER IT HAS BEEN USED TO WIPE THE SOURCE.

e) Carefully place the cotton applicator in the labeled container and securely tighten the cap.

f) Remove the vial containing the cotton applicator from the radiation field to a location where only background (~0.01 millirem per hour) is indicated on the meter. Measure the radiation field on the wipe. Do not touch the survey meter with the cotton applicator. If the wipe reads twice background or greater, shield the wipe as if it is itself a radiation source and take two more wipes of source as verification of the leak.

g) After all leak tests have been completed and properly identified, send them to the Nuclear Measurements Skill Center for analysis.

h) Other techniques may be approved by the RSO.

6) The individual performing the leak test shall prepare a note summarizing:

a) The name of the individual who performed the leak test.
b) The address where the results are to be sent
c) The name and telephone number of the individual responsible for Radiation Safety.
d) The purchase order or UCC charge number for billing purposes.

7) In the event the removable contamination exceeds 0.005 microcuries, the source is considered to be leaking. The source container will be closed and tagged until it can be prepared for shipment, repair, or disposal. (See Chapter XVI, Emergency Procedures)

8) Sources that are leaking may be returned to the manufacturer for repair or disposal: if this is not possible they may be disposed of as outlined in Chapter III.

9) Notify the appropriate governmental agency as required in the Technical Center USNRC License and 10 CFR 20 & 10 CFR 21.

B. Radiographic and Similar Sealed Sources

High intensity gamma ray sources used for radiography or other similar industrial purposes will be leak-tested by wiping the nearest accessible point to the sealed source storage position, and then following the pertinent portions of the procedure outlined in Paragraph 3.A. above.

4. PROCEDURES FOR PERFORMING RADIATION SURVEYS

A. Survey of a Sealed Radiation Source.
When a radiation source is first installed or when it is move, it is necessary to perform a radiation survey of that source. The purpose of a survey is to measure and document the radiation fields around a radiation source, to assure that it is properly installed and to assure that all necessary signs and warning labels are in place.

A formal survey should include measurement of the radiation fields with a suitable survey meter. Measurements are made at standard locations such as top, bottom, left side, right side, back side and across and around the vessel to which it is mounted. Measurements are made on contact and at 12" from the surface of the source. These measurements are recorded on the survey form. A general survey of radiation fields around the source should also be made to assure that the recorded measurements are typical.

Maximum permissible radiation levels are:

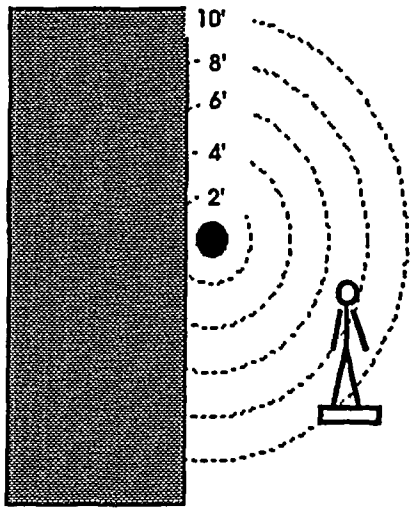
- less than 5 mrem/hr at 12" from the surface of the source holder
- less than 2 mrem/hr at all other locations accessible to a person's whole body.
- radiation areas only accessible to a person's extremities will be screened or equipped with guards to prevent such access.

If the source is in a high occupancy area, shielding the source to lower levels may be necessary as described under the

topic Occupancy Factors. The installation should be reviewed for personnel access areas within 12 feet of the source. If there is an area near the source where persons are routinely present, then the occupancy factor for that location must be determined.

A survey should also include a check that all hand guards, signs and warning labels are in place and clearly visible. The results of the survey should be documented on a survey form and this record should be retained until another survey is made.

B. Occupancy Factors



Distance from Source, Feet	Dose rate mrem/hr
1	5.00
2	1.54
3	0.74
4	0.43
5	0.28
6	0.20
7	0.15
8	0.11
9	0.09
10	0.07
11	0.06
12	0.05
13	0.04

The occupancy factor (OF) is an estimate of the fraction of a persons time that is spent in the area or location in question. To determine this value for a location, estimate the maximum fraction of time that the person who is most frequently at that location, is at that location. The OF can be estimated on an hourly, daily, monthly or annual basis, as appropriate. The technique for estimating would be to ask the person most frequently at the location in question, how many minutes per shift he/she would be at that location under normal circumstances. Dividing the number of minutes given in their response by the length of a shift in minutes is the occupancy factor for that location. The table in the figure gives the maximum radiation field at various distances from a source according to the inverse square law. The radiation field is assumed to be 5 mrem/hr at 12" from the surface and the source is located 4" below the surface of the source holder. The actual activity of the source doesn't enter into the calculation.

Estimating the potential dose that personnel might receive from a particular source can be done relatively easy. The permitted dose to the public is 100 mr/yr. If the work year is taken to be 2000 hours then a person could be in any radiation field of less than 0.05 mrem/hr (100/2000) continuously and not exceed the 100 mrem/yr. limit. Therefore, in the above example any source located more than 12 ft. from a personnel access area (PAA) can not expose a person to more than the permitted dose under normal circumstances. A PAA is defined as a walkway, platform, fixed ladder or pad where a person can be present in the course of his/her normal duties. As an example, the nearest PAA is 8 ft. away and the calculated radiation field is 0.11 mrem/hr (the actual field may be less than this). Therefore a person could be in this location (100/0.11) for 909 hr. per year or 45% of the time and not exceed the limit.

Three types of work areas are defined to facilitate determination of acceptable radiation levels in work areas. This is for personnel who are not to be exposed to more than the permissible dose of 100 millirem per year.

The first type of work area is defined as an Active Work Area (AWA). This is an area where personnel work on a more or less continuous basis in one location. Examples of such an area might be a control room, a work shop or an office. It is assumed that personnel are present from 50% to 100% of the time. Permissible radiation fields would be 0.05 to 0.1 millirem per hour based on a 2000 hour work year.

The second type area is termed an Intermittent Work Area (IWA). The worker is assumed to only be in this area part of the time. As an example, assumes a person is present in the area for 15 minutes, four times a day for a total of 12.5% of the time. The permissible dose rate for this area would be 0.4 millirem per hour.

The third type of area is termed a Passage Area. Examples would be walk ways, platforms, fixed ladders and pads where personnel only pass by on an occasional basis. Assume that the radiation field that is greater than 0.05 mr/hr

extends 12 ft. on either side of the source. It takes a person about 6 seconds to walk 24 ft. Assume this person passes this point 16 times per day. The radiation field could be 15 mrem/hr and the individual would still not exceed the permitted annual dose of 100 mrem/yr. The maximum permitted dose rate is 2 mrem/hr. There is little chance of the annual exposure limit being exceed by walking past a source, even if the person walks very slowly and passes a source more than 16 times per day.

C. Signs and Warnings

Every container of radioactive materials must have a label on it with the words "Caution -Radioactive Material", the international symbol for radiation hazard, as well as information on the radioisotope and quantity of material. Normally this label is printed in magenta on yellow although other black on yellow may be used.

Every area where the radiation field exceeds 5 mrem/hr at 12" from the radiation source or any surface from which the radiation is emitted must be delineated with a sign saying "Caution-Radiation Area".

Every area where the radiation field is such that an individual could receive a dose of 100 mrem in any one hour at 12" from the radiation source or any surface from which the radiation is emitted must be delineated with a sign saying "Caution-High Radiation Area".

Vessels which utilize nuclear level or density gauges may have a high radiation area in their interior. In such cases, any entry ports or man-ways should have a sign with words to the effect, "Caution-High Radiation Area Inside. Do not enter unless checked by the Site Radiation Safety Officer". Unit, Maintenance and Plant Standard Operating Procedures should include provision for checking such vessels with a survey meter prior to entry.

Each source of radiation should be evaluated for the need for additional warnings, other than the prescribed "Caution Radioactive Material" labels. Regulations require that each licensee "may provide on or near the required signs and labels, additional information, as appropriate, to make individuals aware of potential radiation exposures and to minimize the exposures". In most cases, this requirement is satisfied by installing a large (~8" x 10") "Caution Radioactive Material" sign in a highly visible location near the radiation source. The general public dose limit may make wording such as "Caution Radioactive Material-Unauthorized personnel should not remain within 5 ft. of this source for more than 10 minutes per hour" appropriate.

Whenever maintenance work or scaffolding is being done within 12 feet of a radiation source, possible exposure of personnel should be considered and the option of removing the source evaluated.

D. Survey Procedures

1) Obtain an operable, calibrated survey meter appropriate for the radiation to be measured. All radiation fields are recorded in millirem per hour.

2) Using the standard "Radiation Survey Form", record the information about the source being surveyed and the survey meter being used.

3) Measure and record the radiation field in mrem/hr at 12" from the source in all directions (top, bottom, left, right, front & back sides). Optionally, the radiation field on contact with the source holder may be recorded. All measurements will be made with the source in the "ON" position unless otherwise noted.

4) Test the shutter mechanism to assure that it is effective in shutting off the radiation beam by measuring the radiation fields when "OFF" & "ON".

5) Measure and record the radiation field at the density or level gauge's detector at 12" from the surface where the radiation beam emerges.

6) Measure and record the radiation field at mid torso level (~4' off the floor) at any and all passage ways or work stations within 12' of the source.

7) Estimate the occupancy factor for the locations identified in step 5).

8) If the product of the occupancy factor and the dose rate is greater than 0.05 apply further shielding to the source.

9) Assure that the sources "Radioactive Material Identification and Data" label is affixed to the source and is readable.

10) Apply additional signs and warnings as appropriate.

11) Check source to assure that it is securely mounted.

12) Complete the Radiation Survey Form, obtain the RSO's approval signature and file the form in the appropriate location.

13) Any abnormal occurrence or situation regarding the radiation source that is encountered in the process of making the radiation survey may be treated as an emergency. In which case the procedures of Chapter XVI, Emergency Procedures will apply.

5. PROCEDURES FOR INSTALLATION OF RADIATION SOURCES

A. Do not turn the source "ON" at any time until physical installation is complete and the source is ready for a Radiation Survey.

B. When removing a source from its "use" or "storage" location, check to assure that it is locked in the "OFF" position. Verify by use of a radiation survey meter.

C. Maintain visual contact with the source while it is being handled by maintenance personnel during mounting and transport at the job site.

D. If the source is damage during these operations, the requirements of Chapter XVI Emergency Procedures will apply.

E. After the source is physically secured in its permanent location, verify that all bolts and fasteners are securely fastened. Assure that the mounting appears to be adequate to hold the mass of the source holder.

F. Check for any access points where an individual may insert, intentionally or inadvertently, any portion of his body into the radiation beam. Arrange to have these openings blocked or screened before permitting operation of the source.

G. Before turning the source on to make the initial and any subsequent radiation surveys, make sure that no personnel are in a position to get into the radiation beam.

F. Post appropriate warning signs near the source and on any entry point to the vessel, if there is potential for personnel to get into the radiation beam.

G. Perform the radiation survey and leak wipe test as described above.

H. Advise operations and/or maintenance supervision that the installation has been completed and that the source is either "ON" or "OFF".

I. Submit survey forms to the site RSO for approval. Discuss any issues concerning the installation at that time.

CHAPTER VIII

LEAK WIPE COUNTING AND SURVEY METER CALIBRATION

1.0 GENERAL

The Safety and Industrial Hygiene Technology Group, Nuclear Measurement Skill Center maintains and operates facilities for the counting of leak wipe tests and for the calibration of survey meters and other radiation detection instruments. In addition, a capability is maintained for analysis and repair of damaged or faulty instruments.

2.0 LEAK WIPE AND CONTAMINATION SMEAR COUNTING CALIBRATION PROCEDURES.

The apparatus for counting leak wipes or contamination smears is calibrated at the beginning of each counting session or more frequently as indicated by the stability of the counting apparatus. The calibration procedure is based on the use of calibration sources whose activity is typically known within ±5%. A calibration source of the particular isotope which is being analyzed is used as a calibration source. If such a calibration source is not available, the isotope emitting radiation most similar to the radioisotope in question shall be used. The system used has the capability of detecting less than 0.0005 mCi. The step-by-step procedure for calibrating the counting system is as follows:

The following table gives recommended counting systems and calibration sources to use in analyzing various common radioisotopes. Unlisted isotopes will be analyzed using the most appropriate source or combination of sources and systems.

Isotope to be counted	Primary Radiation	Counter to use	Calibration Source
Cs-137	0.662 MeV gamma	Gamma-7000	Cs-137
Fe-55	<0.2 MeV x-ray	PIC	Fe-55
Ni-63	0.067 Beta	PIC	Ni-63
C-14	0.156 Beta	PIC	C-14
Bi-210	1 MeV Beta	PIC	Sr-Y-90
Po-210	5.3 MeV Alpha	PIC	Th-230
Am-241	5.5 MeV Alpha	PIC	Am-241
Cd-109	0.088 MeV x-ray	Gamma-7000	Cs-137
Rn-226	Various gamma	Gamma-7000	Cs-137

2.1 BECKMAN GAMMA 7000

When using the Beckman Gamma 7000, leak wipes are counted in glass vials. Usually, the customer sends the leak wipe in a labeled glass vial.

A. Load an empty glass vial into the first counter sample carrier vial after the four counter control plugs to measure the background count rate. The sample carrier vials are white plastic vials that fit into slots in the carrier sample handling system.

B. Insert the proper calibration source into the second carrier vial to determine the calibration source count rate.

C. Load the leak wipes to be counted, still in their glass vials, into the carrier vials following the background and calibration source. Samples not already in glass vials will be placed in clean new vials for the counting process. The End of Samples counter control plug must be placed after the last vial to be counted

D. Record all pertinent data about the leak wipes or contamination smears on the Counter Input Data form in the sequence that they are loaded into the counter.

E. Using the middle (back arrow) button on the counter, back the carrier up until the background vial and the four counter control plugs, are past the counter well

F. Press the green button labeled "AUTO" to commence the counting sequence.

G. Note the date and customer's name or location on the Gamma 7000 printer paper to identify the data that will be printed out.

H. After the counter has completed counting all wipes (~10 minutes per wipe), take the Counter Input Data form and the print-out from the Gamma 7000, to the Laboratories Compac computer. The name of the computer is SCTNUCLB and the pass word will be written on the computer.

I. Go to the appropriate file location using the path <My Computer, sctnuclb$on..., NucLabFiles, Leak Wipes, Location>(eg.515). Open up the most recent Leak Wipe Results file and do a Save As giving the new data file name in the format, "Location Number, month, year". Up-date the information at the top of the form.

J. Enter the count rate from the Gamma 7000 computer print out in column I, and from the Counter Input Data form enter the Sample ID in column B, the Sample date in Column D and the isotope in Column E. Follow the instructions on the template for entering data and it will calculate the activity on the leak wipe. If the result is less than 5 E-04, enter <0.0005 column F. Hit Save

K. Print two copies of the Leak Wipe Results form. Sign both copies. File one copy in the locations "Leak Wipe" file and send the second copy to the customer.

2.2 PROTEAN INSTRUMENTS CORP (PIC) MODEL IPC 9025 COUNTER

A. Turn on the counter gas and purge the instrument for 1 hour at a flow rate of 60 ml per minute. Turn on the counter and let the electronics warm up during this period.

B. Place the dark gray plastic planchet sleeve on the planchet stacking jig and adjust the height as appropriate. Place a clean empty stainless steel planchet in the carrier ring and stack it on the planchet stacking jig. Place the calibration source(s) in a planchet(s) and add it to the stack.

C. Note the information about the wipe or contamination smear on the Counter Input Data form. Place a piece of paper on the work surface to avoid contamination of the lab bench. Remove the contamination smear from the container. Place the contamination smear in a stainless steel planchet with the contaminated side up and stack on the planchet stacking jig. Make sure that the contamination smear does not extend over the side of the planchet. It is to be below the edge of the planchet at all times. Do not touch the contamination smear with your hands, but use tweezers..

D. Continue until all smears to be counted are in the planchet stacking jig and all data is logged on the Counter Input Data form. Top the stack with another empty planchet for an additional back ground measurement.

E. Carefully, remove the dark gray plastic sleeve with all the planchets from the stacking jig and place it in the front sample hole of the PIC

F. After completion of the purge cycle, press the "count" button on the PIC. In succession, press the following commands: "Menu directed batch", "enter", "gross alpha/beta 10 minute" ,"enter". Press "Alt-break" and "enter" simultaneously to start the counter. The counter will count the samples in sequence. Total counting time is about 15 minutes per sample.

G. When the counting is complete, the PIC display will read "printer error detected". Turn on the PIC's Dell computer. Open the program "PICdos" at the top of the start-up menu. Click "OK". It will have the default parameters:

Instrument Selector	"PIC 1"
Input data type	"Data Buffer - CSV"
Print file selector	"DATA BUFFER"
File Name	"C:\PIC\PICDATA.CSV"

H. Return to the PIC and punch "Enter". The PIC will then download the data to the computer. Exit the program PICdos. On the C drive open the folder PIC. Look for the file "PICDATA". Open it. It is the last download from the PIC. Do a "Save As" an Excel Workbook in the "My Documents" folder and name it with the date and location providing the samples such as "515 1 12 99".

I. The only data used on the spreadsheet down loaded from the PIC is the date, time, count time, alpha counts, alpha cpm, beta counts and beta cpm. All other columns may be deleted. In the sample description column type in the sample description. Print out the data.

J. After counting of the wipes is finished, dispose of them in the general trash. If a wipe is contaminated, place it in the radioactive waste container.

K. Enter the data generated in the counting process into the laboratory's computer as described above starting with step 2.1H. The computer will calculate the activity on the sample and prepare a report of the findings.

L. Return one copy of the computer calculated results to the person who submitted the leak wipe and place one copy in the file for that location. The raw data from the counting will be kept in a separate file.

M. Example:

A = Calibration source activity = 0.0698 mCi (Automatic decay correction)
CAL = Counts per minute from cal. source (10 minute count) = 65,879 cpm
BG = Background count rate (10 minute count) = 268.5 cpm
SAMP = Counts per minute from sample (10 minute count) =270.9 cpm
WIPE = Activity on leak wipe = (SAMP-BG) x A / (CAL-BG)
= (270.9-268.5) x 0.0698 mCi / (65,879-268.5)
= 2.4 x 0.0698 mCi/ 65,611 = 2.5 x 10-6 mCi
which would be reported as <0.0005 mCi. (See Standard Forms, Appendix VIII)

3. RADIATION SURVEY METER CALIBRATION

The survey meter calibration apparatus consists of two radiation sources in collimated holders with a scale marking the distance from each source. The radiation field has been determined at set distances from each source. The survey meter calibration apparatus is inside a locked room with filled concrete block walls.

The radiation field from a cesium-137 source was measured at several distances from the source(s) using a Victoreen "R" Meter (accuracy +5%). From these readings, a dose-rate-versus-distance-from-the-source curve was prepared. Two different sized sources are used to provide the range of dose rates required to calibrate all instruments. The magnitude of the "calibrated" radiation fields is automatically reduced by the laboratory computer as a function of time as the sources decay.

A. The detector of the survey meter to be calibrated, is placed in the calibrated radiation field from the cesium source. Use care to assure that the entire detector is in the radiation field.

B. The meter is then adjusted at one point in that range to agree as closely as possible with the calibration dose rate. The linearity of the meter is verified by checking the detector at least two different dose rates in each range. These steps are followed until all ranges have been calibrated and recorded. If the reading of the meter being calibrated is not adjustable, the reading is compared to the known radiation field. If the meter being calibrate agrees with the calibrated radiation field within ±20%, the meter is considered to be in calibration. If not within 20% the discrepancy is noted in the report to the customer.

C. Upon completion of calibration, the record of the calibration is stored in the laboratory computer following the path path <My Computer, sctnuclb$on..., NucLabFiles, Survey Meter, Location>(eg.515). The measured radiation field and other pertinent data is entered in the appropriate columns of the form. The form calculates the ratio of the measured to actual radiation field as a percentage. A ratio of +/- 20% is acceptable.

D. A certification sheet, showing the calibration and remarks or recommendations, is forwarded to the owner of the survey meter. A copy of the certification sheet is retained in the files for that location or customer. (See Standard Forms, Appendix VIII)

E. Before the survey meter is returned, a stamp similar to the one shown below is affixed to show the date and place of calibration. The person calibrating the meter should write his initials on the stamp on the "Date" line.

Calibrated by U.C.C. Process Measurement Systems Tech Center Bldg. 747 Date_____ Next Calibration Due Date_____

Occasional checks of the calibration facility are made by comparison with survey meters calibrated by vendors or other facilities.

Survey meters for use in neutron fields will be returned to the vendor (Eberline) for periodic recalibration.

5. DOSIMETER CALIBRATION PROCEDURE

Manually record all data on a blank "Dosimeter Calibration Form" (See Appendix VIII, Standard Forms"). At the completion of the test, log the data in the computer, generating a copy of the completed form for the client and the for the files.

A. Inspect the dosimeter for obvious physical damage.
B. Place the dosimeter in the dosimeter charger and adjust until it reads between zero and 10% of full scale. Record this reading, "Initial mR",and the time and date in the format "m/d/y h:m"
C. Place the dosimeter in an area free of radiation fields for at least 24 hours.
D. Reread the dosimeter and record the reading, "Final mR", and the time in date as above.
E. If the difference in the initial and final reading has changed by more than 2% of full scale (R_{fs}) per 24 hours, reject the dosimeter. Cleaning the dosimeter with ethanol and baking for 24 hours in a low temperature oven will frequently correct drift problems.
F. Repeat step B.
G. Place the dosimeter in a known radiation field and leave it there long enough to receive a dose greater than 50% of the full scale reading for that dosimeter, but still less than full scale. Note the time and date of the completion of this part of the test as above.
H. If the difference in the dosimeter reading before and after completion of step G. is greater than ±20% of the true value of the radiation dose, the dosimeter is rejected.

If at any time in this procedure the dosimeter is dropped or receives a sharp blow, stop the test and start over from either Step B or Step F, as appropriate.

CHAPTER IX

ANALYTICAL X-RAY DEVICES

1. GENERAL

Although there are published reports dealing with radiation protection and apparatus design, there is a lack of generally accepted standards or recommendations for X-ray diffraction and spectrographic equipment: For these reasons, this chapter was prepared using material developed by the Medical and Occupational Radiation Program of the National Center for Radiological Health. These statements containing the word "shall" are considered necessary to meet minimal standards for protection; those statements using the word "should" are considered advisory and are to be applied when practical.

2. RESPONSIBILITIES

A. For each operation involving radioactivity or radiation-producing devices, a person shall be appointed to be responsible for radiation safety. This person shall be familiar with the basic principles of radiation protection and the particular hazards of the specific device under consideration. This person shall be responsible for the following:

1) Insuring that operational procedures pertaining to radiation safety are established and carried out so that the radiation exposure of each worker is kept at a minimum.

2) Providing instruction in safety practices for all personnel who work with or near the equipment.

3) Arranging for the establishment of radiation control areas, including placement of appropriate radiation warning signs and/or devices.

4) Providing periodic radiation safety inspection of the equipment and operations.

5) Reviewing modifications to X-ray apparatus, including X-ray tube housing, cameras, diffractometers, shielding, and safety interlocks.

6) Investigating any case of abnormal radiation exposure of personnel.

7) Closely coordinating all of the above with the RSO.

B. Operating supervisors will further ensure that:

1) Individuals who act as operators of analytical X-ray devices receive an acceptable amount of training in radiation safety. (Refer to Chapter XII of this manual.)

2) Operators have demonstrated competence in the use of X-ray devices and radiation survey equipment.

C. The operators of analytical X-ray equipment shall be responsible for all operations associated with the equipment, including radiation safety. In particular, he shall:

1) Keep radiation exposure to himself and to others at a minimum.
2) Be familiar with safety procedures as they apply to each machine.
3) Wear personnel-monitoring devices if necessary.
4) Notify his supervisor and the RSO of known or suspected abnormal radiation exposures to himself or others.

3. OPERATING PROCEDURES

For each operation involving analytical X-ray devices, operating procedures reflecting safety practices will be prepared. As a minimum, the following points must be covered. Other points applicable to the specific equipment shall also be included.

A. Personnel shall not expose any part of their body to the primary radiation beam.

B. Only trained personnel shall be permitted to install, repair, or make other than routine modifications to the X-ray generating apparatus and the tube housing apparatus complex.

C. Procedures and apparatus utilized in beam alignment should be designed to minimize radiation exposure to the operator.

D. If, for any reason, it is necessary to alter safety devices temporarily, such as by removing shielding or bypassing

interlocks, such action shall be specified in writing, approved by the RSO, and posted near the X-ray tube housing so that other persons will know the existing status of the machine.

E. Radiation exposure to individuals, either within the radiation controlled area or its surroundings, shall be controlled so that dose limits specified in Chapter V of this manual are not exceeded.

4. AREA MONITORING

A. Area radiation protection surveys will be made to detect stray radiation. Records of these surveys will be maintained by the operator and the RSO.

B. During changes in operations or modification to equipment, surveys will be performed for proper placement of shielding or for the location of barriers that limit the entry of persons into the area.

C. In addition to the above, certain permanent area monitoring locations may be established by the RSO.

CHAPTER X
GAS CHROMATOGRAPHY EQUIPMENT CONTAINING RADIOACTIVE COMPONENTS

All gas chromatography units in which radioactive materials are to be used will be regulated as follows:

1. All radioactive foils to be used in gas chromatograph cells must be shipped to the RSO or the designated responsible individual who will maintain a file describing the type of source and its location.

2. Each cell containing a foil will be registered by the RSO or the designated responsible individual. A file describing the type of source and its location shall be maintained.

3. Each cell containing a radioactive foil must have a label showing the radiation caution symbol with the words "Caution Radioactive Materials" and the isotope and activity of the radioactive material.

4. The radioactive foil shall not be removed from its identifying cell except for cleaning and shall not be transferred to other cells.

5. Gas chromatography units utilizing radioactive sources must be vented through plastic tubing into a chemical hood or room exhaust to avoid contamination of work areas from the release of radioactive tagged samples introduced into thesystem or from the accidental overheating of radioactive foils in the cell.

6. The RSO shall perform periodic leak tests on all appropriate cells and foils and maintain the necessary records as required by the license on such tests.

7. All work on cells such as cleaning shall be performed in a hood with absorbent material covering the work place. Gloves shall be worn during cleaning operations.

8. Liquids generated during cleaning process may be disposed of into sanitary sewer with large quantities of water.

9. All gas chromatographs shall be operated so as not to exceed the temperature limits specified by the manufacturer.

10. All instruments containing small radioisotope sources shall have a label on the outside of the case indicating that there is radioactive material inside the device, as shown in the following.

WARNING

THIS DEVICE CONTAINS RADIOACTIVE MATERIAL

This device contains material which we possess and inventory under license from the U.S. Nuclear Regulatory Commission. Its exact location must be known by the South Charleston Technical Center Radiation Protection Officer at all times. Before removing this device from this laboratory, notify the RPO at Ext. 5314 or 5412

Isotope Qty. Date ID#

If the device is stored in a box, cabinet, drawer or other closed container, the warning label shall be attached to the outside of that container in a highly visible location to facilitate control and inventory of such materials.

CHAPTER XI

THE RADIATION PHYSICS LABORATORY

1. GENERAL DESCRIPTION OF THE LABORATORY

The Radiation Physics Laboratory, Building 747, is a 30 x 48 ft one-story masonry building. It consists of an office, a general laboratory, a shielded high radiation area, an instrument storage area, and an unencapsulated radioisotopes laboratory. An area for the storage of radioisotopes are located adjacent to Building 747.

2. DETAILED DESCRIPTION AND SPECIAL FEATURES

A. Building Ventilation Building 747 is maintained at a slightly positive atmosphere pressure. All air entering the building comes through a conventional heating and air conditioning system at an air flow of approximately 1800 cubic feet per minute. The incoming air is distributed throughout the building except for the unencapsulated radioisotopes lab, by a system of conventional metal ducts. The unencapsulated radioisotopes laboratory has a separate exhaust fan which can place this room under a negative pressure with respect to the rest of the building. No work with unencapsulated radioisotopes is done in this building at this time.

B. High Radiation Shielded Area The high radiation area is surrounded by a masonry block wall which is sand filled and is approximately 6 ft in height. A large overhead mirror permits work to be performed over this wall by means of various remote manipulators when necessary. Entry into this area is secured by a locked metal gate and features a high intensity audible alarm to indicate any openings of the gate or entry into the cell. This cell is currently used exclusively for the calibration of survey meters.

C. Unencapsulated Radioisotopes Laboratory This laboratory is constructed of 6-inch thick masonry blocks with two 16 x 25 inch filtered ventilators through which the air from the main lab is admitted. The room is always maintained under slightly negative pressure with respect to the general laboratory by means of a high capacity exhaust fan which operates independently of the main laboratory air handling system. All floor drains in the laboratory are sealed to prevent leakage of any radioactive material into the sewer system. The floors are covered with a vinyl asbestos tile that could be easily removed in case of contamination.

D. General Laboratory Area The general laboratory area contains about 600 sq. ft of floor space and is maintained for general laboratory activities, instrument repair, etc. Apparatus for counting leak wipe tests are maintained in this area.

E. Instrument Storage Area This room contains approximately 250 sq. ft and is primarily used for storage of instruments.

3. RADIATION STORAGE AREA

The radiation storage area is located approximately 25 ft from the east side of Building 747. The area consists of a 6 x 16 ft masonry building which rests on a concrete pad of approximately 626 sq. ft. The area is surrounded by a security type 6 ft high chain link fence, topped by barbed wire. This area is secured by a limited access lock system and is provided with an automatic dusk-to-dawn lighting system.

4. INSTRUMENTATION

See Appendix-IV

CHAPTER XII
RADIATION SAFETY TRAINING

Assurance of proper training will be maintained through formalized training requirements for each employee whose regular job assignment involves work with radiation. The Technical Center RSO is responsible for all radiation safety training. Four formal training programs have been developed, as outlined below.

1. RADIATION SAFETY OFFICERS TRAINING COURSE

The RSO Training Course is a one-week intensive course in radiation safety aimed at preparing Union Carbide personnel to assume the duties of Plant Radiation Safety Officer. This course is also used to train Technical Center personnel as "users" on USNRC License No. 47-260-02. The RSO Training Course is given whenever there is sufficient demand for it, approximately once per year. Class size is limited to ten students. A description of the course is listed below:

A. Classroom Lectures:

1) Introduction

2) Health Physics Terminology
Basic terms and definitions necessary to function as a competent RSO - refer to Glossary in the Radiological Health Handbook.

3) Nuclear Physics/Radiation
Classification of matter, model of atom, basic sub-atomic particles atomic structure, periodic table of elements. Define radioactivity, half-life, types of radiation, characteristics and penetration ability of various radiations, shielding and build-up factor. Energy transfer, dose: define Roentgen, rad, rem, discuss natural radioactivity, non-ionizing radiation.

4) Calculation Techniques
Scientific notation, linear first order equations, inverse square law, dose calculation.

5) Radiation Detection Interaction of radiation and matter with respect to ionization and excitation. Energy deposition. Different detection principles (ionization, scintillation, GM, proportional) specifications and characteristics, includes a half day laboratory session.

6) Biological Effects of Radiation RBE of various radiations, dose-effect relationship stressing non threshold model, acute radiation syndrome, radiation accidents.

7) Personnel Dosimetry Pocket dosimeters, film badges, and thermoluminescent dosimeters, accuracy with respect to different radiations.

8) Survey Meters Theory of gas-filled instruments, operating instructions, calibration procedure.

9) Encapsulated Sources Special Form encapsulation, external radiation exposure hazards, and source holder construction.

10) Leak Wipe Testing Define government limits but stress UCC policy. Show how wipes are performed and analyzed.

11) Transportation Discussion of excellent safety record of transporting radioactive material. Definition of special containers, classifications, labels, placards, transport index, contamination check, special form and documentation requirements. Prepares person to perform all acts necessary to properly ship any radioactive material up to and including Type A quantities.

12) Government Regulations Title 10, Parts 19 (Notice to Workers), 20 (Standards for Protection Against Radiation), 30 (Licensing) and 34 (Radiography). A paragraph by paragraph review of pertinent sections of the regulations. Includes why segment on philosophy of regulation.

13) Record keeping
a) Inventory
b) Personnel Dosimetry
c) R-A Material Data Sheets
d) Survey Meter Calibration
e) Leak Wipe Results
f) Radiation Surveys
g) Transfer Records
h) Shipment Records

i) Disposal Records

14) Emergency Definition of emergencies - explosion resulting in the destruction of containment and shielding, unauthorized servicing of sources, theft of R-A material. Step by step procedure on what is to be done during an emergency which may have involved radioactive materials. Provide emergency phone numbers.

B. Films
1) Radiation Safety and Common Sense, J. W. Duley, Radiological Training Services
2) Radiation Risks Revisited, J. W. Duley, Radiological Training Services
3) Biological Effects of Ionizing Radiation - Parts 1 to 4.
4) Double Edge Sword
5) Fundamentals of Radiation Safety, J. W. Duley, Radiological Training Services
6) Risks Associated With Occupational Radiation Exposure, J. W. Duley, Radiological Training Services
7) Radiation Safety Series, Contamination Detection, Contamination Control & Decontamination Procedures, New Dimension Media, Inc.
8) Radiation Detection Instruments
9) Naturally Occurring Radioactive Material in Oil and Gas Production Operations
10) Radiation Naturally
11) An Added Sense: Detection of Nuclear Radiation

and other borrowed or rented films as available and appropriate.

C. Laboratories

1) Leak Wipes and Survey Techniques.
2) Proper use of different survey instruments.
3) Absorption of Gamma Rays
4) Density and Level Gauging
5) Inverse Square Law

D. Final Examination The last day of this course includes a one-hour final examination comprised of 40 multiple choice questions. A grade of 70% or better is required to pass the course. A grade between 60% and 69% will enable the student to retake the test. Any grades below 60% require the student to repeat the entire course for a retest. The exam results are kept on file at the Technical Center and serve as documentation.

2. RADIATION SAFETY FOR UNENCAPSULATED ISOTOPES

This course is designed for Union Carbide Technical Center personnel who plan on using unencapsulated isotopes in the research laboratory. Each new employee is given a training session appropriate for the isotopes and work to be performed, that provides a short theoretical background and much practical radiation safety information. A description of the course content is listed below.

A. Radioactivity and Radiation Basic definitions of alpha, beta, and gamma radiations, ion production, activity, activity units.

B. Dose and Biological Effect of Radiation Rad, rem, relative biological effectiveness, natural background radiation, short-term and long-term effects, external and internal exposure, biological pathways, critical organs, body burden.

C. Laboratory Control Techniques Contamination hazards, work area housekeeping, isotope inventory, protective clothing, glove boxes, intra-lab transportation, solid and liquid waste disposal, C-14 portable survey meter use.

D. Government Regulations United States Nuclear Regulatory Commission, Code of Federal Regulations Title 10, Parts 19 and 20, West Virginia Department of Health Radiological Health Regulations, United States Department of Transportation Regulation.

E. Examination and Laboratory Training A short written examination is administered at the end of the day, consisting of twenty multiple choice questions. A grade of 70% or better is required before the employee may begin training in the laboratory.

After the formal course, the employee undergoes hands-on training in the laboratory. This training is supplied by the employee's direct supervisor. The training will include all proper laboratory control techniques. The employee will be allowed to work with radioisotopes without supervision only after he/she has demonstrated to their supervisor that they understand the radiological hazards associated with the work and can demonstrate proper experimental techniques.

A shortened, 2-hour version of the formal training course is presented at a minimum of three years, to all employees who use radioisotopes. This assures a continuing awareness of radiation safety.

Researchers using radioisotopes on a one-time, short-term basis, nominally a month or less, are not required to complete this full course. They will receive a shortened version of the training course. These personnel may only use these materials under the direct supervision of a member of the Radiation Safety Staff who is responsible for safe use and control of the material.

3. ANALYTICAL X-RAY MACHINE SAFETY

A one-hour short course in radiation safety has been developed for operating supervisors and operators of all analytical X-ray equipment at the Technical Center. A videotape called "The Double-Edged Sword" is shown during the presentation.

New employees proposing to use analytical X-ray equipment must take this course prior to operation.

4. MISCELLANEOUS RADIATION SAFETY TRAINING

Under normal operating circumstances, no unauthorized persons may use radioactive material or radiation-producing devices, or be in a restricted area: All routine housekeeping in unencapsulated laboratories is performed by the technicians assigned to that lab.

Occasionally, however, there are instances where janitors, service personnel, or maintenance personnel need to enter restricted areas to perform non routine maintenance or emergency repair. Prior to these instances, radiation safety training will be supplied by the Technical Center RSO. The extent of the training shall be determined by the scope of the job to be accomplished: As a minimum, the following items will be discussed;, radiation, natural background radiation, dose (internal and external), biological effects of radiation, and some government regulations.

CHAPTER XIII

INDUSTRIAL RADIOGRAPHY

1. GENERAL

X-rays are electromagnetic radiations originating in electron clouds surrounding the nuclei of atoms. They are produced when the target material is bombarded by a stream of high energy electrons. They are extremely short wavelength and occupy the portion of the electromagnetic spectrum above the ultraviolet region. Gamma rays have characteristics identical to X-rays, but they originate from within the nucleus of the atom.

2. PURPOSE

The regulations in this chapter establish radiation safety requirements for UCC and contractor personnel who utilize any source of radiation for industrial radiography.

3. LICENSING REQUIREMENTS

Industrial radiography is somewhat unique in that the particular governmental agency which regulates its use depends upon the type of source used to produce the radiation. Radiographers in non-Agreement States using radiation sources of byproduct material (see Byproduct Material in the Glossary) such as Cesium-137 or Cobalt-60 are regulated by the U. S. Nuclear Regulatory Commission, whereas radiographers using an X-ray machine or naturally occurring radioactive material such as radium to produce radiation are regulated by the State where they are located. It is important to note that having a license to possess radiographic material does not permit the use of this material for radiographic purposes. Such permission is granted only by a specific license from the USNRC to perform radiography (see USNRC Rules and Regulations, Title 10, Part 34). In Agreement States, both types of sources may be regulated by one agency.

4. DEFINITIONS (As used in this Chapter)

A. "Radiographer" means any individual who performs or who, in attendance at the site where the sealed source or sources of radiation are being used, personally supervises industrial radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of these regulations, the regulations of the State where they are located and/or the USNRC Rules and regulations, Title 10, Part 34, and all conditions of the license.

B. "Radiographer's Assistant" means 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.

C. "Radiographic exposure device" means any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure.

D. "Radiography" means the examination of the structure of materials by non destructive methods utilizing sealed sources of byproduct materials.

E. "Registrant" means any person who is registering or who has registered an industrial radiographic X-ray source with the State where they are located or has obtained a specific license from the USNRC to use byproduct material for radiography. A registrant may or may not be a user.

5. PROTECTION

The principle method of protection from radiation is by shielding the tube and by enclosing the machine or source in a protective housing, or a high density concrete and/or lead-lined room. Other methods used in conjunction with shielding are: restricting the direction of the useful beam, limiting the workload, restricting the occupancy of adjacent areas, and using interlocks to shut off the beam when the doors or access covers are opened.

6. NEW INSTALLATIONS

A. The design criteria and drawings of each new radiographic installation will be submitted to the RSO for review. Each installation will be designed to limit exposures to those outlined in Chapter V.

B. After the installation is completed, the RSO will be notified so that a survey with radiation detection instruments can be made before operations begin to ensure adequate protection to operators and personnel occupying adjacent areas.

7. STANDARD OPERATING PROCEDURES

A. An adequate operating procedure is required for the operation of all equipment producing ionizing radiation.

B. The operating procedure shall be submitted to the RSO for review and approval prior to commencing operations. It shall include instructions for at least the following:

1) The handling and use of sources of radiation to be employed such that no person is likely to be exposed to radiation doses in excess of the limits established in 1O CFR 20, "Standards for Protection Against Radiation" or the applicable State regulations. Radiation exposures shall be kept as low as reasonably achievable at all times.

2) Methods and occasions for conducting radiation surveys.

3) Methods for controlling access to radiographic areas.

4) Methods and occasions for locking and securing sources of radiation.

5) Personnel monitoring and the use of personnel monitoring equipment.

6) The procedures for notifying proper persons in the event of an accident.

7) The maintenance of records.

8. GENERAL SAFETY REQUIREMENTS

A. Sources of radiation shall be operated only by trained and qualified personnel.

B. Each registrant or user shall maintain current logs, which shall be kept available for inspection by the RSO, showing for each source of radiation the following information:

1) A description (or make and model number) of each source of radiation.

2) The identity of the radiographer to whom assigned.

3) Methods for controlling access to radiographic areas.

4) This paragraph applies only if the radiation sources are in non interlocked facilities.

C. No registrant or user shall permit any person to act as a radiographer or a radiographer's assistant unless, at all times during radiographic operations, each person wears a TLD, an alarming rate meter and either a pocket dosimeter or pocket chamber. Pocket dosimeters and pocket chambers shall be capable of measuring doses from 0 to at least 200 milliroentgens. A TLD shall be assigned to and worn by only one person.

D. Pocket dosimeters and pocket chambers shall be read and doses shall be recorded daily. A TLD shall be immediately processed if a pocket chamber or pocket dosimeter is discharged beyond its range. The TLD reports received from the TLD processor and records of pocket dosimeters and pocket chamber readings shall be maintained for inspection by the RSO.

E. Notwithstanding any provisions in 20.204(c) of NRC Regulations, areas in which radiography is being performed shall be conspicuously posted as required by 10 CFR 20.203 (Note: See Appendix III) or the equivalent State regulations.

F. During each radiographic operation, the radiographer and radiographer's assistant shall maintain a direct surveillance of the operation to protect against unauthorized entry into a high radiation area as defined in Part 20 of the USNRC Regulations, or the equivalent State regulations, except where the high radiation area is equipped with a control device or an alarm system as described in 20.203(C)(2), or where the high radiation area is locked to protect against unauthorized or accidental entry.

G. No radiographic operation shall be conducted unless calibrated and operable radiation survey instrumentation is available and in use at each site where radiographic exposures are made..

H. The registrant or user shall maintain sufficient calibrated and operable radiation survey instruments to make physical radiation surveys. Each radiation survey instrument shall be calibrated at intervals not to exceed three months, and, after each instrument servicing, a record shall be maintained of the latest date of calibration. Instrumentation required by this chapter shall have a range such that 2 milliroentgen/hour through 1 roentgen/hour can be measured for the energy of radiation being measured. Records shall be kept of the surveys required by this chapter and maintained for inspection by the

RSO

I. Each source of radiation shall be provided with a lock or outer locked container designed to prevent unauthorized or accidental exposure to radiation, and the source shall be kept locked at all times when not under direct surveillance.

J. Full use of protective barriers, lead aprons, gloves, etc., will be made.

K. Observe any restrictions on the use of the machines or sources recommended by the RSO.

L. Each sealed source containing byproduct material used for radiographic purposes shall be tested for leakage at intervals not to exceed six months. Sealed sources which are portable will be leak wiped before they are removed from their normal storage or operating locations to a field location. The leak test will be capable of detecting 0.005 microcurie of removable contamination on the sealed source and will be counted as described in Chapter VIII. A record of all leak tests will be kept. Any source found to be leaking will be reported as required in 10 CFR 34.25d, or as required by the State's regulations.

M. All sealed sources of byproduct material used in radiography at the Technical Center will be inventoried quarterly. Records of the inventory will be kept and will include the quantity and kinds of byproduct material, location of sealed sources, and the date of the inventory.

N. A log shall be maintained for each radiographic device which lists its description (or make and model number), the radiographer to whom it is assigned, the site at which it is located or used, and the dates of use.

9. LIMITATIONS

A. The registrant or user shall not permit any person to act as a radiographer until such person has

1) been instructed in the subjects outlined in Paragraph 10 of this chapter and has demonstrated an understanding of them;

2) received a copy of this manual and the User's Operating and Emergency Procedures and has demonstrated an understanding of them; and

3) demonstrated competence in the use of radioactive exposure devices, related handling tools, and survey instruments that will be employed in his assignment.

B. The registrant or user shall not permit any person to act as a radiographer's assistant until such person has:

1) received copies of the instructions in the User's Operating and Emergency Procedures and has demonstrated an understanding of them; and

2) demonstrated competence to use, under the supervision of the radiographer, the radiographic exposure devices, related handling tools, and radiation survey instruments that will be employed in his assignment.

10. RADIATION TRAINING OUTLINE

A. Fundamentals of Radiation Safety
1) Characteristics of Gamma and X-radiation.
2) Units of Radiation Dose (millirem) and Quantity of Radioactivity (curie)
3) Hazards of Excessive Exposure to Radiation
4) Levels of Radiation from Sources or Machines
5) Methods of Controlling Radiation Dose
a) working time
b) working distance
c) shielding.

B. Radiation Detection Instrumentation to be Used
1) Use of Radiation Survey Instruments
a) operation
b) calibration
c) limitations.
2) Survey Techniques
3) Use of Personnel Monitoring Equipment
a) film badges
b) pocket dosimeters

c) pocket chambers.
d) alarming rate meters

C. Radiographic Equipment to be Used.
1) Remote Handling Equipment
2) Radiographic Exposure Devices
3) Storage Containers

D. The Requirements of Pertinent Federal and State Regulations

E. The Registrant's or User's Written Operating and Emergency Procedures

11. CONTRACT RADIOGRAPHY

A. Questionnaire Any person performing radiography at this site who is not a permanent employee of this site, shall complete the form "Questionnaire to be Filled Out by Contract Personnel Performing Radiography" or "Questionnaire to be Filled Out by Contract Personnel Performing Machine Radiography", as appropriate, before being permitted to commence radiographic operations at this site. All questions must be answered satisfactorily. The questionnaire will be administered by the RSO or his delegate.

B. Radiographer Escort The contract radiographer will be escorted and observed by the RSO or his delegate at all times while radiographic operations are in progress. This requirement may be waived at the RSO's discretion, if the RSO is satisfied that the contractor has, and will continue to conduct radiographic operations in a safe and legal manner that will not cause undue radiation exposure of site personnel.

CHAPTER XIV
RADIO FREQUENCY RADIATION

1. GENERAL

Radio frequency radiation is being used increasingly within plants for process measurements, telemetry, and heating food in snack bars and cafeteria areas. The biological effects of radio frequency radiation are to a great extent dependent upon the frequency and the average field density or power. When radio frequency radiation is absorbed, it produces localized heating. Frequencies above about 3000 megahertz are reflected or absorbed by the outer layers of the skin where they can be detected by the thermal sensory elements in the skin. At frequencies of less than about 1000 megahertz, the radio frequency radiation can penetrate deeper into the body's tissue where temperature sensors are fewer and hence possible overheating could occur before any sensation of heat or pain is perceived. Frequencies between 1000 and 10,000 megahertz tend to produce eye cataracts.

Radio frequency power densities greater than 1 mW/cm can interfere with the operation of cardiac pacemakers. Areas where this power density may ever potentially exist must be marked with proper warning signs.

2. EXPOSURE LEVELS

The following guidelines for exposures are generally acceptable:

A) Above 10 mW/cm^2	Potentially hazardous
B) Between 1 and 10 mW/cm^2 exposure	Safe for incidental or occasional
C) Less than 1 mW/cm^2	Safe for indefinite exposure.

The OSHA radiation protection guide for normal environmental conditions and for incident electromagnetic energy of frequencies from 10 MHz to 100 MHz is 10 mW/cm as averaged over any possible 0.1-hour period.

Power Density: 10 mW/cm^2 for periods of 0.1 hour or more

Energy Density: 1 mWh/cm^2 (milliwatt-hour per square centimeter during any 0.1-hour period).

3. STANDARD WARNING SYMBOL

The standard warning symbol for radio-frequency radiation hazards shall consist of a red isosceles triangle above an inverted black isosceles triangle, separated and outlined by an aluminum colored border. The common side of the two triangles will be about 1.414 times longer than the other sides. The wording "Warning--Radio Frequency Radiation Hazard" shall appear in the upper triangle. The lower triangle may be used for other warnings as necessary.

4. MICROWAVE OVENS

Microwave ovens used in association with food vending services present a particular hazard for several reasons. Since these devices are available to any person at the site, the potential for a defective machine irradiating a great number of people exists. Most such devices are intended to be tamper proof and fail-safe; however, the ingenuity of people in overcoming such safety measures is legendary. Since these machines are usually not used under trained supervision, the potential for misuse or improper use is quite high. Because of their general accessibility, special care should be exercised in posting warning signs near these machines and in checking them for safe operation regularly.

The following list of safe practices should be posted near or on microwave ovens:

a) Stay at least three feet away from the front of an operating oven.
b) Make sure that the oven is off anytime that the door is opened.
c) Do not attempt to watch the food cooking through the viewing port.
d) Never insert objects through the door grill or around the door seal.
e) Never tamper with or inactivate the oven safety interlocks.
f) Do not operate the oven while empty.

Microwave ovens used for heating food in snack areas will be surveyed periodically or upon demand, to check for excess leakage of radiation. Standard procedures for making this measurement are currently in a state of flux. The most current procedure will be used.

CHAPTER XV
LASERS

1. REFERENCES

A) American National Standard for the Safe Use of Lasers, ANSI.
B) Laser Safety Guide, Laser Institute of America.
C) Radiation Safety Handbook for Ionizing and Non ionizing Radiation, U.S. Department of Health, Education and Welfare.

2. GENERAL

The increasingly widespread use of lasers requires the plant RSO to become familiar with the potential hazards associated with the misuse of lasers. Primary hazards of laser radiation consist of danger to the eyes and skin.

The basic approach of most recent safety standards has been to classify lasers by their potential hazard based upon their optical emission.

3. CONTROL MEASURES

The fundamental objective of the control methods as outlined in this chapter is to limit the possibility of a potentially hazardous exposure, particularly to unaware transient personnel and to provide reasonable and adequate guidance for the safe use of lasers and laser systems.

In establishing laser control measures, the following factors determine the type and amount of control necessary:

a) Power or energy output of laser.
b) Pulse length.
c) Pulse repetition rate.
d) Wavelength.
e) Beam path.
f) Beam shape (divergence, hot spots, atmospheric effects).
g) Number of laser systems at particular location.
h) Position of windows, doors, laboratory layout.
i) Degree of isolation of location.
j) Type of population (informed staff in control, local knowledgeable personnel, uninformed transients).

In addition to the aforementioned factors, control measures also depend on laser classification. In general:

A) A Class I Exempt Laser Device is one that is considered to be incapable of producing damaging radiation levels and is, therefore, exempt from any control measures or other forms or surveillance.

B) A Class II Low Power Laser Device may be viewed directly but must have a caution label warning against continuous intra-beam viewing affixed to the device.

C) A Class III Medium Power Laser Device requires control measures that shall prevent viewing of the direct beam.

D) A Class IV High Power Laser Device requires the use of controls which shall prevent exposure of the eyes and skin to the direct and diffusely reflected beam.

E) Class V lasers are either Class II, Class III, or Class IV lasers contained in a protective housing and operated in such a manner as to be incapable of emitting hazardous radiation from the enclosure; a stringent control system shall be installed and maintained for any laser system to qualify for this classification.

This classification scheme relates specifically to the laser device itself and its potential hazard, based on operating characteristics. The extent to which this section is applicable to FDA facilities utilizing laser or laser systems is dependent on the magnitude of the hazard from these sources within that facility.

For those laboratories using Class II, Class III, and Class IV lasers, a Laser Safety Officer shall be appointed. This person shall be properly indoctrinated in laser safety and will have the authority to supervise the control of laser hazards.

4. SPECIFIC CONTROL MEASURES

To reduce the controls required and the potential hazard from a laser source, a complete enclosure of the laser beam (an

enclosed laser) shall be used when feasible. A closed installation (any location where lasers are used which will be closed to transient personnel during laser operation) provides the next most desirable hazard measure. Specific control measures to reduce the possibility of exposure of the eyes and skin to hazardous laser radiation and to other hazards associated with the operation of those devices are outlined in the "American National Standard for the Safe Use of Lasers" (ANSI Z-136.1 - 1973), some of which are excepted below.

A) Class I - Exempt Lasers and Laser-Systems

No control measures or warning labels are required, however, any needless direct exposure of the eyes should be avoided as a matter of good practice.

B) Class II - Low Power Visible Lasers and Laser Systems

These lasers shall have an appropriate warning label (see page Warning Signs and Labels) affixed to a conspicuous place on the laser housing or control panel, or on both the laser housing and control panel.

C) Class III - Medium Power Lasers and Laser Systems

Class III systems shall have engineering controls and appropriate safety mechanisms as an integral part of the system. Examples include beam stops, beam enlarging systems, enclosures, shutters, interlocks, etc.

D) Classes III, IV, and V Lasers and Laser Systems

These shall be operated only in a controlled area (an area where occupancy can be controlled).

1) Special emphasis shall be placed on controlling the beam path of these type lasers by the use of beam enclosures.

2) When a beam enclosure cannot be used, the laser beam shall be terminated by a beam stop at the end of the useful path.

E. Laser Operations
Only authorized personnel shall operate laser systems.

F. All Operators & Other Personnel in the Vicinity of Laser Operations

These personnel shall be duly informed concerning the potential hazards from these devices.

G. Spectators

Spectators shall not be permitted into the laser controlled areas unless appropriate supervisory approval has been obtained and protective measures taken.

H. Responsibility of Laser Safety Officer

The Laser Safety Officer shall have the responsibility and authority to:

1) Provide consultation services on laser hazard evaluation and control.

2) Suspend, restrict, or terminate the operation of a laser system if he deems that laser hazard control is inadequate.

3) Use this section and applicable sections of ANSI Z-136.1 - 1973 as official guidelines in providing safe practices for laser operations.

4) Maintain the necessary records required by applicable governmental regulations.

5) Provide approved protective equipment to control laser hazards when necessary.

6) Submit the names of those employees to the FDA Radiation Safety Council who are scheduled to work with any laser except Class I. These employees will then be scheduled for medical surveillance.

7) Maintain appropriate records on medical examinations of employees and schedule periodic medical examinations.

8) Survey all areas using laser equipment as frequently as necessary.

9) Review plans for installation and/or modification of laser equipment relative to laser hazards and their control.

10) Investigate upon notification of a real or suspected accident resulting from laser operation and initiate corrective action.

11) Post warning signs in appropriate locations and ascertain that warning systems are functional.

I. Responsibility of Employees Working With or Near Lasers

1. An employee will not work with or near a laser until authorized by the supervisor of the laser.

2. Employees must comply with the safety procedures of this section and with any regulations prescribed by the laser supervisor or safety officer.

3. When an employee knows or suspects that an accident has occurred involving a laser, he will immediately notify the laser supervisor and laser safety officer.

4. All employees shall wear prescribed safety equipment and observe all safety procedures at all times.

5. WARNING SIGNS AND LABELS

The laser hazard symbol shall be represented by a sunburst pattern consisting of two sets of radial spokes of different lengths and one longer spoke radiating from a common center. The color, dimension, and location of the symbol within the sign shall be as specified in ANSI Z-25.1 - 1972, "Specifications for Accident Prevention Signs."

A. The signal word "Caution" shall be used with all signs and labels associated with Classes II and III lasers having an output power between 1 and 5 mW and a maximum emergent beam irradiance of 2.5 mW per cm as measured over a 7 mm aperture.

B. The signal word "Danger" shall be used on all signs and labels associated with Class III lasers other than those defined above, and Class IV high-powered lasers.

C. In addition to the appropriate signal word, all signs and labels will have sufficient space to allow inclusion of pertinent information. Such information may be included during the printing of the sign or label or may be handwritten in a legible manner to include the following information:

1) Above the tail of the sunburst: Type of laser (Pulsed, Ruby, C. W. Helium - Neon, etc.).

2) Below the tail of the sunburst: Special precautionary instructions or protective actions required by the reader.

CHAPTER XVI

EMERGENCY PROCEDURES

1. REFERENCES

   A. United States Public Health Service (USPHS) "Radiological Health Handbook".

   B. National Bureau of Standards Handbook 48, "Control and Removal of Radioactive Contamination in Laboratories".

   C. Radiological Emergency Operation, TID-24919, U.S. Atomic Energy Commission, Division of Technical Information.

   D. Basic Radiation Protection Technology, 3rd Ed., Daniel A. Gollnick, Pacific Radiation Corp.

2. GENERAL

   Any site incident that might result in damage to or loss of radioactive material will be handled under the following emergency procedures.

   A. Any emergency in an area which uses radioactive material must be treated slightly differently than an emergency in other units. The first consideration is to provide emergency squad personnel training in the nature and hazards associated with radiation and radioactive material. They must also know which areas at the site contain radioactive material or sources of ionizing radiation and how to recognize radioactive materials. They should have access to information on the exact location of radiation sources in each unit.

   B. There must be a mechanism in the site's emergency response procedures to assure that the site's Radiation Safety Officer and his/her staff are notified of any emergency. In the event of an emergency involving radioactive material or radiation emitting devices, they should report to the emergency scene to provide assistance and information on the location of these sources and to monitor for radiation and radioactive material contamination.

   C. Most radioactive materials used in UCC are relatively low activity and do not represent a life threatening danger in their own right. An exception to this rule is the larger sources used in radiographic operations. In the event of any emergency such as a fire or explosion which may have involved radioactive material, the most important thing to do is to get that emergency under control. Put out the fire, render what ever aid is necessary to injured personnel, and stabilize all systems. Radiation exposure to personnel is not likely to be life threatening or even above permissible limits for the general public.

   D. If however the source is relatively large such as the sources used by radiographers more precautions must be used in dealing with the emergency. Other than specific instructions received from the Individual User or RSO, the only action that should be taken by the site personnel would be to zone the damage area containing the radioactive source of sources with rope and warning signs, denying access to ALL personnel. Generally speaking, the Zoned Danger Area should extend at least 50 ft. in all directions from the radioactive source for emergency personnel with personal dosimeters and approximately 100 ft. for non-essential personnel.

   E. When the emergency situation is under control, the RSO or his delegate will rope off the affected area. Wearing appropriate personal dosimetry, he or she will enter the area to find the radiation sources and render the area safe for general access. Personnel entering the roped off area will continuously monitoring for radiation fields and locate the radiation sources using appropriate radiation survey meters.

   F. When the radioactive material has been located, approach it in a manner that minimizes personal exposure and take contamination smears on the radioactive material holder and surrounding area. If the radioactive material is encapsulated and contained in a shuttered source holder and the shutter is operable and the source may easily be turned off, do so. If the radioactive material has come out of its holder or if the holder is severely damaged and the radioactive material is not approachable without personnel receiving excessive exposure, summon professional assistance in dealing with the situation. Regulatory agencies will assist in this or direct you to qualified personnel to assist in gaining control of the radioactive material. Barricades may be moved in to the 2 mrem/hr limit, but the area must be kept isolated.

   G. Rupture of a special form radioactive material source capsule is very unlikely but a few simple precautions at this time can minimize the later clean-up, if it is necessary. Wearing gloves, take a contamination smear on the source. Go to an area away from any source and see if the smear causes a deflection higher than background on a Geiger counter set on the most sensitive scale. 0.005 mCi of cesium -137 will produce about a 3 microrem/hr response when held about 1 inch from the detector. Normal background is about 10 to 20 microrem/hr. Therefore any

increase above background level is significant. If the radioactive material is not a gamma ray emitter, use only an appropriate thin end window Geiger counter or other beta radiation monitoring survey meter. Advise the person analyzing the contamination smear of the need for urgent, expeditious analysis.

If there was detectable response when the smear is held near the Geiger counter, keep the area isolated and check for local contamination. Personnel who have been near the source should consider their clothing contaminated and leave their clothing in the roped-off area. After leaving the area, wash thoroughly. If there was no detectable response when the smear is held near the Geiger counter, you may assume that, if there was leakage, it was relatively minor. The radioactive material may now be moved to a secure storage area. Assume there is minor contamination and wear gloves and encase the radioactive material in a plastic bag until it is proven to be contamination free.

H. The USNRC has specific requirements concerning notification of any incidents involving radioactive materials. As soon as the situation permits, consult your copy of the regulations to review these requirements. No matter how much time is given in the regulations for issuing a report to the regulating organization, it is recommended that they be notified informally (a telephone call) as soon as possible giving information about the situation and what is being done to control it.

I. After the emergency is controlled, the exposure that people have received must be estimated. This data is needed to determine reporting requirements and to advise people of their exposure. The value and accuracy of this data requires that all people involved be interviewed as soon as possible after the incident, while memories are fresh. Take accurate notes and make sure that the individuals agree with your record of their time and location in the affected areas. A map of the incident site is a helpful way of pin pointing locations. The following steps may be helpful in getting all data.

1. Identify all personnel in area (name, SS #, birth date).
2. Produce a map & have each individual indicate locations where they were and their times at each location.
3. Generate a dose vs. distance chart.
4. Multiply each individuals time at each location by dose rate at that location to get location-dose for that individual.
5. Sum all location-doses for each individual to get total dose for that individual.
6. Report doses to individuals and regulatory agencies, as required.

APPENDIX I
REFERENCES

1. U. S. DEPARTMENT OF COMMERCE, NATIONAL BUREAU OF STANDARDS

   A. Handbook 50, X-Ray Protection Design.
   B. Handbook 55, Protection Against Betatron-Synchrotron Radiations up to 100 Million Electron Volts.
   C. Handbook 60, X-Ray Protection.
   D. Handbook 69, Maximum Permissible Body Burdens and MPS's.
   E. Handbook 73, Protection Against Radiation from Sealed Gamma Sources.
   F. Handbook 92, Safe Handling of Radioactive Materials.

2. NATIONAL ACADEMY OF SCIENCES - NATIONAL RESEARCH COUNCIL
   A. The Biological Effects of Atomic Radiation, Summary Reports.
   B. The Biological Effects of Atomic Radiation, A Report to the Public.

3. U. S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE - PUBLIC HEALTH SERVICE
   A. Concepts of Radiological Health.
   B. Radiological Health Handbook.

4. U. S. NUCLEAR REGULATORY COMMISSION
   A. NRCU-2226, Design of Laboratories for Safe Use of Radioisotopes.
   B. Code of Federal Regulations, Title 10, Atomic Energy
      1) Part 20, Standards for Protection Against Radiation.
      2) Part 30, Rules of General Applicability to Licensing of Byproduct Material.
      3) Part 31, General Licenses for Certain quantities of Byproduct Material and Byproduct Material Contained in Certain Items.
      4) Part 32, Specific Licenses to Manufacture, Distribute, or Import Exempted and Generally Licensed Items Containing Byproduct Material.
      5) Part 33, Specific Licenses of Broad Scope for Byproduct Material.
      6) Part 34, Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations.
      7) Part 35, Human Uses of Byproduct Material.
      8) Part 36, Export and Import of Byproduct Material.
   C. Code of Federal Regulations, Title 49, Transportation
   D. Technical Bulletin No. 4, Radiation Hazards of Fire Fighting.
   E. Isotope Division Circular B-4, Some Practical Consideration in Radiation Shielding.

5. INTERNAL ASSOCIATION OF FIRE CHIEFS
   A. Radiation Hazards of Radioactive Isotopes in Fire Emergencies.
   B. Radiation and Monitoring Fundamentals for the Fire Service.

6. AMERICAN STANDARDS ASSOCIATION
   A. Z54.1 - 1946, Safety Code for the Industrial Use of X-Rays.

7. SOURCE BOOK OF ATOMIC ENERGY - Glasstone

8. THE HEALTH PHYSICS HANDBOOK, Rev. Ed, Bernard Shleien, 1992

9. RADIATION PROTECTION - BRAESTRUP AND WYCKOFF

10. RADIATION HYGIENE HANDBOOK - HANSON BLATZ, MCGRAW HILL, 1959

11. NUCLEAR RADIATION PHYSICS - LAPP & ANDREWS, PRENTICE-HALL, INC. 1963

12. NUCLEAR RADIATION DETECTION - W. J. PRICE, MCGRAW-HILL, 1964

13. RADIOLOGICAL CONTROL MANUAL, J. W. NOBLIN, NASA MARSHALL SPACE FLIGHT CENTER, MARCH 1972.

14. RADIATION PROTECTION, 3rd ed., Jacob Shapiro, 1990

15. BASIC RADIATION PROTECTION TECHNOLOGY, 3rd. ed., Daniel A. Gollnick, 1994

APPENDIX II

GLOSSARY

A_1 The maximum activity of special for Class 7 (radioactive) material permitted in a Type A package

A_2 The maximum activity of Class 7 (radioactive) material, other than special form, LSA or SCO, permitted in a Type A package. These values are listed in 49 CFR 173.435.

Absorbed Dose The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy). The rad is a function of the material in which the radiation is absorbed and is sometimes specified as rad (air) or rad (tissue).

Act The Atomic Energy Act of 1954, as amended.

Activity A measure of the strength of a radioactive source. Activity is the rate of disintegration or decay of radioactive material and is measured in units of curies (Ci) or becquerels (Bq).

Acute Radiation Exposure Exposure to a large dose of radiation in a short period of time.

Acute Radiation Syndrome The medical term for radiation sickness. Usually not observed at less than 100 rem.

Adult An individual 18 or more years of age.

Airborne radioactive material Radioactive material dispersed in the air in the form of dusts, fume, particulate, mist, vapors, or gases.

Airborne radioactivity area A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations--

(1) In excess of the derived air concentrations (DAC)

(2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

Agreement State Any state with which the U.S. Nuclear Regulatory Commission has entered into an effective agreement under subsection 274b of the Atomic Energy Act of 1954. Such states effectively assume the regulatory control of byproduct material exercised by the USNRC in non-agreement states.

ALARA (Acronym for "As Low As is Reasonably Achievable") Making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic consideration, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Alpha Particle (alpha ray, alpha radiation) A particle with a mass of four atomic mass unit, consisting of two protons and two neutrons and having two units of positive charge; commonly emitted during decay of some higher atomic number radioisotopes.

Annual limit on Intake (ALI) The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rem (0.05 Sv) or a committed dose equivalent of 50 rem to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 & 2 of Appendix B of 10 CFR 20.)

Atom A unit of matter. An atom consists of a central charged nucleus (made up on neutrons and protons) and electrons that surround the nucleus.

Attenuation The reduction in the intensity of radiation as it passes through any material, for example, through lead shielding.

Background Radiation (Natural) Radiation that is emitted from the naturally occurring radioactive materials in the earth, fallout from nuclear explosive tests and from cosmic rays that bombard the earth from outer space.

Becquerel The unit of activity in the SI system of units equal to 1 disintegration per second.

Bioassay The determination of kinds, quantities or concentration, and in some case, the location of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

Beta Particle (beta ray, beta radiation) A particle, having the mass and charge of an electron, emitted from the nucleus of an atom in the process of radioactive decay; most common in low atomic mass isotopes

Bill of Lading A document accompanying a shipment of goods that lists the contents of the shipment.

Byproduct Material (1) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or utilizing special nuclear material; and (2) The tailings or wastes produced by the extraction or concentration of uranium or thorium from ores process primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "byproduct material" within this definition.

Calibration Adjustment of a radiation survey meter to make it read a radiation dose accurately. A radiation source must be used for proper calibration.

CFR Abbreviation for "Code of Federal Regulations"

Class (or lung class or inhalation class) A classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-time: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days.

Class 7 Department of Transportation classification for radioactive material.

Collective dose The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

Committed dose Equivalent ($H_{T,50}$) The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

Committed effective dose equivalent ($H_{E,50}$) The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues ($H_{E,50}$= SUM($W_T H_{T,50}$))

Contamination, Radioactive Radioactive material deposited in any place where it is not desired, and particularly in any place where its presence may be harmful.

Controlled area An area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

Cosmic Radiation Ionizing radiation that comes from outer space.

Curie A special unit of radioactivity, defined as that quantity of any radioactive nuclide which has 3.700×10^{10} disintegrations per second (2.22×10^{12} disintegrations per minute).

Decay, Radioactive The spontaneous breaking up or disintegration of atoms. Radiation is emitted in the process.

Declared pregnant woman A woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Deep-dose equivalent (H_d) The dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2), applies to external whole-body exposure.

Derived Air Concentration (DAC) The concentration of a given radio-nuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3 of Appendix B of 10 CFR 20.

Derived Air Concentration-hour (DAC-hour) The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2, 000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 5 rem.

Disintegration, nuclear The spontaneous breakdown of the nucleus of an atom, characterized by the emission of energy and or mass from the nucleus.

Disintegration per minute (dpm) The rate at which a quantity of radioactive material is disintegrating. A measure of the quantity of radioactive material.

Dose Equivalent (H_T) The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

Dose rate A measure of how fast a radiation dose is being received. It is a dose per unit of time. For example, "The dose rate is 10 millirems per hour."

Dosimeter A device used to determine the radiation dose a person has received. See dosimeter, pocket; film badge; and dosimeter, thermoluminescent.

Dosimeter, Pocket A small air-filled ionization chamber (about the size and shape of a fat pencil) that measures radiation dose by responding to ionization of the air.

Dosimeter, thermoluminescent (TLD) A dosimeter worn by a person to measure radiation dose. It contains a radiation-sensitive crystal that responds to radiation like the film in a film badge.

DOT U.S. Department of Transportation, A federal agency that regulates the transport of radioactive materials.

Electron An elementary particle that orbits the nucleus of an atom and carries a negative electric charge. It has a mass 1/1837 that of the proton. Electricity is the flow of electrons.

Electron Volt A small unit of energy. The energy of x-rays and gamma rays is often given in units of electron volts. Abbreviations: eV-electron volts; keV-thousand electron volts; MeV-million electron volts.

Element A basic type of matter. Each element has distinct chemical properties. There are 92 different elements that are found in nature, for example, hydrogen, oxygen, lead, uranium, carbon, tungsten and iron.

Exposure Being exposed to ionizing radiation or to radioactive material..

Film Badge A device worn by radiation workers to measure their absorbed dose of radiation. The badge contains one or more pieces of film that darkens when exposed to radiation. The radiation dose can be determined by reading how dark the film is.

Gamma Rays A type of penetrating ionizing radiation use in industrial radiography and process level and density gauges. Gamma rays are similar to x-rays but are emitted from the nucleus of an atom during the process of radioactive decay.

General License A license issued by NRC or an Agreement State for possession and use of certain radioactive materials, often for small quantities, for which no specific application is required. Individuals are automatically licensed when they buy or obtain the radioactive material or use them in some manner. For example, luminous aircraft exit signs containing radioactive materials are licensed without any application. Airlines receive a license simply because they possess such radioactive material.

General Public (49 CFR 171.8) Any person other than an occupationally exposed hazmat employee.

Gray (Gy) The unit of dose in the SI system of units. 1 gray equals 100 rad.

Half-life The average time it takes for half the atoms in a quantity of radioactive material to decay. Half-lives vary from a fraction of a second to billions of year.

Half-value thickness (or half-value layer) The thickness of a material that will reduce the amount of radiation passing through the material to one-half of its initial intensity. The thickness of the half-value thickness will depend on the material and the energy of the gamma rays.

Hazmat employee A person who is employed by a hazmat employer and who in the course of employment directly affects hazardous materials transportation safety. (See 49 CFR 171.8 for fully detailed definition.)

Hazmat employer A person who uses one or more of its employees in connection with: transporting hazardous materials in commerce; causing hazardous material to be transported or shipped in commerce; or representing, marking, certifying,

selling, offering, reconditioning, testing, repairing, or modifying containers, drums, or packaging as qualified for use in the transportation of hazardous materials.

High Radiation Area An area where the radiation dose to a person could exceed 100 millirems (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. There are special requirements for controlling access to high radiation areas.

ICRP International Commission on Radiological Protection. An international group of scientists representing their countries who develop recommendations on radiation dose limits and other radiation protection measures.

Individual monitoring Means:
(1) The assessment of dose equivalent by the use of devices designed to be worn by an individual;
(2) The assessment of committed effective dose equivalent by bioassay or by determination of the time-weighted air concentrations to which an individual has been exposed, i.e., DAC-hours; or
(3) The assessment of dose equivalent by the use of survey data.

Individual Monitoring Devices (Individual Monitoring Equipment) Devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLD), pocket ionization chambers, and personal air sampling devices.

Industrial Package A packaging that, together with its LSA or SCO contents, meets the requirements of 49 CFR 173.410 and 173.411.

Internal Dose That portion of the dose equivalent received from radioactive material taken into the body.

Ion An atom that has gained or lost one or more electrons or an electron that is not attached to an atom. Ions have an electrical charge.

Ion pair A positively charged ion and an electron. The production of ion pairs is the method by which ionizing radiation gives up its energy.

Ionization The process of adding electrons to, or removing electrons from, atoms or molecules. This creates ions.

Ionization chamber (or ion chamber) An instrument similar to a Geiger counter that is used to detect and measure radiation.

Isotope A particular form of an element. The isotopes of an element have the same chemical properties but different nuclear properties. One isotope of an element may be radioactive while another isotope of the element is stable.

keV (kilo electron volts) A unit of energy equal to 1,000 electron volts.

Leak test A check for the escape of radioactive material from a sealed source.

Licensee The company or the person authorized to use radioactive materials under a license issued by the Nuclear Regulatory Commission or an Agreement State.

Licensed material Source material, special nuclear material, or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the USNRC or the regulating agency in an agreement state.

Limited quantity of Class 7 A quantity of Class 7 (radioactive) material not exceeding the materials package limits specified in 49 CFR 173.425 and conforming with requirements specified in 49 CFR 173.421.

Location-dose The product of the dose rate at a particular location multiplied by the time that a person was at that location. Used in evaluation of personal-dose when personnel were not wearing personal monitoring devices.

LSA (Low specific activity) material Radioactive material that emits very little radiation for its weight. Exactly defined in 10 CFR 71.4(g)(15) & 49 CFR 173.403.

Member of the public An individual in a controlled or unrestricted area. Anyone who is not a worker receiving an occupational dose. An individual is not a member of the public during any period in which the individual receives an occupational dose.

MeV (million electron volts) A unit of energy equal to 1 million electron volts. Used to express the energy of gamma rays and x-rays.

Millirem (mrem) A commonly used unit of radiation dose, abbreviated mrem. A millirem is equal to one-thousandth of a rem.

Minor An individual less than 18 years of age.

NCRP National Council on Radiation Protection and Measurements. A group of scientists in the U.S. that develops recommendations on radiation protection.

Neutron One of the basic particles within atoms. It has the approximately the same mass as the proton but lacks the electric charge.

Non-stochastic effect Health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a non-stochastic effect.

Normal Form All radioactive materials which have not been demonstrated to qualify as special form radioactive material.

NRC U.S. Nuclear Regulatory Commission. A federal agency that regulates the use of certain radioactive materials as given in Title 10 of the Code of Federal Regulations.

Nucleus The inner core of an atom or a living cell. In an atom, the nucleus consists of neutrons and protons tightly locked together. ...

Occupational dose The dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation and/or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.

Occupationally exposed hazmat employee (49 CFR 171.8) A hazmat employee whose duties involve exposure to ionizing radiation.

Package For radioactive materials, the packaging together with its radioactive contents as presented for transport.

Packaging For radioactive materials, the assembly of components necessary to ensure compliance with the packaging requirements of 49 CFR.

Photon A single unit of electromagnetic radiation.

Proton One of the basic particles of an atom (the others are neutrons and electrons). Its electrical charge is the same as that of the electron, but positive rather than negative.

Pocket Dosimeter or Pocket Ion Chamber A self-reading, pencil size ionization chamber with a built-in electrometer, but usually requiring an accessory device for "zeroing" or charging.

Positron A positively charged electron. A positron is the anti-particle to an electron and can not exist in the vicinity of an electron. When encountering an electron. They annihilate each other giving off gamma rays.

Public dose The dose received by a member of the public from exposure to radiation and/or to radioactive material released by a licensee, or to any other source of radiation under the control of the licensee. It does not include occupational dose or doses received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

Quality Factor The factor by which the energy deposited by radiation (absorbed dose) is to be multiplied to obtain a quantity that expresses, on a common scale for all types of ionizing radiation, the biological damage to an exposed person. It is used because some types of radiation such as alpha particles are more biologically damaging than other types such as gamma rays and x-rays.

Rad The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs /gram or 0.01 joule/kilogram (0.01 gray) For gamma rays and x-rays, one rad is equal to roentgen or one rem.

Radiation A very broad term that refers to waves or clouds of pure energy or very fast-moving particles such as electrons, beta particles, alpha particles. Radiation made of pure energy includes gamma rays, x-rays, visible light, microwaves, infrared waves, ultraviolet rays, and radio waves.

Radiation Area An area where a person could receive a radiation dose in excess of 5 mrem in any 1 hour or 100 mrem in any 5 consecutive days at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Radiation, Electromagnetic A technical term for radiation that travels as waves, composed purely of electrical and magnetic energy. For example, gamma rays, x-rays, microwaves, visible light, radio wave, infrared waves, and ultraviolet waves or rays.

Radiation, Ionizing Any radiation that has enough energy to break apart chemical bonds and cause atoms to form ions (charged particles). For example, gamma rays, x-rays, beta particles.

Radioactive material A material containing unstable or radioactive atoms that break up or decay and emit radiation in the process. In the 49 CFR, any material having a specific activity greater than 70 Bq per gram (0.002 microcurie per gram).

Radiographer An individual who performs or who, in attendance at the site where x-ray or gamma ray sources are being used, personally supervises radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of state and federal regulations and the conditions of the radiography license or registration.

Radiographer's Assistant An individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, x-ray machines, sealed sources or related handling tools, or radiation survey instruments in radiography.

Radiographer Escort An individual who has receive training in the principles of radiation safety, use of personal dosimetry, use of radiation survey instruments, applicable regulations and basics of radiography. Training shall be at a level to permit her or him to escort contract radiographers and assure that radiographers are following all applicable rules and regulations.

Radiography The examination of the macroscopic structure of materials by nondestructive methods, utilizing sealed sources of byproduct material or x-ray machines.

Radioisotope A form (isotope) of an element that is radioactive. For example, cobalt-60 is an isotope of cobalt that is radioactive.

Reciprocity The recognition by the NRC or by an Agreement State of a license issued by the other. Reciprocity allows a radiography company licensed in one jurisdiction (usually a state) to work in a different jurisdiction where it is not specifically licensed.

Reference man A hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

Rem A unit of radiation dose equivalence. A rem is equal to 1000 millirem.

Restricted Area An area, access to which is limited for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. If the dose to a person in an area from radioactive material could exceed 2 mrem in any 1 hour or 100 mrem in a year, access to the area must be restricted.

Roentgen A unit of radiation exposure dose. Abbreviated "R". A roentgen is equal to 1000 milliroentgens (mR).

Scintillation Counter An instrument that detects radiation by counting the small flashes of light (scintillation) the radiation produces when it is absorbed by certain crystalline materials.

Sealed Source Any radioactive material that is encased in, and is to be used in, a container in a manner intended to prevent leakage of the radioactive material or any of its decay products.

Shallow-dose equivalent (H_s) Applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeters (7 mg/cm^2) averaged over an area of 1 square centimeter.

SI An international system of units. Units are the sievert (dose equivalence), gray (absorbed dose) and becquerel (activity). These unit have become standard in international commerce.

Sievert (Sv) The unit of dose equivalence in the SI system of units. One sievert is equal to 100 rem.

Source material means:
(1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or
(2) Ores that contain, by weight, on-twentieth of 1 percent (0.05 percent), or more of uranium, thorium or any combination uranium and thorium. Source material does not include special nuclear material.

Special nuclear material means:
(1) Plutonium , uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the NRC pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, but does not include source material; or
(2) Any material artificially enriched by any of the foregoing but does not include source material.

Special Form Radioactive material in the form of a single solid piece or encapsulated radioactive material that will prevent the loss of any radioactive material after being subjected to extreme tests for corrosion, shock and temperature as defined in 49 CFR 173.403(z).

Specific Activity The activity per unit mass of material.

Specific License A license issued to a company or person to possess and use radioactive material after specific written application has been made. See general license.

Stochastic effects Health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

Surface Contaminated Object (SCO) A solid object which is not itself radioactive but which has Class 7 (radioactive) material distributed on any of its surfaces. (49 CFR 173.403)

Survey, radiation Evaluation of the radiation hazards incident to the production, use, or existence of radioactive materials or other sources of radiation under a specific set of conditions; such evaluation customarily includes a physical survey of the disposition of materials and equipment, measurements or estimates of the levels of radiation that may be involved, and a sufficient knowledge of processes using or affecting these materials to predict hazards resulting from expected or possible changes in materials or equipment. Surveys are made with survey meters or in special cases by calculations. A survey should include a check for proper signs and warning labels.

Thermoluminescent dosimeter, (TLD) A type of personal ionizing radiation dosimeter. Principle of operation is that energy absorbed from the radiation is stored in the dosimeter material. When heated to a particular temperature, the energy is released as light, which is then measured to obtain an indication of dose.

Total Effective Dose Equivalent (TEDE) The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Transport Index (TI) A US Department of Transportation definition. It is a unit-less number, equivalent to the highest radiation field, to the nearest 0.1 mrem, measured 1 meter from the surface of a package of radioactive material that is ready for shipment.

Type A or Type B Packaging A special type of packaging that meets specific regulations for transporting radioactive materials. See 10 CFR 71.4(g) or 49 CFR 173.412.

Unrestricted area An area, access to which is neither limited nor controlled by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

Very High Radiation Area An area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rad in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates. [Note: At very high doses received at high dose rates, units of absorbed dose (e.g., rad and gray) are appropriate, rather than units of dose equivalent (e.g., rem and sievert).]

X-Rays Electromagnetic radiation similar to visible light, but having a higher energy and the ability to penetrate through materials. X-rays originate from interactions in the orbital electrons surrounding the nucleus of atoms. X-rays are usually generate by x-ray machines.

Week Seven consecutive days starting on Sunday.

Weighting factor, W_T, for an organ or tissue (T) is the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of W_T are:

Organ or tissue	W_T
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.03[a]
Whole body	1.00[b]

[a] 0.30 result from 0.06 for each of 5 "remainder" organs (excluding the skin and the lens of the eye) that receive the highest doses.

[b] For the purpose of weighting the external whole body dose (for adding it to the internal dose), a single weighting factor, W_T=1.0, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

APPENDIX III
RADIATION DETECTION INSTRUMENTS & CALIBRATION SOURCES

The following is a listing of radiation measuring instrumentation available at the So. Charleston Technical Center. This list may be revised without notice.

Type of Instrument	Number Available	Radiations* Detected	Sensitivity Range	Window (mg/cm^2)	Use
Eberline E-520	5				
HP-270 probe	5	b,g	0 to 2000 mrem/hr	30.0	surveying
HP-190A	2	b,g	cpm	1.4-2.0	contamination
HP-260	2	b,g	cpm	1.4-2.0	contamination
Eberline RO-3C (Cutie Pie)	1	b,g	0-5, 5000 5,000, 10,000	3.5	surveying
Eberline 6112 (Teletector)	2	b,g	0-2, 50, 2000, 5,000, I0,000 mrem/hr. (hi range not cal.)	30.0	surveying
Eberline PS-1 Scintillator	2	g	7500 cpm = I mrem/hr.		measurements
Eberline PRM-5 (Portable Rate Meter)	1	a,b,g	Dependent on Probe		measurements
Eberline PAC-4G (Low Energy Beta)	1	b,g	500, 5K, 50K, & 500K counts/min.	0.85	surveying
Eberline PNC-4	1	n	0-500,000 counts/min.	(BF_3 tube)	surveying
Eberline PNR-4	1	n	0-5, 50,000 & 5K millirem/hr.	(BF_3 tube)	surveying
Dosimeter Corp.	6	g, fast n	0-200 mrads		personnel dose
FAG Kugelfischer FH 40F4	1	g	.001 -999 mR/hr 45 keV--1.3 MeV		surveying
Beckman Gamma 7000	1	g	<0.0005 mCi Cs-I37 per swab	--	gamma wipes
Protean Instruments PIC 9025	1	a, b, g	Gas flow proportional	windowless	counting
Keithley 36150	1	g	0.1-20,000 mrem/hr 12 keV-2 MeV		surveying
Pylon PMT/EL	1	radon	0.1 pCi/l		radon meas.
Johnson Labs Triton 955B	1	gases		flow through	radioactive gases
Ludlum 2224 scaler/rate meter	2		0-50k cpm		

(continued on next page)

(continued from previous page)

Type of Instrument	Number Available	Radiations* Detected	Sensitivity Range	Window (mg/cm^2)	Use
Ludlum 2221 scaler/rate meter	1		0-500k cpm		
Ludlum 43-89	2	a,b	scintillator	0.8	contamination
Ludlum 43-2-2	1	a,b	scintillator	0.8	contamination
Ludlum 44-9	1	a,b,g	pancake GM	1.7	contamination
Ludlum 44-10	1	g	2x2 NaI		gamma
Ludlum 43-68	1	a,b	gas flow prop.	0.8	contamination
Ludlum 120	1	a,b	gas flow prop	0.4	wipe counting

* a = alpha radiation, b = beta radiation, g = gamma & x-ray radiation, n = neutron radiation

UCC TECHNICAL CENTER CALIBRATION SOURCES

Isotope	uCi	±%	NIST	Date	Vendor	Use
Fe-55	11.2	5	X	6/7/80	Isotope Product Labs	Weak x-ray contamination
Sr/Y-90	0.75	5	X	10/24/96	Isotope Product Labs	Strong beta contamination
Cs-137	0.0939	5	X	1/9/95	Isotope Product Labs	Cs-137 Leak wipes, etc.
Am-241	0.1	3		5/21/70	Monsanto Research Corp.	Am-241 Leak Wipes, etc.
C-14	1.068	5	X	1/1/93	Isotope Products Labs.	C-14 contam. smears, etc.
C-14	0.1	5	X	1/1/93	Isotope Products Labs.	C-14 contam. smears, etc.
Ni-63	0.114	5	X	1/1/93	Isotope Products Labs.	Ni-63 leak wipes, etc.
Cs-137	0.1	3		1/1/80	Beckman	Gamma-7000 Cal.
Ba-133	0.018			1/1/92	Packard	Liq.Scint. Ctr.Cal.
Cs-137	7			4/4/77	Victoreen	Dosimeter Calibrator
Sr/Y-90	0.073	5	X	8/9/94	The Source	Beta per 100 cm^2 survey meter cal.
Th-230	0.055	5	X	7/15/94	The Source	Alpha per 100 cm^2 survey meter cal.
Th-230	0.055	5	X	8/9/94	The Source	Alpha survey meter cal.
Sr/Y-90	0.069	5	X	8/9/94	The Source	Beta survey meter cal.
Cs-137	0.107	3	X	12/1/70	Isotope Products Labs.	Cs-137 Leak Wipes

APPENDIX IV

PROCEDURES FOR FIELD ANALYSIS OF LEVEL AND DENSITY

"Field Analysis" means the use of process nuclear gauge hardware and/or sensitive laboratory electronic devices to make level and density measurements of a non-permanent or investigative nature. The source holder and detector are not permanently mounted to the structure, but are hand-held or controlled by nuclear application technicians. The radiation sources used are source-source holder combinations such as those supplied by Ohmart Corp. or Texas Nuclear Corp. for process level and density gauges. Typical source holders used are Texas Nuclear 5192 or 5176, and Ohmart SR-I or SHLG-1. Characteristically, these all are lead filled steel vessels with a lockable on/off shutter and tightly collimated beam ports. An exception to this general rule are a couple of small (<1 mCi) special form encapsulated sources which have been placed in fabricated lead pigs. All source holders have less than 5 mrem/hr fields at I2" from their surface except for the directed radiation beam. Sources are normally selected to produce radiation fields of 1 to 10 mrem/hr at the detector.

This work will be performed or supervised by senior nuclear applications personnel, normally the RSO or his alternate. All participating personnel will wear film badges. Auxiliary personnel occasionally required by work site conditions such as hoist operators or chemical safety monitors will be briefly instructed as to the nature and hazards of the activity, issued pocket dosimeters and kept out of any radiation fields. All other personnel will be cleared from the area and the area will be barricaded at the • 2 mrem/hr limit. Operations will be conducted in a manner consistent with all requirements of 10 CFR Part 20.

The radiation source will be kept under the supervision of UCC nuclear applications personnel at all times during use. During short work breaks, it will be locked in the OFF position and secured to the structure. When not in use, the source will be stored in the facility's radioactive materials storage area. If the facility does not have a storage area, a temporary storage area will be created and posted with signs such that the material is inaccessible to unauthorized personnel. After the source is placed in the storage area, the area perimeter will be surveyed to assure that the area is in compliance with 10 CFR Part 20.

APPENDIX V

OPERATING AND EMERGENCY PROCEDURES

FOR CARBON BUILDUP TESTS USING Am 241-Be

OPERATING PROCEDURES

1. Areas at least 20 foot square at both the top and bottom of the reactor will be roped off and posted with "Caution - Radioactive Materials" signs. No one will be allowed inside this area unless equipped with proper dosimetry equipment (TLD or pocket dosimeters).

2 The neutron source will be kept in its shielded container until all personnel are prepared for testing.

3. Personnel will have an operable and calibrated portable neutron survey meter available or a sensitive x-ray survey meter capable of detecting the 60 keV x-ray from americium-241.

4. The source will be transferred to the detector probe over a flat surface using channel lock pliers. One person will perform the transfer and one person will observe the transfer. The observer should remain close enough to the transferor to locate the source if it is accidentally dropped.

5. The observer will then proceed to place the source in predetermined locations within the vessel while his partner observes the readout device.

6. Upon completion of the test, personnel will remove the source from the detector probe and place it in its shielded container. The container will be locked and a security seal affixed.

EMERGENCY PROCEDURES

The most likely incident involving this source is dropping the source capsule when attaching it to the probe. The source is an encapsulated sealed source and the spread of contamination is highly improbable; however, it would present a radiation hazard. If the source is dropped:

1. Locate the source. If the transfer was attempted over a flat surface and the source is readily available, pick up the source with the pliers and attached it to the detector probe.

2. If the source is out of sight, attempt to locate it with a survey meter. When located, transfer the source to the detector probe or return it to the storage container.

3. If the source cannot be located with a survey meter, rope off the immediate area and do not permit anyone inside. Contact the Plant Radiation Safety Officer.

In emergencies not involving the radiation source, the source will be returned to its storage container if time permits. If the site must be evacuated, safety of involved personnel is the primary concern. If the source was left at the job site during the evacuation, notify the emergency director and the site RSO as soon as possible. After the "All Clear", work with the site RSO to locate the source, taking all appropriate precautions.

Remember, in any radiation hazard, use these simple concepts to minimize your dose:

TIME: Minimize your time near the source.
DISTANCE: Maximize your distance from the source.

APPENDIX VI
RADIATION EXPOSURE REQUIREMENTS
"SAFETY CHECKS", FOR LOCKED DOOR PROCEDURE[1]
"X-RAY", BUILDING 713[2]

1. Clip on and wear assigned film badge, alarming rate meter and dosimeter.
2. Zero dosimeter and record reading, check dosimeter frequently during radiation exposures.
3. Check radiation survey meter-Battery check for operational service. (Survey meter shall be calibrated every three months).
4. Review reference code(s), UCC specification(s), drawings for x-ray requirements and acceptance standard regarding the item being examined
5. Set up outside safety chain with the radiation caution signs attached.
6. Review drawing(s) and identify item for film exposure with lead numbers, letters, penetrameter(s), date. Identify weld joint(s) examined on drawing(s).
7. Set up item for x-ray exposure. Direct the x-ray beam towards lead wall; place portable lead shield panels into position.
8. Turn on outside warning light and the darkroom lights. Lock all outside doors to darkroom and work shop. Select and load film(s) for area of interest to be exposed.
9. Stir film developer, short stop bath, and fix tank solutions. Maintain water temperature in tank reservoir 65°F through 85°F. Temperature of water is not to exceed 90°F.
10. Warm up radiation (x-ray) equipment per manufacturer's instruction. Check radiation emission in work shop (through partial door opening) using radiation survey instrument. (Log results).

    NOTE: During exposure(s) - radiation intensity level in the darkroom with the door closed, the radiation intensity level shall be such that dose received will be less than 2.0 mR in any one hour. Should the intensity be greater, shut down the x-ray equipment. Check the portable lead shield panel(s) for improper positioning and/or lower the KV-voltage value for the exposure and compensate for the new exposure time rate. (Enter radiation levels in log).
11. After warm up, place film with identification on the area of interest. Establish the source to film distance (SFD) normally 27 inches (may be less or greater) and calculate exposure time rate KV and MA from graphs.
12. Upon completion of the radiation exposure, re-check the work shop through the darkroom door with the radiation survey meter before entering.

A RADIATION SURVEY IS TO BE PERFORMED AND DOCUMENTED UPON COMPLETION OF EACH EXPOSURE.

13. Remove and develop exposed film. Write "exposed" on film cassette or ready pack holder. To develop film:

Developer	-	5 minutes
Short Stop	-	5 seconds
Fix	-	5 minutes
Water Wash	-	15-30 minutes
Dry	-	In air heater dryer.

    Read all exposure (interpretation per required code(s), etc.) and log film exposure finding (acceptance/rejection) on record sheets.
14. Upon completion of the job, replace all lead letters and numbers including penetrameters to their respective storage boxes. Disconnect and store x-ray (head) equipment in darkroom, clean up work area. Shut off water to reservoir tank. Replace film badge(s) and dosimeter(s) to storage drawers. Log dosimeter reading change. Remove safety chain and signs; turn off outside warning and darkroom light(s). Lock up.

Date_____ Signature_____
Radiographer Level 1___, 11___, 111__

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[1]The procedures of the Technical Center Radiation Protection Manual and the regulations of the State of West Virginia shall be followed at all times. Copies of these documents are available from the Radiation Protection Officer.

[2]This record shall be maintained in a permanent file.

APPENDIX VII

STANDARDS FOR PROTECTION AGAINST RADIATION

Current copies of the following regulations are kept in the Radiation Safety Officers office or may be accessed at their respective Internet Web-sites

UNITED STATES NUCLEAR REGULATORY COMMISSION
RULES AND REGULATIONS
10 CFR 19, 20, 30, & 34
(www.nrc.gov/NRC/CFR/index.html)

UNITED STATES DEPARTMENT OF TRANSPORTATION
RULES AND REGULATIONS
49 CFR 100 TO 180
(www.dot.gov)

AND

UNITED STATES DEPARTMENT OF LABOR (OSHA)
RULES AND REGULATIONS FOR
IONIZING AND NON IONIZING RADIATIONS
29 CFR 1910.96 & .97
(www.osha.gov)

APPENDIX VIII

STANDARD FORMS

- RADIOACTIVE MATERIAL DATA SHEET
- TRANSFER OF RADIOACTIVE MATERIAL
- SEALED SOURCE INVENTORY (TYPICAL)
- UNENCAPSULATED MATERIAL INVENTORY (TYPICAL)
- GENERAL RADIATION SURVEY FORM
- PROCESS GAGE RADIATION FORM
- INSTRUMENT RADIATION SURVEY FORM
- SHIPMENT RADIATION SURVEY FORM
- SHIPPER'S CERTIFICATION FOR RADIOACTIVE MATERIALS
- RADIATION SURVEY METER CALIBRATION RECORD
- ALPHA-BETA RADIATION SURVEY METER CALIBRATION RECORD
- PANCAKE SURVEY METER CALIBRATION RECORD & DATA SHEET
- LEAKWIPE TEST-CONTAMINATION SMEAR RESULTS
- COUNTER INPUT DATA FORM
- POCKET ION CHAMBER CALIBRATION
- MACHINE RADIOGRAPHY QUESTIONAIRE
- RADIOACTIVE MATERIAL RADIOGRAPHY QUESTIONAIRE
- REQUEST FOR APPROVAL OF IONIZING RADIATION EMITTING DEVICE
- MICROWAVE SURVEY DATA SHEET
- MICROWAVE OVEN SURVEY DATA SHEET
- SEALED SOURCE LEAK TEST INSTRUCTIONS & FORM

Copies of these forms are available from the Radiation Safety Officer, M. L. Green 304/747-5314

UNION CARBIDE CORPORATION

So. Charleston Technical Center
Nuclear Measurement Skill Center
So. Charleston, WV

RADIOACTIVE MATERIAL DATA SHEET

Source Identification No. _____
Serial Number _____
Isotope _____
Quantity, (mCi) _____
Date of Calibration _____
Vendor _____
Source Holder Description _____
Model of Encapsulation _____
Encapsulator _____
Leak Wipe Certification _____
Received: Date _____
From _____
P.O. # _____

Comments:

UNION CARBIDE CORPORATION
Radiation Safety Office, 740-1101
So. Charleston Technical Center
P. O. Box 8361
So. Charleston, WV 25303-8361

To:

Subject: Transfer of Radioactive Material from USNRC License No. 47-00260-02 to License No. issued by

RADIOACTIVE MATERIAL DESCRIPTION

Mfg. Serial No.:
UCC Property No.:
Isotope:
Activity (mCi)
Assay Date:
Material Form:
Type of Holder:
Leak Wipe Test Date:
Manufacturer:
Original PO No. & Date:

As of the Union Carbide Technical Center, USNRC License No. 47-00260-02, relinquishes all license responsibility for the above stated radioactive material unless informed in writing by the addressee.

Signed

Michael L. Green, Radiation Safety Officer

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Inventory updated to 11/11/98														
2	Status, A.1 = In storage, B = In use, C = disposed of or transfered to another license														
3	Status	ISOTOPE	INV.DATE	LW	Ck	SERIAL #	MANUFACTURER	MODEL #	ENCAPSULATION	DATE	ACTIVITY	CURRENTLY	UNITS	COMMENTS	LOCATION
4	A.1	RA-226	1/19/99		x	175	PYLON	RNC		Jan-93	0.00222	0.00221	mCi	Calibrator	Bldg. 747 Storage Cabinet
5	A.1	CS-137	1/19/99		x	215	TEXAS NUC	5192	TN570-57157C	Sep-73	200	107.29	mCi	Property #6901-25185	Bldg. 747 Storage
6	A.1	CS-137	1/19/99		x	226	TEXAS NUC	5192	TN570-57157C	Sep-73	200	107.29	mCi		Bldg. 747 Storage
7	A.1	CS-137	1/19/99		x	228	TEXAS NUC	5192	TN570-57157C	Sep-73	200	107.29	mCi		Bldg. 747 Storage
8	A.1	CS-137	1/19/99		x	234	TEXAS NUC	5192	TN570-57157C	Aug-73	200	107.08	mCi	See also Serial #234*	Bldg. 747 Storage
9	A.1	CS-137	1/19/99		x	236	TEXAS NUC	5192	TN570-57157C	Aug-73	200	107.08	mCi		Bldg. 747 Storage
10	A.1	CS-137	1/19/99		x	238	TEXAS NUC	5192	TN570-57157C	Oct-73	200	107.49	mCi		Bldg. 747 Storage
11	A.1	CS-137	1/19/99		x	274	TEXAS NUC	5192	TN570-57157C	Dec-73	200	107.90	mCi		Bldg. 747 Storage
12	A.1	CS-137	1/19/99		x	285	TEXAS NUC	5190	TN570-57157C	Dec-73	200	107.90	mCi		Bldg. 747 Storage
13	A.1	CS-137	1/19/99		x	297	TEXAS NUC	5190	TN570-57157C	Dec-73	200	107.90	mCi		Bldg. 747 Storage
14	A.1	CS-137	1/19/99		x	302	TEXAS NUC	5192	TN570-57157C	Dec-73	200	107.90	mCi		Bldg. 747 Storage
15	A.1	CS-137	1/19/99		x	305	TEXAS NUC	5190	TN570-57157C	Dec-73	200	107.90	mCi		Bldg. 747 Storage
16	A.1	CS-137	1/19/99		x	307	TEXAS NUC	5190	TN570-57157C	Dec-73	200	107.90	mCi		Bldg. 747 Storage
17	A.1	CS-137	1/19/99		x	454	OHMART	Steel Holde	A-5776	Nov-64	0.5	0.22	mCi	Comp Source Tool Cabinet in Lead Pig with	Bldg. 747 Storage
18	A.1	CS-137	1/19/99		x	517	TEXAS NUC	5192	TN570-57157C	Jan-75	200	110.64	mCi		Bldg. 747 Storage
19	A.1	CS-137	1/19/99		x	518	TEXAS NUC	5192	TN570-57157C	Oct-74	200	110.00	mCi		Bldg. 747 Storage
20	A.1	CS-137	1/19/99		x	534	TEXAS NUC	5192	TN570-57157C	Jan-75	200	110.64	mCi		Bldg. 747 Storage
21	A.1	CS-137	1/19/99		x	559	TEXAS NUC	5192	TN570-57157C	Jan-75	200	110.64	mCi		Bldg. 747 Storage
22	A.1	CS-137	1/19/99		x	1266	OHMART	SHRM-36	A-5771	Mar-66	100	45.10	mCi	In Collimator Bracket Fair Condition	Bldg. 747 Storage
23	A.1	CS-137	1/19/99		x	1760	OHMART	SHRM-36	A-5771	Aug-70	100	49.95	mCi	Property #6901-25092 Fair Condition	Bldg. 747 Storage
24	A.1	CS-137	1/19/99		x	2372	TEXAS NUC	5176	TN570-57157C	Aug-74	4000	2191.52	mCi		Bldg. 747 Storage
25	A.1	H-3	1/19/99		x	3274	3M			Dec-82	200	74.03	mCi	Statis Meter from Dick Billups	Bldg. 747, Tool Cab.
26	A.1	AM-241	1/19/99		x	5861	MONSANTO		2722	Jul-84	1000	974.47	mCi	Stored in Poly Filled Steel Pot in Aluminum Co	Ret. to 747 Storage 2/25/97
27	A.1	CS-137	1/19/99		x	50850	OHMART	LEAD PIG	A-5776	May-64	0.5	0.22	mCi	Comp Source Tool Cab. in Lead Pig 6901-25	Bldg. 747 Storage
28	A.1	CS-137	1/19/99		x	60234	OHMART	SR-2	A-2102	Jul-74	3000	1640.42	mCi		Bldg. 747 Storage
29	A.1	CS-137	1/19/99		x	63141	OHMART	SR-2	A-2102	Jul-74	3000	1640.42	mCi		Bldg. 747 Storage
30	A.1	CS-137	1/19/99		x	64126	OHMART	SHRM-PA	A-2102	Jun-75	100	55.85	mCi	Received from Sistersville Plant 6/18/87	Bldg. 747 Storage
31	A.1	CS-137	1/19/99		x	64128	OHMART	SHRM-PA	A-2102	Jun-75	100	55.85	mCi	From Sill II	Bldg. 747 Storage
32	A.1	CS-137	1/19/99		x	65402	OHMART	SR-1	A-2102	Nov-76	100	57.72	mCi	Old Model ED-3	Bldg. 747 Storage
33	A.1	CS-137	1/19/99		x	65574	OHMART	SHLG-1	A-2102	Sep-77	750	441.27	mCi	Poor Condition/Came from Taft Plant	Bldg. 747 Storage
34	A.1	CS-137	1/19/99		x	70924	OHMART	HLG-1A-210	A-2102	Aug-82	1500	988.64		Has 45 Degree Collimation	Bldg. 747 Storage
35	A.1	CS-137	1/19/99		x	71516	OHMART	SHD	A-2102	Apr-82	150	98.10	mCi	Received from Taft Plant 5/13/88	Bldg. 747 Storage
36	A.1	CS-137	1/19/99		x	73483	OHMART	SHD	A-2102	Nov-83	150	101.76	mCi	45 Degree Collimation from Sill II	Bldg. 747 Storage
37	A.1	CS-137	1/19/99		x	74049	OHMART	SHD	A-2102	Nov-83	50	33.92	mCi	30 Degree Collimation from Sill II	Bldg. 747 Storage
38	A.1	CS-137	1/19/99		x	74050	OHMART	SHD	A-2102	Oct-83	50	33.85	mCi	30 Degree Collimation from Sill II	Bldg. 747 Storage
39	A.1	CS-137	1/19/99		x	75203	OHMART	SHD	A-2102	Jan-85	100	69.70	mCi	45 Degree Collimation from Sill II	Bldg. 747 Storage
40	A.1	CS-137	1/19/99		x	75204	OHMART	SHD	A-2102	Jan-85	100	69.70	mCi	45 Degree Collimation from Sill II	Bldg. 747 Storage
41	A.1	AM-241	1/19/99		x	46-1154	TROXLER LABS	3216A-180	102451	Apr-83	40	38.90	mCi	ROOF READER Special Form Certif. USA/026	Bldg. 747 Storage
42	A.1	CS-137	1/19/99		x	511-36	OHMART	SHRM-PA	A-2102	May-64	10	4.32	mCi	Painted Yellow	Bldg. 747 Storage
43	A.1	NI-63	1/19/99		x	A-5693	VARIAN	ECD		May-87	8	7.27	mCi	ECD for Chromatograph-W. L. Shen	Bldg 747 Storage
44	A.1	CS-137	1/19/99		x	B-1240	TEXAS NUC	5192	TN570-57157C	Nov-77	50	29.53	mCi	Received from Sistersville	Building 747 Storage
45	A.1	CS-137	1/19/99		x	J-698	OHMART	LEAD PIG	A-5776	Nov-67	0.5	0.23	mCi	Storage Bldg. Goss Cylinder	Bldg. 747 Storage
46	A.1	CS-137	1/19/99		x	L-351	OHMART	SHD-O	A-2102	Mar-89	20	15.35	mCi	From Quantum at Morris, IL Unipol	Bldg. 747 Storage
47	A.1	CS-137	1/19/99		x	L-353	OHMART	SHD-O	A-2102	Mar-89	20	15.35	mCi	From Quantum at Morris, IL Unipol	Bldg. 747 Storage
48	A.1	CS-137	1/19/99		x	L-469	OHMART	SHRM-PA	A-2102	Feb-75	100	55.43	mCi	New Condition	Bldg. 747 Storage
49	A.1	CS-137	1/19/99		x	L-837	OHMART	LEAD PIG	A-5776	Jul-65	0.25	0.11	mCi	Tool cabinet in lead pig with V-856	Bldg. 747 Storage
50	A.1	H-3	1/19/99		x	M-166	CUSTOM MATERIALS			Sep-70	200	37.23	mCi	Static meter from Jack Chapman	Bldg. 747 Tool Cabinet
51	A.1	CS-137	1/19/99		x	M-3573	OHMART	AS-2	A-2102	Oct-89	80	62.22	mCi	Source for Gamma Scans of Scrubber Colur	Bldg. 747 Storage
52	A.1	CS-137	1/19/99		x	M-629	OHMART	LEAD PIG	A-5776	Jul-65	0.1	0.04	mCi	Tool Cabinet	Bldg. 747 Storage

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
3	Status	ISOTOPE	INV.DATE	LW	Ck	SERIAL #	MANUFACTURER	MODEL #	ENCAPSULATION	DATE	ACTIVITY	CURRENTLY	UNITS	COMMENTS	LOCATION
53	A.1	CS-137	1/19/99		x	M-644	OHMART	Steel Holde	A-5776	Nov-67	0.5	0.23	mCi	Tool Cabinet	Bldg. 747 Storage
54	A.1	CS-137	1/19/99		x	M-645	OHMART	Steel Holde	A-5776	Jun-66	0.5	0.23	mCi	Tool Cabinet	Bldg. 747 Storage
55	A.1	NI-63	1/19/99		x	S-10026	H-P	1903C		Apr-85	15	13.42	mCi	ECD for Chrom. Chris Peters	Bldg. 747 Storage
56	A.1	CS-137	1/19/99		x	T-609	OHMART	LEAD PIG	A-5776	Dec-67	0.25	0.12	mCi	Tool Cabinet	Bldg. 747 Storage
57	A.1	CS-137	1/19/99		x	V-856	OHMART	LEAD PIG	A-5776	Dec-67	0.5	0.23	mCi	Storage Bldg. Goss Cylinder	Bldg. 747 Storage
58	A.1	CS-137	1/19/99		x	V-857	OHMART	LEAD PIG	A-5776	Nov-67	0.5	0.23	mCi	Storage Bldg. Goss Cylinder	Bldg. 747 Storage
59	B	CS-137	1/19/99	x	x	299	TEXAS NUC	5192	TN570-57157C	Dec-73	200	107.90	mCi	Level Alarm Purge Bin	Bldg. 773-LPPE
60	B	CS-137	1/19/99	x	x	524	TEXAS NUC	5192	TN570-57157C	Oct-74	200	110.00	mCi	High Level Alarm TDI Tank (Blake Gasoway)	Bldg. 727-101
61	B	CS-137	1/19/99	x	x	567	TEXAS NUC	5192	TN570-57157C	Jan-75	200	110.64	mCi	Low Level Alarm TDI Tank (Blake Gasoway)	Bldg. 727-101
62	C	NI-63	1/19/99	x	x	1189	ENV.TECH. GROUP		SPECIAL FORM	Mar-96	10	9.68	mCi	Ammonia analyzer	Bldg. 771, North end, 2nd lvl.
63	B	H-3	1/19/99		x	1882	3M		FOIL	Jul-76	200	51.64	mCi	Static Meter Tritated Titanium Foil-Larry Britto	Bldg. 776
64	B	CS-137	1/19/99	x	x	60476	OHMART	SHRH-A	A-2102	Dec-68	2000	961.35	mCi	Calibration Table Source	Bldg. 747 Calib.
65	B	CS-137	1/19/99	x	x	64154	OHMART	SHRM-PA	A-2102	Feb-75	100	55.43	mCi	Calibration Table Source	Bldg. 747 Calib.
66	B	BA-133	1/19/99		x	400978	PACKARD	B 1600		Jan-92	0.018	7.85E-03	mCi	Reference Source for Liquid Scintillation Cou	Bldg. 770-354 Xiujin Qiu
67	B	FE-55	1/19/99	x	x	6125 LG	OXFORD	L-1004		Sep-93	20	3.35	mCi	Source in Oxford LAB-X100 Anal. Karen Matt	Bldg. 740-2114
68	B	NI-63	1/19/99	x	x	K-0666	H-P		ECD	Jan-95	15	14.40	mCi	ECD	Bld 770-159B Sarah Woods
69	B	Cd-109	1/19/99	x	x	NR0251	Niton	XL 309	Pb Det.	Oct-98	10	3.61	mCi	Portable Pb Det. for painted surfaces	Bld 701-3 Vance Stover
70	B	NI-63	1/19/99	x	x	OO7	MSA			Jan-96	2.6	2.51	mCi	Lisa Wallace	Bld 770-317
71	B	NI-63	1/19/99	x	x	U0267	H-P	ECD	ECD	1/1/1996 es	15		mCi	ECD	Bld 701-220 Mike Spratt
72	C	AM-241	01\13\94			2	TEXAS NUC	5010	TN570-57157C	Sep-65	1300	1229.13	mCi	Shipped for Disposal 6/20/85	Texas Nuclear in Texas
73	C	H-3	01\13\94			119	ANALOG TECH	ECD		Aug-75	1000	245.26	mCi	Electron Capture Detector	Picked up by RSO 10/8/92
74	C	H-3	01\13\94			146	AID	ECD		Dec-73	200	44.68	mCi	Electron Capture Detector	Picked up by RSO 10/8/92
75	C	CS-137	01\13\94			217	TEXAS NUC	5192	TN570-57157C	Sep-73	200	107.29	mCi	Installed S-105 Scrubber Sm. Scale Prod. 12/1	Sistersville Plant
76	C	CS-137	01\13\94			220	TEXAS NUC	5192	TN570-57157C	Sep-73	200	107.29	mCi	Installed at Sistersville 2/4/93	Sistersville Plant
77	C	CS-137	01\13\94			222	TEXAS NUC	5192	TN570-57157C	Sep-73	200	107.29	mCi	Intermediates S-174 Scrubber Bottom	Sistersville Installed 9/14/88
78	C	CS-137	01\13\94			223	TEXAS NUC	5192	TN570-57157C	Sep-73	200	107.29	mCi	Intermediates S-174 Scrubber Top	Sistersville Installed 9/14/88
79	C	NI-63	01\13\94			234	BENDIX	2260		Apr-71	15	12.13	mCi	ECD for Chromatograph	Picked up by RSO 10/8/92
80	C	CS-137	01\13\94			283	TEXAS NUC	5190	TN570-57157C	Dec-73	200	107.90	mCi	Monomers S-43 Scrubber Bottom	Sistersville Installed 10/19/88
81	C	CS-137	01\13\94			287	TEXAS NUC	5190	TN570-57157C	Dec-73	200	107.90	mCi	Monomers S-43 Scrubber Top	Sistersville Installed 9/14/88
82	C	CS-137	01\13\94			291	TEXAS NUC	5190	TN570-57157C	Dec-73	200	107.90	mCi	Shipped to Sistersville Plant 4/21/89	Sistersville Plant
83	C	CS-137	01\13\94			292	TEXAS NUC	5190	TN570-57157C	Dec-73	200	107.90	mCi	Shipped to Sistersville Plant 4/21/89	Sistersville Plant
84	C	CS-137	01\13\94			523	TEXAS NUC	5192	TN570-57157C	Jan-75	200	110.64	mCi	From Sanderson Silo Levels/for Disposal	Shipped to Texas Nuc. 3/23/88
85	C	CS-137	01\13\94			525	TEXAS NUC	5192	TN570-57157C	Oct-74	200	110.00	mCi	From Sanderson Silo Levels for/Disposal	Shipped to Texas Nuc. 3/23/88
86	C	CS-137	01\13\94			533	TEXAS NUC	5192	TN570-57157C	Jan-75	200	110.64	mCi	Installs at Sistersville 2/4/93	Sistersville Polymers II
87	C	CS-137	01\13\94			543	TEXAS NUC	5192	TN570-57157C	Jan-75	200	110.64	mCi	From Sanderson Silo Levels for/Disposal	Shipped to Texas Nuc. 3/23/88
88	C	CS-137	01\13\94			550	TEXAS NUC	5192	TN570-57157C	Jan-75	200	110.64	mCi	From Sanderson Silo Levels for/Disposal	Shipped to Texas Nuc. 3/24/88
89	C	CS-137	01\13\94			572	TEXAS NUC	5192	TN570-57157C	Jan-75	200	110.64	mCi	Seadrift, TX	Shipped to Seadrift 3/31/93
90	C	NI-673	01\13\94			767	VARIAN	3700		Jan-80	8	6.89	mCi	ECD for Varian Chromatograph	Picked up by RSO 10/8/92
91	C	AM-241	01\13\94			1504	MONSANTO		2426	Jun-74	2390	2291.63	mCi	Shipped for disposal 8/15/84	Monsanto in Ohio
92	C	CS-137	01\13\94			2180	OHMART	SHRM-36	A-5771	Oct-77	50	29.47	mCi	Good condition from Coker Unit	Shipped to Taft 3/5/90
93	C	CS-137	6/24/98			2181	OHMART	SHRM-36	A-5771	Oct-77	50	29.47	mCi	Good Condition from Coker Unit	Seadrift 10/98
94	C	CS-137	01\13\94			2182	OHMART	SHRM-36	A-5771	Oct-77	50	29.47	mCi	Transferred to Sistersville 1/17/90	Sistersville CNT Unit
95	C	CS-137	6/24/98			2503	OHMART	SHRM-36	A-5771	Oct-77	50	29.47	mCi	Good Condition from Coker Unit	Seadrift 10/98
96	C	CS-137	01\13\94			2553	OHMART	SHRM-60	A-5771	Aug-76	500	286.90	mCi	(Model ELJ-60) Ret. to OHMART	Shipped 05/04/94
97	C	CS-137	01\13\94			2555	OHMART	SHRM-60	A-5771	Aug-76	500	286.90	mCi	(Model ELJ-60) Ret. to OHMART	Shipped 05/04/94
98	C	CS-137	01\13\94			2561	OHMART	SHRM-60	A-5771	Aug-76	500	286.90	mCi	(Model ELJ-60) Ret. to OHMART	Shipped 05/04/94
99	C	CS-137	01\13\94			2563	OHMART	SHRM-60	A-5771	Aug-76	500	286.90	mCi	(Model ELJ-60) Ret. to OHMART	Shipped 05/04/94
100	C	CS-137	01\13\94			2683	OHMART	SHRM-36	A-5771	Apr-77	500	291.35	mCi	Shipped to Marietta Plastics 11/28/84	UCC Marietta Ohio
101	C	CS-137	01\13\94			2684	OHMART	SHRM-36	A-5771	Apr-77	500	291.35	mCi	Shipped to Marietta Plastics 11/28/84	UCC Marietta Ohio
102	C	NI-63	01\13\94			2828	PERKIN-ELMER	830011		Jun-83	15	13.25	mCi	ECD for Chromatograph W-Y	Sent to NRD for Disposal 1995
103	C	CS-137	01\13\94			3133	OHMART	SHRM-B	A-5776	Jun-86	300	216.03	mCi	For Taft SPU Interface gauge/shipped 7/7/86	UCC Taft LA

RADIOACTIVE MATERIAL INVENTORY FORM												
DATE RECEIVED		8/12/92	8/12/92	9/18/92	9/18/92	9/18/92	9/18/92	9/18/92	10/10/97	10/10/97	10/10/97	
Units: Grams and Microcuries												
BATCH #		XXX										
RADIOISOTOPE		C-14	C-14	C-14	C-14	C-14	C-14	C-14	C-14	C-14	C-14	
CHEMICAL NAME		Toluene-ring-UL-14C	Naphthalene-1-14C	1,2-dichloro-benzene-UL-14C	Phynanthrene	Bis(2-ethyle-hexyle)phthalat	Benzo[a]-pyrene	Benzo[a]-pyrene	Pyrene[4,5,9,10-^{14}C)	$NaHCO_3$	Sucrose-UL-^{14}C	Total
Half life(days)		2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	
MOL. WT.		92.1	128.2	147	178.2	390.6	252.3	252.3				
Original Activity	(microcuries)	50	100	100	100	100	50	50	50	250	50	550.00
Activity per mmol		10.2 mCi/mmol	10.1 mCi/mmol	8.8 mCi/mmol	8.3 mCi/mmol	10.6 mCi/mmol	18.4 mCi/mmol	18.4 mCi/mmol				
Physical form		neat gas	neat crystal	neat liquid	neat crystal (2.2	neat liquid(4.0	0.5 mCi/ml in toluene		58.7mCi/mmol	15.1 mCi/mmo	6 mCi/mmol	
Lot		051H9203	048F9224	120H9217-1	049F9271-1	111H9220-1	042H9223	042H9223	075H0174	076H9255	070H9242	
PUR.ORDER #		0511-753947	0511-753947	0511-757522	0511-757522	0511-757522	0511-757522	0511-757522	0511-762256-1	0511-762256-1	0511-762256-L307	
SUPPLIER		SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	
Cat. Number		31,435-8	31,366-1	31,498-6	31,528-1	31,281-9	B9776	B9776	P4185	S5763	S4141	
Date of Data		10/23/92	10/23/92	10/23/92	10/23/92	10/23/92	10/23/92	10/23/92				10/23/92
Decay Correction	(microcuries)	(decay correction not applied to in process data)										
Unused Portion	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	50.00				50.00
In-Process (total)	(microcuries)	7.83	63.87	122.27	120.10	126.04	45.42	0.00				485.52
In-Process (stock solution)	(microcuries)	7.21	63.87	104.17	103.29	17.65	40.87	0.00				337.06
In-Process (w/ experiments)	(microcuries)	0.62	0.00	18.10	16.81	108.39	4.54	0.00				148.46
In-Waste (total)	(microcuries)	42.17	36.13	0.00	0.00	0.00	4.58	0.00				82.88
In-Waste (solid)	(microcuries)	41.30	32.53	0.00	0.00	0.00	4.58	0.00				78.41
In-Waste (liquid)	(microcuries)	0.87	3.60	0.00	0.00	0.00	0.00	0.00				4.47
Incinerated	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	0.00				0.00
Total	(microcuries)	50.00	100.00	122.27	120.10	126.04	50.00	50.00				618.41
Deviation	(microcuries)	0.00	0.00	-22.27	-20.10	-26.04	0.00	0.00				-68.41
A red color number indicates the solvent in the stock solution container had dried out. There is no indication of possible spill. It is most likely due to solvent evaporation, even if at <0°C.												
It is most likely due to solvent evaporation, even if at <0°C.												

RADIOACTIVE MATERIAL INVENTORY FORM												
DATE RECEIVED		8/12/92	8/12/92	9/18/92	9/18/92	9/18/92	9/18/92	9/18/92	10/10/97	10/10/97	10/10/97	
Units: Grams and Microcuries												
BATCH #		XXX										
RADIOISOTOPE		C-14	C-14	C-14	C-14	C-14	C-14	C-14	C-14	C-14	C-14	
CHEMICAL NAME		Toluene-ring-UL-14C	Naphthalene-1-14C	1,2-dichloro-benzene-UL-14C	Phynanthrene	Bis(2-ethyle-hexyle)phthalat	Benzo[a]-pyrene	Benzo[a]-pyrene	Pyrene[4,5,9,10-^{14}C)	$NaHCO_3$	Sucrose-UL-^{14}C	Total
Half life(days)		2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	2092882.5	
MOL. WT.		92.1	128.2	147	178.2	390.6	252.3	252.3				
Original Activity	(microcuries)	50	100	100	100	100	50	50	50	250	50	550.00
Activity per mmol		10.2 mCi/mmol	10.1 mCi/mmol	8.8 mCi/mmol	8.3 mCi/mmol	10.6 mCi/mmol	18.4 mCi/mmol	18.4 mCi/mmol				
Physical form		neat gas	neat crystal	neat liquid	neat crystal (2.2	neat liquid(4.0	0.5 mCi/ml in toluene		58.7mCi/mmol	15.1 mCi/mmol	6 mCi/mmol	
Lot		051H9203	048F9224	120H9217-1	049F9271-1	111H9220-1	042H9223	042H9223	075H0174	076H9255	070H9242	
PUR.ORDER #		0511-753947	0511-753947	0511-757522	0511-757522	0511-757522	0511-757522	0511-757522	0511-762256-L	0511-762256-L	0511-762256-L307	
SUPPLIER		SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	SIGMA	
Cat. Number		31,435-8	31,366-1	31,498-6	31,528-1	31,281-9	B9776	B9776	P4185	S5763	S4141	
CHEMICAL NAME		Toluene-ring-UL-14C	Naphthalene-1-14C	1,2-dichloro-benzene-UL-14C	Phynanthrene	Bis(2-ethyle-hexyle)phthalat	Benzo[a]-pyrene	Benzo[a]-pyrene	Pyrene[4,5,9,10-^{14}C)	$NaHCO_3$	Sucrose-UL-^{14}C	Total
Date of Data		2/6/98	2/6/98	2/6/98	2/6/98	2/6/98	2/6/98	2/6/98	2/6/98	2/6/98	2/6/98	2/6/98
Decay Correction	(microcuries)	(decay correction not applied to in process data)										
Unused Portion	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50	250	50	400.00
In-Process (total)	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
In-Process (stock solution)	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
In-Process (w/ experiments)	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
In-Waste (in lab)	(microcuries)	7.13	63.87	102.51	116.74	122.51	44.51	0.00	0.00	0.00	0.00	457.26
In-Waste (solid)	(microcuries)	0.00	0.00	0.10	1.35	1.41	0.36	0.00	0.00	0.00	0.00	3.22
In-Waste (liquid)	(microcuries)	7.13	63.87	102.41	115.39	121.10	44.14	0.00	0.00	0.00	0.00	454.04
In-Waste (disposed)	(microcuries)	42.87	36.13	19.76	3.36	3.53	5.49	0.00	0.00	0.00	0.00	111.14
Store (in Tech Center)	(microcuries)	41.86	32.53	15.80	0.84	0.88	4.81	0.00	0.00	0.00	0.00	96.73
Incinerated	(microcuries)	1.01	3.60	3.95	2.52	2.65	0.68	0.00	0.00	0.00	0.00	14.41
Total	(microcuries)	50.00	100.00	122.27	120.10	126.04	50.00	50.00	50.00	250.00	50.00	968.40
Deviation	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
CHEMICAL NAME		Toluene-ring-UL-14C	Naphthalene-1-14C	1,2-dichloro-benzene-UL-14C	Phynanthrene	Bis(2-ethyle-hexyle)phthalat	Benzo[a]-pyrene	Benzo[a]-pyrene	Pyrene[4,5,9,10-^{14}C)	$NaHCO_3$	Sucrose-UL-^{14}C	Total
Date of Data		6/28/98	6/28/98	6/28/98	6/28/98	6/28/98	6/28/98	6/28/98	6/28/98	6/28/98	6/28/98	
Decay Correction	(microcuries)	(decay correction not applied to in process data)										
Unused Portion	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
In-Process (total)	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	250.00	50.00	400.00
In-Process (stock solution)	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	250.00	50.00	400.00
In-Process (w/ experiments)	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
In-Waste (in lab)	(microcuries)	7.13	63.87	102.51	116.74	122.51	44.51	0.00	0.00	0.00	0.00	457.26
In-Waste (solid)	(microcuries)	0.00	0.00	0.10	1.35	1.41	0.36	0.00	0.00	0.00	0.00	3.22
In-Waste (liquid)	(microcuries)	7.13	63.87	102.41	115.39	121.10	44.14	0.00	0.00	0.00	0.00	454.04
In-Waste (disposed)	(microcuries)	42.87	36.13	19.76	3.36	3.53	5.49	0.00	0.00	0.00	0.00	111.14
Store (in Tech Center)	(microcuries)	41.86	32.53	15.80	0.84	0.88	4.81	0.00	0.00	0.00	0.00	96.73
Incinerated	(microcuries)	1.01	3.60	3.95	2.52	2.65	0.68	0.00	0.00	0.00	0.00	14.41
Total	(microcuries)	50.00	100.00	122.27	120.10	126.04	50.00	50.00	50.00	250.00	50.00	968.40
Deviation	(microcuries)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

GENERAL RADIATION SURVEY FORM

SOURCE INFORMATION

		SOURCE NUMBER	SURVEY DATE
ISOTOPE	ACTIVITY (MCI)	TYPE HOLDER	SURVEY FREQUENCY
PLANT	BUILDING/UNIT	ROOM/VESSEL	PERSON RESPONSIBLE
HAZ. WORK PERMIT		SIGNS	

SURVEY INFORMATION

TYPE METER USED E-520	SERIAL NO.	LAST CALIBRATION
SOURCE POSITION	WIPE TEST	SURVEYED BY

METER READINGS		SKETCH
LOCATION	MREM/HR	

REMARKS

	Radiation Safety Officer

UCC, EMTS, Nuclear Measurement Skill Center, 8/16/00

PROCESS GAUGE RADIATION SURVEY FORM

SOURCE INFORMATION

		SOURCE NUMBER	SURVEY DATE
ISOTOPE	ACTIVITY (MCI)	TYPE HOLDER	SURVEY FREQUENCY
PLANT	BUILDING/UNIT	ROOM/VESSEL	PERSON RESPONSIBLE
HWP	SHUTTER OPER. CHECKED	SIGNS	MOUNTING BOLTS CHECKED

SURVEY INFORMATION

TYPE METER USED		SERIAL NO.	LAST CALIBRATION
SOURCE POSITION ON OFF	WIPE TEST		SURVEYED BY

METER READINGS	
LOCATION	MREM/HR
12" -TOP	
12" -BOTTOM	
12" -RIGHT	
12" -LEFT	
12" -NEAR*	
12" -DETECT.	
C -TOP	
C -BOTTOM	
C -RIGHT	
C -LEFT	
C -NEAR	
C -DETECT.	

SKETCH

*The NEAR side is defined as the side of the radiation source away from the vessel

Is there an area where personnel regularly perform tasks within 12 ft. of this sourc	yes no
What is the highest radiation field at the elevation of a person's torso at the abo	mrem/hr
What fraction of a day will a person be present at the above location (occupation factor)?	
Is the product of the Occupation Factor and the dose rate more than 0.05?	yes no

If the answer to the above question is yes, then this radiation source installation needs to be evaluated for further shielding

REMARKS

Radiation Safety Officer

Example of a form for making radiation surveys of process nuclear gauges. (Rev.2/96)

UNION CARBIDE CORPORATION

So. Charleston Technical Center
Nuclear Measurement Skill Center
So. Charleston, WV

RADIATION PRODUCING DEVICE DATA SHEET

Device Number _____

Type Device _____

Use _____

Manufacturer _____

Model Number _____

Radiation Energy _____

Power Output _____

Class and Type (lasers only) _____

WV Regostratopm Mi,ber _____

Location/Building/Room # _____

Operating Supervisor _____

Other Operators _____

_____

_____

Requirred Surveys _____

_____

Required Training _____

SHIPMENT RADIATION SURVEY FORM

SOURCE INFORMATION

		SOURCE NUMBER	SURVEY DATE
ISOTOPE	ACTIVITY (MCI)	TYPE HOLDER	SURVEY FREQUENCY
PLANT	BUILDING/UNIT	ROOM/VESSEL	PERSON RESPONSIBLE
HAZ. WORK PERMIT		SIGNS	

SURVEY INFORMATION

TYPE METER USED	SERIAL NO.	LAST CALIBRATION
SOURCE POSITION	WIPE TEST	SURVEYED BY

METER READINGS		SKETCH
LOCATION	MREM/HR	
contact-north		
contact-south		
contact-top		
contact-bottom		
contact-east		
contact-west		
1m-north		
1m-south		
1m-top		
1m-bottom		
1m-east		
1m-west		

REMARKS Transport Index TI=

Radiation Safety Officer

UCC, EMTS, Nuclear Measurement Skill Center, 8/16/00

SHIPPER'S CERTIFICATION FOR RADIOACTIVE MATERIALS

SSO No.	511-01-
Item Number	
Number of Items	

Union Carbide Corporation
Technical Center, 3200 Kanawha Turpike
So. Charleston, WV 25303

The following information may be included her for each package of the consignment; if not, it must be given in other shipping documents

Proper Shipping Nam	Hazard Class	Identification Number	RQ?	Radioisotope	Physical Form (dim. & wt. if >110 lb.)	Activity mCi	Label	Transport Index	Package Specification
Radioactive Material, Special Form, n.o.s.	7	UN2974		Cesium-137	Special Form		Radioactive Yellow-II		DOT 7A,Type
24 Hour EMERGENCY CONTACT: 800-424-9300				Charge Nun	502500-00015970				

THIS IS TO CERTIFY THAT THE ABOVE-NAMED MATERIALS ARE PROPERLY CLASSIFIED, DESCRIBED, PACKAGED, MARKED, & LABELED, AND ARE IN PROPER CONDITION FOR TRANSPORTATION ACCORDING TO APPLICABLE REGULATIONS OF THE DEPARTMENT OF TRANSPORTATI

Signature and Title of Person Signing this Certification Ship to:

	Security Seal Affixed
	Emergency Response Doc

Michael L. Green, Radiation Safety Officer

UNION CARBIDE CORPORATION
ANALYTICAL AND PHYSICAL MEASUREMENTS
P. O. BOX 8361, 3200 KANAWHA TURNPIKE
SOUTH CHARLESTON WV 25303

RADIATION SURVEY METER CALIBRATION RECORD

TO
LOCATION
METER MFG.
MODEL NO.
SERIAL NO.
CAL. DATE
CAL. DUE 6/29/04

This survey meter was calibrated in a Cesium-137 radiation field with a calibrated accuracy of plus or minus 5%. The readings of the meter after calibration are listed in the following table.

Calibrated Radiation Field From Cs-137 Source in mrem/hr	SCALE	Survey Meter Reading		
			mrem/hr	deviation
0.31	0.1			0
1.06	0.1			0
4.72	1			0
9	1			0
31	10			0
83	10			0
428	100			0
768	100			0

COMMENTS Meter was checked but not calibrated on the X 0.01 scale.

Calibrated Michael L. Green
(Signed) _____

	A	B	C	D	E	F	G	H
1	**Alpha/Beta Survey Meter Calibration & Data Sheet**							
2	Background			Calibration		INSTRUMENTATION		
3	Alpha	Beta		Alpha	Beta	Counter		
4			ID #			Model		
5			Det. Area (cm2)			Serial No.		
6			dpm			Detector		
7			count 1			Model		
8			count 2			Serial No.		
9			count 3				HV 721	
10			Avg. (cpm)	#DIV/0!	#DIV/0!		Contamination Threshold	
11			Efficiency	#DIV/0!	#DIV/0!		alpha (cpm)	#DIV/0!
12			MDA (dpm/100cm2)	#DIV/0!	#DIV/0!		beta(cpm)	#DIV/0!
13				β from α	α from β	β cross talk	α cross talk	
14	#DIV/0!	#DIV/0!	Avg. Backgrnd.			#DIV/0!	#DIV/0!	
15	MDA for unequal counting times calculation							
16			Background count time, minutes					
17			Sample count time, minutes					
18	#DIV/0!	#DIV/0!	Variable count time MDA, dpm/100 cm2					
19								
20				% of Detector	Alpha	Alpha	Beta	Beta
21	Date	Location/Item		Exposed	Gross cpm	dpm/100cm2	Gross cpm	dpm/100cm2
22		Example data		100		#DIV/0!		#DIV/0!
23				100		#DIV/0!		#DIV/0!
24				100		#DIV/0!		#DIV/0!
25				100		#DIV/0!		#DIV/0!
26				100		#DIV/0!		#DIV/0!
27				100		#DIV/0!		#DIV/0!
28				100		#DIV/0!		#DIV/0!
29				100		#DIV/0!		#DIV/0!
30				100		#DIV/0!		#DIV/0!
31				100		#DIV/0!		#DIV/0!
32				100		#DIV/0!		#DIV/0!
33				100		#DIV/0!		#DIV/0!
34				100		#DIV/0!		#DIV/0!
35				100		#DIV/0!		#DIV/0!
36				100		#DIV/0!		#DIV/0!
37				100		#DIV/0!		#DIV/0!
38				100		#DIV/0!		#DIV/0!
39				100		#DIV/0!		#DIV/0!
40				100		#DIV/0!		#DIV/0!
41				100		#DIV/0!		#DIV/0!
42				100		#DIV/0!		#DIV/0!
43				100		#DIV/0!		#DIV/0!
44				100		#DIV/0!		#DIV/0!
45	MDA=	(2.71+4.65(sqrt(Rb * tb)))/(E *(A/100)* tb)				for equal ts & tb		
46	MDA=	(2.71+3.29(sqrt(Rb * ts*(1+ts/tb))))/(E *(A/100)* ts)				for unequal counting times		
47	Rb = background countrate (cpm)							
48	tb = background count time (min)					Signature		
49	ts = sample count time (min)							
50	E = system efficiency					Date		
51	mlg 92898							
52								
53	**INSTRUCTIONS FOR USE OF FORM**							
54	This form is intended as a uniform method for recording measurements with an alpha beta radiation counter.							
55	It automatically converts instrument readings from cpm to dpm/100 cm2 and calculates the instrument's							
56	Minimum Detectable Activity (MDA). In addition, it calculates (cells H11 & H12), the instrument reading, in							

	A	B	C	D	E	F	G	H
57	cpm that is equivalent to a contamination standard such as 5000 dpm/100cm2. 5000 dpm/100 cm2 is the							
58	default standard							
59	The MDA is the reading below which a measurement is not statistically distinguishable from background							
60	at the 95% confidence level.							
61								
62	1	Enter 1 to 10 background readings for alpha and beta respectively in cells A4 to A13 and B4 to B13.						
63		Only 1 value is needed but more values gives a better estimate of the true background						
64	2	Enter the calibration source identification numbers in cells D4 & E4						
65	3	Enter the area of the detector in cm2 in cells D5 & E5						
66	4	Enter the disintegration rates for the calibration sources in cells D6 & E6						
67	5	Measure the count rate from the calibration source(s) and enter those values in cells D7 & E7.						
68		Two additional measurements can be entered in cells D8, D9, E8 & E9 if time permits.						
69		The spreadsheet will now calculate the average background and calibration measurements and						
70		calculates the efficiency and MDA, and calculates the instument reading that is exactly equal						
71		to 5000 dpm per 100 cm2 (in cells H11 & H12).						
72		To correct for alpha-beta cross talk, enter the beta counts registered when calibrating with the alpha						
73		cal. source in cell D14. Enter the alpha counts from calibrating with the beta source in cell E14.						
74	6	Estimate % of area of detector exposed for each measurement & enter in column D starting at D18						
75	7	Enter information on the counter and detector in cells G3 to G8.						
76	8	Enter data on the date and measurement location in cells A18 & B18						
77	9	Enter percentage of detector exposed to the potentially contaminated surface, default is 100%.						
78	10	Enter the instrument alpha reading in cell E18 and the beta reading in cell G18.						
79		The spreadsheet will now calculate the dpm/100 cm2 for that measurement.						
80		Additional data may be entered in subsequent rows.						
81	Variable Count time MDA							
82	11	To determine the MDA for different background and sample counting times enter the corrected						
83		counting times in cells A16, B16, A17 & B17						

UNION CARBIDE CORPORATION
SAFETY & INDUSTRIAL HYGIENE TECHNOLOGY
P. O. BOX 8361, 3200 KANAWHA TURNPIKE
SOUTH CHARLESTON WV 25303
(form is an interactive spreadsheet)
PANCAKE SURVEY METER CALIBRATION RECORD & DATA SHEET

TO	Joe Torre
LOCATION	Comet Plant
METER MFG.	Eberline
MODEL NO.	E-520/HP-260
SERIAL NO.	549
CAL. DATE	6/9/99
CAL. DUE	9/9/99

EFFICIENCY DETERMINATION		
CAL SOURCE	Sr/Y-90	SN 1948
CAL. SOURCE DPM		153000
CAL. SOURCE AREA, cm2		3.8
DETECTOR CPM @ 1/4"		31000
EFFICIENCY		0.20
Plastic alpha screen in place'		yes

This survey meter was calibrated with a Sr/Yt-90 radiation source with a calibrated accuracy of plus or minus 5%.

MDA	1872	dpm/100 cm2		Detector Area	15	cm2
BG cpm	50	Efficiency	0.20	Time Constant	0.167	minutes
Conditions Description			Distance from surface	Meter Reading in cpm	Contam. dpm/100 cm2	*cpm = to 5000 dpm/100 cm2
Example data			1/4"	150	3290	202
					-1645	
					-1645	
					-1645	
					-1645	
					-1645	
					-1645	
					-1645	
					-1645	
					-1645	
					-1645	
					-1645	
					-1645	
					-1645	

*5,000 dpm/100 cm2 is the level below which surfaces are not considered contaminated.
COMMENTS:

Calibrated by
(Signed) _____

Example of a Pancake Survey Meter Calibration with typical data

LW Example

UNION CARBIDE CORP
SAFETY & INDUSTRIAL HYGIENE TECHNOLOGY
Nuclear Measurements Skill Center
P O Box 8361, So. Charleston, WV
LEAKWIPE TEST RESULTS

TO ML Green DATE 5/12/99
DIVISION
LOCATION So. Charleston Technical Center

Listed below are the result of the leakwipe tests on your devices. The samples were analyzed for radioactive material content in a counting system calibrated to measure the isotope indicated b
This document should be kept on file for inspection by your regulatory agency.
The results of the analyses are as follows

Sample Identification	Sample Date	Isotope	Activity in microCuries
S-8096	1/24/99	Ni-63	<0.0005
L-4876	1/26/99	Ni-63	0.00056

The notation <0.0005 microcurie is used where there is no meaningful statistical difference at the 95% confidence level between the samples and the background counting rate.

Comments

Sample Analyst M L Green Phone 304/747-5314

UNION CARBIDE CORPORATION
ANALYTICAL & PHYSICAL MEASUREMENTS
Nuclear Measurements Skill Center
COUNTER INPUT DATA

To: _____ Date: _____
Location: Analyst:

Descriptive Information:

No.	Sample Identification	Sample Date	Isotope	Counts	Minutes	CPM
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						

TO: Bill Aaron
LOCATION Star

UNION CARBIDE CORPORATION
ANALYTICAL AND PHYSICAL MEASUREMENTS
P.O. BOX 8361, 3200 KANAWHA TURNPIKE
SOUTH CHARLESTON, WV 25303

POCKET ION CHAMBER CALIBRATION

		DRIFT CHECK						CALIBRATION		
Serial No	Time Start	Initial	Time End	Final	Change	Time	24 hr.Drift	CAL. Ck End	Final	Change
		mR		mR	mR	hours	mR		mR	mR
8060194	11/8/96 12:30	33	11/9/96 12:16	31	-2	23.77	-2.02	11/11/96 17:01	83	52
8061071	11/8/96 12:30	30	11/9/96 12:16	33	3	23.77	3.03	11/11/96 17:01	83	50
6013292	11/8/96 12:30	41	11/9/96 12:16	41	0	23.77	0.00	11/11/96 17:01	91	50
					0	0.00	#DIV/0!			0
					0	0.00	#DIV/0!			0
					0	0.00	#DIV/0!			0
					0	0.00	#DIV/0!			0
					0	0.00	#DIV/0!			0
					0	0.00	#DIV/0!			0

Calibration Dose Rate	Today	Cal Date	Acceptable Results		Acceptable Drift
1.227012 mR/hr	#######	4/4/77	65	Actual Dose, mR	2% or 4 mR/day
			78	20%	
			52	-20%	

Based on the manufacturers specification a new pocket ion chamber should have an accuracy of ±20% and a 24 hour drift rate of no more than 2% or for a 200mR ion chamber, 4 mR.

The above instruments met this criteria. Pocket ion chambers are intended as secondary dosimetry and should be checked for proper operation at 6 month intervals.

SIGNATURE OF PERSON PERFORMING CALIBRATI Michael L. Green
Telephone UNICOM 8-721-4713 or 304/747-4713

QUESTIONNAIRE TO BE FILLED OUT BY CONTRACTORS PERFORMING MACHINE RADIOGRAPHY

Date_____ Time in:_____ Time out:
Name of Company: _____.
Address:_____.
_____

Registration Number: _____.
Make and Model number of exposure device._____.
Serial Number_____ Maximum Voltage_____kVp
Maximum Current_____mA.
Name of radiographer: _____.
Radiographers Assistants_____.
_____.
_____.

YES	NO	Do you have in your possession the following?
___	___	Registration or specific license?
___	___	Operating & Emergency Procedures?
___	___	Do you keep utilization logs that specify the voltage, current, and exposure time for each radiographic exposure?
___	___	Dose your device have a lock to prevent unauthorized or accidental energization of the x-ray tube?
___	___	Does your device have a lock to prevent unauthorized or accidental removal?
___	___	Do you have an operable survey meter?
___	___	Has it been calibrated within the last 3 months?
___	___	Does its range cover 2 to 1000 mrem/hr?
___	___	Are all personnel assigned & required to use a pocket dosimeter, alarm rate meter and film badge or TLD?
___	___	Is direct surveillance of the radiation area maintained during operations to prevent unauthorized entry?
___	___	Is the area going to be posted with proper radiation area and high radiation area signs?
___	___	Is a complete, documented, radiation survey going to be made after each exposure to assure that the machine is "off" and that no radiation fields are present?

AFTER PERFORMING THE RADIOGRAPHY, THIS COMPLETED QUESTIONNAIRE AND A COPY OF THE RADIATION SURVEY WILL BE FURNISHED TO THE SHIFT SUPERINTENDENT BEFORE LEAVING THE PLANT

I HEREBY DECLARE UNDER PENALTY OF LAW THAT THE ABOVE STATEMENTS ARE TRUE TO MY KNOWLEDGE AND MADE SURE THAT THE X-RAY MACHINE IS OFF AND PROPERLY SECURED IN OUR VEHICLE PRIOR TO DEPARTING THIS PLANT.
Signature of Radiographer Preparing Form_____.

Signature of Site RSO or RSO's representative_____.

QUESTIONNAIRE TO BE FILLED OUT BY CONTRACTORS PERFORMING RADIOGRAPHY

Date_____ Time in:_____ Time out:
Name of Company: _____.
Address:_____.
_____

Registration Number: _____.
Make and Model number of exposure device or storage containers to be used.
(Serial Number, Isotope and Curies)_____.
_____.
_____.

Name of radiographer: _____.
Radiographers Assistants_____.
_____.
_____.

YES	NO	Do you have in your possession the following?
___	___	Registration or specific license
___	___	Operating & Emergency Procedures
___	___	Do you keep utilization logs
___	___	Did you measure the field at 1 meter from the surface of the source transportation container? What is the field in mr/hr____?
___	___	Does your device have a lock to prevent unauthorized or accidental removal
___	___	Do you have an operable survey meter
___	___	Has it been calibrated within the last 3 months
___	___	Does its range cover 2 to 1000 mrem/hr
___	___	Are all personnel assigned & required to use a pocket dosimeter, alarm rate meter and film badge or TLD
___	___	Is direct surveillance of the radiation area maintained during operations to prevent unauthorized entry
___	___	Is the area going to be posted with proper radiation area and high radiation area signs
___	___	Is a complete radiation survey going to be made after each exposure to assure return of the source to its storage container
___	___	Is a complete radiation survey and record made after the source is secured in its storage container

AFTER PERFORMING THE RADIOGRAPHY, THIS COMPLETED QUESTIONNAIRE AND A COPY OF THE RADIATION SURVEY WILL BE FURNISHED TO THE SHIFT SUPERINTENDENT BEFORE LEAVING THE PLANT

I HEREBY DECLARE UNDER PENALTY OF LAW THAT THE ABOVE STATEMENTS ARE TRUE TO MY KNOWLEDGE AND MADE SURE THAT THE RADIOACTIVE SOURCE IS CLOSED AND PROPERLY SECURED IN OUR VEHICLE PRIOR TO DEPARTING THIS PLANT.
Signature of Radiographer Preparing Form_____.

Signature of Site RSO or RSO's representative_____.

MICROWAVE OVEN SURVEY DATA SHEET

Survey Date

Manufacturer			Recommended Survey Frequency
Plant Locatic	Building No.	Room No.	Person Responsible

Survey Meter Model		Cal. Date	Surveyed by:
Location	mW/cm2	Sketch: Levels below 0.5 mW/cm2 are not shown.	

For an oven in use, the allowable emission rate is 5 mW/cm2

Remarks

Signature of surveyer	Interlocks Checked: Yes No

MICROWAVE SURVEY DATA SHEET

Survey Date

Manufacturer			Recommended Survey Frequency
Plant Locatic	Building No.	Room No.	Person Responsible

Survey Meter Model		Cal. Date	Surveyed by:
Location	mW/cm2	Sketch: Levels below 0.5 mW/cm2 are not shown.	

The acceptable emission rate is 5 mW/cm2

Remarks

Signature of surveyer	Interlocks Checked: Yes No

SEALED SOURCE LEAK TEST INSTRUCTIONS

(Applicable to Process Nuclear Gauge, Electron Capture Detector and other similar sources)

a) Complete the leak test kit labels as to:
   1) the location of the source;
   2) the date the leak test was made;
   3) the identification (a serial number, property number, etc.)
   4) type of isotope that is contained within the source holder.

b) Use protective gloves and accessories. In wiping special-form sources with a cotton tipped wooden applicator, gloves may hinder efficient completion of the task and prolong the individuals time in the vicinity of the radiation source. Since this type source has an extremely low probability of leaking, use of gloves is optional.

c) If the source holder is in a storage container, cautiously remove the cover of the storage container, so as not to spread contamination if the source is leaking. DO NOT ATTEMPT TO OPEN THE SOURCE HOLDER UNLESS SPECIFICALLY AUTHORIZED AND LICENSED TO DO SO.

d) Do not expose any part of your body to a direct beam from the source holder.

e) Remove cotton applicator from its container. Saturate the cotton applicator with leak wipe solvent and wipe all external seams, cracks, and openings of the source holder to achieve maximum surface material removal.

- DO NOT DISASSEMBLE THE SOURCE HOLDER.
- DO NOT PLACE THE COTTON APPLICATOR IN THE SOLVENT DURING OR AFTER IT HAS BEEN USED TO WIPE THE SOURCE.

f) Carefully place the cotton applicator in the labeled container and securely tighten the cap.

g) Remove the vial containing the cotton applicator from the radiation field to a location where only background (~0.01 millirem per hour) is indicated on the meter. Measure the radiation field on the wipe. Do not touch the survey meter with the cotton applicator. If the wipe reads twice background or greater, shield the wipe as if it is itself a radiation source and take two more wipes of source as verification of the leak.

h) Leaking Source

1. In the event the removable contamination exceeds 0.005 microcuries, the source is considered to be leaking. The source container will be closed and tagged until it can be prepared for shipment, repair, or disposal.

2. Sources that are leaking may be returned to the manufacturer for repair or disposal; if this is not possible they must be disposed of by transfer to a licensed disposal vendor.

3. Notify the appropriate governmental agency as required in the Site's State or NRC License and the Code of Federal Regulations, Title 10, Part 20.

i) After all leak tests have been completed and properly identified, send them to the Safety & Industrial Hygiene Technology Group, Nuclear Measurements Skill Center for analysis.
PLEASE COMPLETE THE FORM ON THE REVERSE SIDE AND RETURN WITH LEAK WIPE KITS

PLEASE COMPLETE THE . LOWNG FORM AND RETURN W. LEAK WIPE KIT

a) The name of the individual who performed the leak test.

_____

b) The address where the results are to be sent

_____
_____
_____
_____

c) The name and telephone number of the individual responsible for Radiation Safety.

_____
_____

d) The purchase order or UCC charge number for billing purposes.

_____

ISOTOPE	NUMBER OF WIPES	DO NOT WRITE IN THIS SPACE

Send to: Union Carbide Corp.
Attn: M. L. Green, Bldg. 740-1101
PO Box 8361
3200 Kanawha Turnpike
So. Charleston, WV

APPENDIX IX

PROCEDURES TO REPORT DEFECTS OR FAILURES

Compliance with 10 CFR § 21.21 (Added 6/29/00)

Procedure to identify, evaluate and report defects or failures in systems associated with USNRC licensed activities that could create a substantial safety hazard, were it to remain uncorrected.

A "substantial safety hazard" means a loss of safety function to the extent that there is a major reduction in the degree of protection provided to public health and safety for any facility or activity licensed, other than for export, pursuant to Parts 30, 40, 50, 60, 61, 70, 71, or 72 of Title 10 of the Code of Federal Regulations. (10 CFR 21.3)

1. Any individual identifying a defect or failure to comply with USNRC Regulations associated with a substantial safety hazard shall immediately render any corrective, palliative or preventative action required to treat an immediate substantial safety hazard, consistent with his/her level of knowledge and training. The individual shall notify the site Radiation Safety Officer (RSO) or, in his/her absence, the Alternate RSO, of the defect or failure to comply with USNRC Regulations associated with a substantial safety hazard immediately by verbal communication, followed within 24 hours by a written communication with copies to the individual's supervisor and the site safety manager.

2. The RSO will evaluate the hazard, rendering immediate corrective, preventative or palliative action. A Root-Cause Analysis will be performed and appropriate permanent corrective actions will be taken.

3. The RSO will notify the individual first reporting the substantial safety hazard, the individual's supervisor and the site safety manager of the corrective actions taken. The notification will be in writing, within 5 working days of the first report of the hazard. If the hazard can not be corrected within 5 working days, an interim notification will be issued delineating actions to be taken and the schedule for completion of the correction.

4. If the RSO determines that the reported hazard qualifies as a substantial safety hazard, as defined in 10 CFR 21, he/she will report the situation to the senior site manager verbally immediately and in writing within 24 hours. The USNRC will be notified as required in 10 CFR § 21.21(a)(1) and 21.21(d).