FORM NRC-313 I
(1-79)
10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

1. APPLICATION FOR: *(Check and/or complete as appropriate)*

	a. NEW LICENSE
	b. AMENDMENT TO: LICENSE NUMBER
X	c. RENEWAL OF: LICENSE NUMBER 21-00265-06

2. APPLICANT'S NAME *(Institution, firm, person, etc.)*
The Dow Chemical Company
TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
517-636-0860

3. NAME OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION
G. W. Engdahl
TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
517-636-3205

4. APPLICANT'S MAILING ADDRESS *(Include Zip Code)*
Industrial Hygiene Laboratory
1803 Building
Midland, MI 48640

5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED *(Include Zip Code)*
1803 Bldg., Midland, MI 48640
9001 Bldg., Ag Res. Ctr., Midland, MI 48640
4868 Wilder Rd., Bay City, MI 48706
Larkin Lab, Midland, MI 48640

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	Radioactive materials are to be used by or	under the direct supervision of
b.	individuals designated by the Radiation Sa	fety Committee; Chairman, L. W. Rampy
c.		

7. RADIATION PROTECTION OFFICER
G. W. Engdahl/T. W. Parsons

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.

8. LICENSED MATERIAL

LINE NO.	ELEMENT AND MASS NUMBER A	CHEMICAL AND/OR PHYSICAL FORM B	NAME OF MANUFACTURER AND MODEL NUMBER *(If Sealed Source)* C	MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME D
(1)	See Attached			
(2)				
(3)				
(4)				

	DESCRIBE USE OF LICENSED MATERIAL E
(1)	See Attached
(2)	
(3)	
(4)	

8506050420 841207
PDR FOIA
KOHN84-850 PDR

9. STORAGE OF SEALED SOURCES

LINE NO.	CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A.	NAME OF MANUFACTURER B.	MODEL NUMBER C.
(1)	Not Applicable - See Radiation		
(2)	Protection Program		
(3)			
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	TYPE OF INSTRUMENT A	MANUFACTURER'S NAME B	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED *(alpha, beta, gamma, neutron)* E	SENSITIVITY RANGE *(milliroentgens/hour or counts/minute)* F
(1)	See Attached					
(2)						
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☒ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

See Attached

☒ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

12. PERSONNEL MONITORING DEVICES

TYPE *(Check and/or complete as appropriate.)* A	SUPPLIER *(Service Company)* B	EXCHANGE FREQUENCY C
☒ (1) FILM BADGE ☒ (2) THERMOLUMINESCENCE DOSIMETER *(TLD)* ☒ (3) OTHER *(Specify)*: See Attached	R. S. Landauer Company Glenwood Science Park Glenwood, IL 60425	☒ MONTHLY ☐ QUARTERLY ☐ OTHER *(Specify)*:

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☐ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS *(Include filtration, if any)*, ETC.

☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING *(fixed and/or temporary)*, ETC.

☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.

☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC. See Item 15

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

Chem-Nuclear Systems, Incorporated or U.S. Ecology, Incorporated

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

See Item 14(b) Discussion Attached

INFORMA N REQUIRED FOR ITEMS 15, 16 AND

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

    c. Mathematics and calculations basic to the use and measurement of radioactivity.

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.–18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)* $300.00	b. CERTIFYING OFFICIAL *(Signature)* L W Rampy c. NAME *(Type or print)* L. W. Rampy
(1) LICENSE FEE CATEGORY: 7B	d. TITLE Chairman, Radiation Safety Committee
(2) LICENSE FEE ENCLOSED: Previously sent	e. DATE 11 Sept 84

Item 8. CONTINUED

A. Element and mass number	B. Chemical and/or physical form	D. Maximum amount that licensee may possess at any one time under this license	E. Intended use of licensed materials

For Use in Research and Development and Specified General Uses - Exceptions Continued

(as defined in Section 30.4(q), Title 10, Code of Federal Regulations, Part 30)

8. a) Curium-244	Any NRC approved* sealed source	Not to exceed 0.5 curie per device and 3 curies total	Research and Development
b) Curium-244	Any NRC approved* sealed source and device or any custom made gauge as approved by the Dow RSC	Not to exceed 0.5 curie per device and 3 curies total	Production gauges for measurements such as density level, moisture or specific chemical analysis
9. a) Americium-241	Any NRC approved* sealed source	Not to exceed 10 curies per device and 75 curies total	For research application as typical gauging devices and as approved by the Radiation Committee (RSC)
b) Americium-241	Any NRC approved* sealed source and device or any custom made gauge as approved by the Dow RSC	Not to exceed 10 curies per device and 75 curies total	Production gauges for measurements such as density, level, moisture or specific chemical analysis
10. Californium-252	Any NRC approved* sealed source	Not to exceed 0.2 curie per device and 2 curies total	As approved by the RSC for research and development of custom designed analyzer device

Note: Prior to purchase of CF-252 sealed sources, the specific model number will be provided to the Region III, U.S. Nuclear Regulatory Commission (NRC), Materials and Licensing Branch Office.

11.** a) Plutonium-238	Sealed sources (Amersham Model PPC-X)	5 sources not to exceed 30 millicuries per source	For use in Telesec Model X-200 X-ray fluorescence analyzers for testing of materials
b) Plutonium-238	Sealed sources (Amersham Model PPC-X)	1 source not to exceed 120 millicuries per source	For use in a Texas Nuclear customer designed thickness gauge for testing of materials

Further details on the intended uses of licensed materials are discussed in the following paragraphs.

Based on more than 30 years of experience with sealed sources and sealed source devices, Dow has an established radiation survey and wipe testing programs in the Midland location. Based on this experience and established monitoring programs, all sealed source gauge devices in possession as of the date of this license renewal approval, are accepted as NRC approved (or equivalent agreement state approval) devices.

*Or equivalent agreement state approval
**To replace NRC license number SNM-1451

Item 8. LICENSED MATERIAL

A. Element and mass number	B. Chemical and/or physical form	D. Maximum amount that licensee may possess at any one time under this license	E. Intended use of licensed materials
For Use in Research and Development and Specified General Uses			
(as defined in Section 30.4(q), Title 10, Code of Federal Regulations, Part 30)			
1. ✓a) Any byproduct materials with Atomic Numbers 3 through 83	✓Any	Not to exceed 1 curie per radionuclide and 75 curies total	Research and Development
b) Any byproduct materials with Atomic Numbers 3 through 84	Any NRC approved* sealed source (or foil) and device or custom made gauge as approved by Dow Radiation Safety Committee (RSC)	Not to exceed 0.5 curie per device and 75 curies toal	Production gauges for measurements such density, level, moisture or specific chemical analysis (e.g., X-ray fluorescence, gas chromatograph)
Exceptions			
2. Mixed fission products	Any	Not to exceed 2 curies total	Research and Development
3. Hydrogen-3	Any	Not to exceed 75 curies total	Research and Development
4. Carbon-14	✓Any	Not to exceed 6 curies total	Research and Development (includes use in field studies of pesticide and in human research)
5. a) Krypton-85	✓Any NRC approved* sealed source	Not to exceed 1.5 curies per device and 10 curies total	Research and Development
b) Krypton-85	✓Any NRC approved* sealed source and device or custom made gauge as approved by Dow RSC	Not to exceed 1.5 curies per device and 10 curies total	Production gauges for measurements such as density, level, moisture or specific chemical analysis
6. a) Cobalt-60	Any	Not to exceed 2 curies total	Research and Development
b) Cobalt-60	✓Any NRC approved* sealed source and device or custom made gauge as approved by Dow RSC	Not to exceed 0.5 curie per device and 2 curies total	Production gauges for measurements such as density, level, moisture or specific chemical analysis
7. a) Cesium-137	✓Any	Not to exceed 2 curies total	Research and Development
b) Cesium-137	✓Any NRC approved* sealed source and device or custom made gauge as approved by Dow RSC	Not to exceed 5 curies per device and 300 curies total	Production gauges for measurements such as density, level, moisture or specific chemical analysis

*Or equivalent agreement state approval

Continued on next page

Add Cs 137
Eberline Mod No 1000
Calibrator 143.1 Ci

Item 8. E. Intended Use of Radioactive Materials

(1) Research and development operations in which radioactive materials are utilized include the following examples.

a. Radioisotopes Used for Toxicology Studies in Animals

Toxicology research activities utilize radioisotopes for metabolism studies in animals, fish, and cell cultures. The levels of radioactivity in most studies are 5 mCi or less of Carbon-14 (C-14) or tritium. However, on occasion, up to 10 mCi per study may be utilized.

The toxicology building is equipped with epoxy coated floors and a ventilation system to supply and exhaust temperature controlled air. The radioisotope experiments involving animals are carried out in dedicated laboratories (for the period of experiments). Each laboratory normally contains metal cabinets with nonporous (e.g., stainless steel, formica, etc.) bench tops. Laboratory fume hoods are used for operations involving dose preparation of volatile or powder materials. Animal exposure chambers are normally metal, glass or plastic cages where precautions are used to isolate the routes of release of effluents from the animal and chamber. Spill precautions are taken to minimize the spread of contamination (e.g., plastic backed absorbent paper is used on bench tops and under animal cages). Equipment utilized is appropriately labeled in accordance with guidelines in 10 CFR 20. The laboratory has been certified to meet American Association for Accreditation of Laboratory Animal Care (AAALAC) operating standards.

Animal caretakers are not allowed to handle radioisotope dosed animals. Handling of dosed animals is limited to approved isotope users involved in each specific study. Animals, animal carcasses, and waste products are all handled as radioactive and waste placed in designated radioactive waste containers. Glass cages are handled as contaminated and the first rinse of the cage is kept for analysis and subsequent disposal. The cages are further washed and rinses collected and disposed of as radioactive waste. Cages are decontaminated and wipe tested to meet the unrestricted use criteria (less than 2 times background) before being returned to general use. Animal handling and decontamination work is performed by the study director or one of the coinvestigators in the study.

The toxicology laboratory is a controlled access building and rooms where radioisotopes are used are clearly labeled.

b. Bioproducts research and development utilizes radioisotopes for fermentation production of radiolabeled antibiotics, radioimmunoassay analysis and DNA labeling for amino acid sequence identification related to genetic research. The levels of radioactivity usually are less than 10 mCi per study.

c. Field Studies of Pesticides

Agricultural research and development operations include synthesis of radioisotope labeled pesticides in quantities up to 200 mCi per synthesis. Most synthesis reactions involve 50 mCi and normally are limited to C-14. These operations are performed in one access controlled laboratory. Other agricultural research operations involve metabolism, residue, and biodegradation studies where the radioactivity is about 5 mCi per study.

Field studies utilizing C-14 labeled pesticides are carried out by the Agricultural Research Center to determine route of uptake, metabolism degradation, and other parameters as necessary. It is estimated that four studies per year are made with approximately one to three applications of material per study. Each study normally totals 50 square feet for all C-14 applications. The maximum anticipated concentration is 0.4 mCi per square foot with most studies at 0.04 mCi per square foot.

Access to field treatment areas is controlled by a fence with a locked gate. The fenced area is posted with a radioactive materials "CAUTION" sign. All studies are performed on Dow property.

The expected radiation dose to the study investigators (i.e., application personnel) and other humans in unrestricted areas as a result of field studies is minimal and well within acceptable NRC exposure guidelines (this is based on exposure monitoring results from previous studies).

Application of the labeled material will be performed using a containment shield under the supervision of radiation safety personnel. The contaminated shield will be treated as radioactive waste. Protective equipment will be worn by the applicator per radiation safety staff instructions.

At the completion of the study, the tagged crops and soil will be removed, counted and treated as radioactive waste if necessary.

Before removing the access control fence, the remaining top soil within the treatment area will have an average C-14 concentration less than 8×10^{-4} µCi/g-soil.

d. Research and development operations include the solidification of small quantities of radioisotopes utilizing the Dow media solidification system. Small quantities of ion exchange beads and other sample wastes from nuclear facilities are solidified to verify the operating parameters for large scale operation at non-Dow nuclear facilities. Radioactivity levels are generally less than 1 mCi per solidification study involving mixed fission products or similar radioisotopes.

e. The NRC licensed (R-108) TRIGA research reactor and an accelerator are used to activate isotopes to their radioactive state for analytical determinations. The level of radioactivity generated is normally 1 mCi or less per sample with radioisotope half lives of seconds to weeks for the majority of materials generated.

f. Research Studies Involving Humans

Human studies will utilize C-14 for research on the metabolic fate of chemicals where routine non-radioactive methods cannot be employed. Dow has experts in inhalation toxicology, pharmacokinetics, metabolism, medicine and analytical chemistry who routinely study the pharmacokinetics and metabolism of various industrial (non-pharmaceutical) chemicals in man and animals. C-14 labeled test materials are frequently used in the animal studies as authorized in the NRC license 21-00265-06. Safe handling procedures and responsibilities of the users are outlined in Dow's Radiation Protection Manual, which is included as Item 15 of this application.

All studies involving C-14 and human volunteers will be conducted using the Dow Midland, Michigan, facilities. Dow possesses facilities for dose administration, sample collection and analysis, and clinical care of the human volunteers. Specific instructions regarding biological excreta collection, radiation safety precautions for the volunteers, diet exercise, alcohol and pharmaceutical consumption will be presented to the human volunteers.

All research protocols pertaining to the use of C-14 in humans would be subjected to scientific review by our technical staff, ethical review by the Dow Human Health Research Review Committee and review for radiation safety by the Dow Radiation Safety Committee (RSC). The protocols would then be forwarded to the University of Michigan, where two independent committees would review the proposed studies. The "Committee to Review Grants for Clinical Research and Investigation Involving Human Beings (IRB)" would provide ethical review as they have been for all of our non-radiotracer studies involving humans. When materials containing C-14 are to be studied, the "Radioactive Drug Research Committee (RDRC)" would review the protocols for radiation safety concerns. The RDRC will meet NRC requirements as it is registered with the Food and Drug Administration as RDRC No. 45. Annex I, Number 1 has letters from R. C. Bishop, M.D., Chairman, RDRC No. 45, and W. W. Corn, M.D., Chairman, IRB, which authorize Dow to submit protocols to the RDRC No. 45 and to the IRB for review.

Employees, identified as the approved users of the radioactive material, will be selected based on the following qualification criteria.

(a) Employee must have attended a Dow training class of at least Class II level (see Item 15, Radiation Protection Program).

(b) Employee must have experience in the use, handling, and administration of non-radioactive or radioactive materials in human studies.

(c) Employee must have supervised or conducted nonhuman studies involving the types and quantities of carbon-14 labeled compounds expected to be used in the human studies.

The use of licensed material in or on human beings shall be by, or under the supervision of, a physician as defined in 10 CFR 35.3(b).

Dow already has much experience in working safely with radioisotopes. The personnel are trained, the equipment and facilities are already in place and procedures exist for safe operation. Thus, no additional radiation safety precautions or procedures are necessary to work with samples from the human research studies.

(2) Sealed Source Uses and Applications

Only NRC approved (or equivalent agreement State approved) sealed sources will be purchased for RSC approved sealed source applications for research and development after September 15, 1984. Only NRC approved (or equivalent State approved) sealed source devices will be purchased for production gauges (after the date of this license renewal approval). The curie limit quantities specified for each sealed source and device is as listed in Item 8.d. Exception to this limit is as follows.

Manufacturer	Model Number	Total Activity	Use
Eberline	1000	143.1 Curies Cs-137	Calibration of Radiation Meters*

max act auth 250 Ci Cs137

Indust Reactor Lab Md 1000

An inventory of approximately 400 sealed sources is maintained with the computerized records updated approximately every six months. In the interim, a running file of sealed source inventory changes is also maintained. The sealed source inventory is reviewed by the RSC.

Sealed sources and devices are used in many applications such as static elimination, measuring density, flow, thickness, level, and specific analyses. Any Dow custom gauge would be used pursuant to RSC approval via the Custom Gauge Review Form.

Custom Made Gauges or Devices

Dow has a trained group of individuals who are involved in fabricating and servicing Dow custom made gauges containing radioactive material. These individuals do not fabricate or otherwise manufacture sealed sources. The extent of hands on sealed source manipulation is limited to installing and replacing of commercially purchased sealed sources in the custom made gauges. The training and experience necessary for individuals to conduct this type of activity is addressed in the Training Program portion of this document, but includes at least a Class III level of Dow conducted training or equivalent with additional on-the-job experience provided. There is a primary group of employees having both adequate education and experience to design and work with custom made gauges. There is a secondary group who work under the supervision of the primary group and their activities are limited to source manipulation only, not design.

*See Item 11 for detailed discussion.

Presently, the custom made gauges are used for activities such as X-ray fluorescence analysis, beta, gamma and X-ray, transmission, n absorption, n scattering, n activation, and prompt gamma ray analysis including, but not limited to isotopes of Cd-109, Fe-55, and Am-241. The level of activity is normally limited to 0.05 Ci of Cd-109, 0.2 Ci of Fe-55, and 5 Ci of Am-241 per device. The fabrication, testing, and servicing of the custom made gauges occurs primarily at the Dow Instrument Development Group in the Analytical Laboratory. The custom made gauges can be used at any of the Dow Midland facilities for development evaluation. The RSC reviews applications for each custom made gauge following the Custom Made Gauge Review Form (Annex I, Number 2) for approval.

After the development evaluation for any custom made gauge has been completed, the gauge may be used as an ongoing production gauge by maintaining the gauge on the sealed source gauge (device) inventory control program and keeping the Custom Made Gauge Review form on file.

Prior to distribution of custom made gauges for routine production applications at other NRC or agreement state licensees, the Instrument Development Group supervisor or a contracted vendor will submit the custom made gauge review requirements to the NRC or appropriate agreement state for approval (this does not affect gauges fabricated prior to the license renewal approval date).

ANNEX I to Item 8 of License Renewal Application

1. Letters from R. C. Bishop, M.D., Chairman, RDRC No. 45, and W. W. Corn, M.D., Chairman, IRB

2. Custom Made Gauge Review form

Item 10. RADIATION DETECTION INSTRUMENTS

Meter Type	Minimum Number Available
Radiation Survey Instruments	9
Contamination Instruments	5
Liquid Scintillation Counter	1

Item 11. Radiation Meter Calibration Procedures

Introduction

The following information details Dow's meter calibration operations. In addition to conducting our own survey meter calibrations, we return meters to various manufacturers and vendors for repair and for calibration. The only meters routinely calibrated outside of Dow are the neutron survey meters. The Geiger-Mueller meters are calibrated by Dow if used for survey purposes.

Criteria for Meter Calibration Frequency

Frequency of calibration as dictated by use but not to be less than annually.

Quarterly Calibration (91 ± 20 days)

Radiography Operations (State of Michigan regulated)
TRIGA Reactor (Emergency Response)

Semi-Annual Calibration (182 ± 30 days)

For example: Radiation Safety Operations
Sealed Source Device Fabrication and Service Operations
TRIGA Reactor Operations
Solidification Research and Development Operations

Annual Calibration (365 ± 40 days)

For example: Emergency Response Meters (e.g., fire, security)
Neutron Survey Meter (Returned to Manufacturer)

Meter Calibration Operators

Meter calibration will be performed only by trained industrial hygienists (radiation safety staff). Specific training in the use of the calibrator device will be provided by the radiation safety officer or an experienced operator of the calibrator. Specific training includes radiation protection techniques of time, distance, shielding, and the use of the interlock system to minimize radiation exposure potential during meter calibrations. Additional training involves operational supervision for the initial meter calibration operation.

Personal Dosimetry

The individual performing the calibration must obtain (from the RSO) and wear a personal radiation dosimeter.

Calibration Specifications and Quality Control

An adequate calibration of a radiation meter cannot usually be performed with check sources. Frequent checks with check sources will be supplemented at periodic intervals using the two point calibration method. Each scale of the meter will be checked at two points; approximately 25% and 75% of full scale. A survey meter may be considered properly calibrated at one point when the exposure rate measured by the instrument differs from the true exposure rate by less than 10% (Regulatory Guide 10.5). However, readings within ±20% are considered acceptable if a calibration chart or graph is prepared and attached to the instrument.

Each instrument will be calibrated for gamma radiation using the Eberline multiple source Gamma Calibrator Model 1000. The Model 1000 calibrator is designed to provide a beam of ionizing radiation internal to a self-contained source shield. On December 12, 1974, the calibrator (Serial No. 112) contained eight individual sources totaling 143.0998 Ci of Cs-137. The source quantity breakdown was as follows.

Postion Number	Source Serial Number	Test Date	Isotope		Quantity
1	422	12-12-74	Cs-137		88 uCi
2	407	12-12-74	Cs-137		8.2 mCi
3	393	12-12-74	Cs-137		322 mCi
4	254	12-12-74	Cs-137		7.5 Ci
5	410	12-12-74	Cs-137		3.5 mCi
6	399	12-12-74	Cs-137		166 mCi
7	386	12-12-74	Cs-137		3.1 Ci
8	253	12-12-74	Cs-137		132 Ci
				TOTAL	143.0998 Ci

The exposure rate (mR/hr) for each source versus height (inches) in the calibration chamber is provided in a table. Annually, the values contained in the table must be updated to account for radioactive decay of the sources (2.284% change per year). Refer to the technical manual for source decay correction procedures. The actual calibration curves for each source and positions is found in the back portion of the technical manual for the Model 1000 (Serial No. 112) provided by Industrial Reactor Laboratories, Incorporated, of Plainsboro, New Jersey, the manufacturer. A description of the initial calibration procedure performed by Industrial Reactor Laboratories is also found in the technical manual. Instructions for operating the calibrator are found in the operations manual.

If an instrument does not read within ±10% of the true or calculated value full scale deflection, the reading may be corrected by adjusting the meter's potentiometer(s) or calibration pod(s). The potentiometers are located in different locations for each meter. Some are located within the instrument housing or on the outside of the meter and some meters have no potentiometers readily available. If a meter reading cannot be adjusted, the instrument will have to be returned to the manufacturer (or similar service) for repairs or adjustment and calibration.

Beta Correction Factor (BCF)

The BCF is used when surveying beta radiation sources to correct for the meter's insensitivity to beta radiation. A BCF for the meters is obtained by using a known beta source.

Calibration Tag

A sticker indicating the calibration date, battery condition, silica gel condition (if applicable) and the initials of the individual who calibrated the instrument will be attached to the side of the meter housing. This practice provides a convienent mechanism for spot checking radiation meters for adequate calibration dates.

Contracted Meter Calibration

In the event that meter calibration can not be performed by Dow Midland personnel, an outside contractor service (NRC or Agreement State Licensed) may be used for calibration.

Calibration Facility Access Control

The meter calibration equipment is stored in a posted and locked room under the adminstrative control of the Industrial Hygiene Group. Access is controlled by the radiation safety staff of the Industrial Hygiene Services Group.

Records Retention

A copy of all meter calibration data will be maintained in the Industrial Hygiene files (at least five years beyond the life of the instrument).

Item 12. Personnel Monitoring

Personnel Monitoring Minimum Criteria

1. Whole Body Radiation Dosimeters

a. Loose Isotopes

All users of loose isotopes which emit hard beta and/or gamma (or X-rays) rays are provided with a whole body radiation monitor dosimeter when the radiation whole body exposure dose rate is likely to exceed 5 mrem/hour (h) and the individual cumulative dose may exceed 25 mrem/week (wk). Also, individuals entering general work areas where the whole body radiation dose rate exceeds 5 mrem/h and the individual cumulative dose may exceed 25 mrem/wk are provided with a whole body radiation monitor dosimeter.

b. Sealed Sources

Personal monitoring is provided for employees who service or modify sealed sources and sealed source devices (custom made devices) where the radiation whole body exposure dose rate is likely to exceed 5 mrem/h and the individual cumulative dose may exceed 25 mrem/wk. However, personal monitoring is usually not provided for employees who use or work near production type gauges used for routine analyses because of the near certainty that 25% of the quarterly allowed dose (10 CFR 20.101) will not be exceeded. No calculations or documentation are maintained because: (1) the sources are shielded to keep radiation levels below 5 mR/hr at 30 cm from the gauge surface, (2) all direct radiation beam areas are identified and posted to prevent access, and (3) employees typically do not spend major portions of the work shift using or even located near the gauges.

2. Extremity Radiation Dosimeters

Individuals handling loose isotopes and sealed source capsules, which emit hard beta and/or gamma (or X-rays) rays, where the radiation extremity dose rate is likely to exceed 75 mrem/hr and the total dose is likely to exceed 360 mrem/wk based on dose rates and anticipated exposure time are provided with extremity monitoring devices.

3. Other Radiation Dosimeters

Individuals who enter radiation areas where whole body exposure dose rates are likely to exceed 50 mrem/hr or the calculated whole body dose is likely to exceed 100 mrem/wk based on anticipated exposure time may be provided with pencil dosimeters for daily recording of exposure doses.

4. Biological Monitoring Program - Criteria for Bioassay

Bioassays for I-125 will be performed in accordance with criteria and frequency positions set forth in Regulatory Guide 8.20. Thyroid measurements will be made routinely as established by the radiation safety officer (or a member of the radiation safety staff) under authorization of the Radiation Safety Committee (RSC).

Bioassays for tritium (H-3) will be performed in accordance with criteria and frequency set forth in the Regulatory Guide for H-3 (see "Guidelines for Bioassay Requirements for Tritium", Nuclear Regulatory Commission, Division of Fuel Cycle and Material Safety, October 19, 1977). Urine measurements will be made unless a different method of bioassay is deemed necessary due to metabolic route of a radio labeled compound. The need to initiate H-3 bioassay will be established by the RSO as designated by the RSC.

The need for biological monitoring for other radioisotopes will be established as deemed necessary by the RSO and the RSC. Criteria for action levels are established for other radioisotopes using similar exposure safety factors relative to maximum permissible body burdens (MPBB) and maximum permissible concentrations (10 CFR 20) as found in Regulatory Guides for I-125, H-3, and Regulatory Guide 8.9.

In setting action levels to initiate bioassay consideration will be given to the concept of keeping personnel exposures as low as reasonably achievable (ALARA).

Item 14(b)(1). Non-Commercial Waste Disposal

Dow will dispose of low level radioactive waste by incineration. The incineration of low level radioactive waste is authorized by the State of Michigan Department of Natural Resources under permits 93-73I and 471-79.

The incinerator is located inside the fenced boundary of Dow's Midland, Michigan, site. Five warehouses are located from 300-450 feet east of the incinerator. Other than the administrative offices for these buildings, the nearest occupied building is approximately 600 feet to the southeast and is a single story structure. The Dow boundary fenceline relative to the incinerator is 800 feet south, 1200 feet west, 4400 feet north and 4400 feet east. The Tittabawassee River traverses the boundary on the west and south sections of the Michigan Division. Prevailing winds are from the southwest.

The incinerator is a rotary kiln design that discharges 27,000 to 32,000 cubic feet per minute (SCFM) of exhaust gases through a stack 200 feet in height with an inner diameter of 12 feet. The normal operation schedule is 24 hours per day, 7 days a week. Under normal conditions, it suspends operations only for breakdowns and scheduled shutdowns. Plant rubbish, industrial solid wastes and liquid organics are examples of typical nonradioactive wastes being incinerated.

Additional details about the operation of the Michigan Division Incinerator as related to its use for disposal of radioisotopes are described as follows. The major radioisotope wastes incinerated are C-14 and H-3 (tritium). Incineration is well within the requirements of the NRC regulations guidelines of 10 CFR 20, Apendix B, Table II, for maximum permissible concentrations (MPCs) for unconditional release of effluents to the environment. The incineration criteria for radioisotopes limit the daily concentration to be equal to or below the allowable MPCs at the source of generation. The weekly average concentration of radioisotopes is limited to 10 percent of the allowable MPCs at the effluent release point (as effluent leaves incinerator facility). Potential exposure to radioactive effluents has been considered for personnel in buildings near the incinerator and to the general population offsite. Based on self-imposed effluent source limits and additional dilution, the potential exposure to all personnel are many fold less than acceptable exposure guidelines set by the NRC.

Enclosed is background information regarding the effluent flow rates of the incinerator, appropriate MPCs, NRC regulations, current NRC license conditions for incineration and calculations used as the basis for incineration guidelines. The effluent flow rates used for the stack gases and quench water are 10 percent less than actual flow rate ranges. This means that actual effluent concentrations for the stack gases and quench water will be less than those calculated and provides an additional safety factor. Included are sampling and analysis protocols for the incinerator when sampling is required.

Based on the enclosed calculations and operating criteria, Dow wishes to incinerate the following radionuclides.

RADIOISOTOPES APPROVED FOR DISPOSAL
BY INCINERATION

H-3, C-14, and any byproduct material licensed with a physical half life greater than 15 days (e.g., excludes Na-24, P-32, Sc-47, Mn-56, I-131, etc.)

The incinerator operates approximately 300 days per year which accounts for breakdowns, maintenance, and planned shutdowns. Radioactive material will be burned not more than 5 days per week or 260 days per year.

The operating guidelines limit the quantity of each radioisotope incinerated per burn. If more than one radionuclide are combined in a single burn, the maximum activity of each radionuclide allowed to be burned would be calculated by the "sum of the ratios" method described in "Note 1 to Appendix B" of 10 CFR 20.

Because of the near certainty that H-3 and C-14 will not be released as ash effluent products of combustion, ash from burns involving one or both of these radionuclides will be treated as ash generated during incineration of nonradioactive waste and will be disposed of as a non-radioactive ash in a hazardous materials landfill. A survey will be made by the RSO to verify these assumptions and calculations. If a burn includes one or more of any other radionuclide, the ash concentrations will be evaluated. If appropriate surveys verify the concentrations (in terms of microcuries per gram) specified for water in Appendix B, Table II, 10 CFR 20 are not exceeded, these ash residues will be disposed of as nonradioactive ash in a hazardous materials landfill.

If ash residues are found to exceed Appendix B, Table II, concentration limits due to the incineration of known radionuclides, the ash will be segregated and packaged for shipment to a federally licensed burial site.

Dow intends to incinerate solid waste, animal carcasses, tissue, combustible liquids, liquid scintillation vials and fluids and any other combustible waste generated from the use of Dow's Midland byproduct materials license and byproduct material licenses held by subsidiaries or divisions of The Dow Chemical Company. It is estimated that the amount of low level radioactive laboratory wastes from other NRC licensed sites of The Dow Chemical Company will not exceed 100 millicuries. These wastes are likely to be limited to carbon-14 and hydrogen-3. This amount of radioactive waste will not significantly impact the overall Midland low level radioactive waste incineration operation. Incineration will not include sealed sources or devices. The Radiation Safety Officers of the Industrial Hygiene Laboratory will monitor the radionuclides and their activities to be incinerated so as not to exceed the limits specified.

Item 15. RADIATION PROTECTION PROGRAM

RADIATION PROTECTION PROGRAM

Summary Outline

I. Radiation Safety Committee

A. Membership, Meeting Frequency and Membership Experience and Training

B. Radiation Safety Committee (RSC) Control Function and Administrative Procedures

1. responsibilities, duties and authority of the committee
2. procedures and criteria for evaluation of uses of radioactive materials
3. training of radioisotope users
4. procedures used for controlling and maintaining inventories, procurement of radioactive materials, possession limits and transfers of radioactive materials
5. methods employed for maintaining records of the RSC proceedings and safety evaluations of proposed uses of radioactive material
6. periodic review of the radiation protection program

II. Radiation Safety Officers

A. Responsibilities, Duties and Authority of Radiation Safety Officers

B. Radiation Safety Group Organizational Structure

C. Experience and Training of the Radiation Safety Officers

III. Loose Radioisotopes - Radiation Protection Procedures

A. Isotope Owner Responsibilities

B. Isotope User Responsibilities

C. Classification of Laboratory Areas

D. Survey Frequency Criteria for Removable and Fixed Surface Contamination

E. Survey Methods

F. Airborne Radioactivity Monitoring Criteria

G. Acceptable Radiation Dose and Contamination Limits

H. Biological Monitoring Criteria

I. Personnel Monitoring Criteria

J. Documentation and Recordkeeping Considerations

K. Posting Requirements for Working with Radioactive Materials

L. Criteria for Use of Ventilation Equipment and Surveys

M. Procedures for Ordering, Receiving, Unpackaging and Transferring of Radioactive Materials

N. Radiation Protection Instructions to Isotope Users

O. Emergency Procedures

P. Storage of Radioactive Materials

Q. Respiratory Protection Policy

Forms: Laboratory Isotope Use Approval
Radiation Training Record/Isotope Use Approval

IV. Sealed Source Radiation Protection Procedures

A. Training Criteria

1. Sealed source device owners
2. Custom made gauge fabrication and service personnel
3. Sealed source device installation and removal personnel

B. Responsibilities of Sealed Source Users

1. Sealed source device owners
2. Custom made device fabrication and service personnel
   a. individual user responsibilities
   b. supervisor's responsibilities

C. Procurement, Use, Transfer and Disposal of Sealed Sources and Devices

1. Procurement
2. Receipt and survey
3. Transfer of sealed sources and devices
4. Use of sealed sources
5. Storage of sealed sources
6. Removal and disposal of sealed sources and devices

In reference to Regulatory Guide 10.5 subnote 7, Dow will update or improve radiation procedures without prior notification (license amendment) of the NRC. The following changes would not require NRC notification; (1) changes dictated by NRC Rule changes, (2) changes in internal management forms, (3) changes in contracted waste disposal firms, (4) changes in personal dosimeter contractor or (5) other changes of similar nature. But changes of this type are not intended to include modification of basic criteria committments. The significance of the change and thus the need for NRC notification would be determined by the Radiation Safety Committee and/or Radiation Safety Officer.

I. Radiation Safety Committee

A. Membership, Meeting Frequency and Membership Experience and Training

L. W. Rampy, Chairman
O. U. Anders, Technical Expert (Radiochemist)
F. A. Blanchard, Technical Expert (Radiochemist and Physicist)
D. J. Ducommon, M.D.
W. H. Lee
G. W. Engdahl, Radiation Safety Officer (RSO)

The Radiation Safety Committee (RSC) is composed of physicians, engineers, scientists, and management with a broad background in the use of radioisotopes and radiation sources. The RSC is responsible for the administration of all Dow Midland location activities involving the use of radioactive materials and radiation sources including assuring compliance with NRC regulations. The RSC will meet at least four times a year. If the full RSC is unable to meet, a minimum of the chairman of the RSC, a technical expert (F. A. Blanchard) and the RSO are authorized and empowered to act for the full RSC as a quorum. RSC actions require a simple majority of those present. A curriculum vitae for each member of the RSC is in Annex II, Number 1.

B. RSC Control Function and Administrative Procedures

1. Responsibilities, Duties, and Authority of the RSC

The RSC has jurisdiction over all activities involving the use of radioactive materials and radiation emitting sources. The RSC has been delegated this authority by and is answerable to the general manager of the Michigan Division and the corporate director of Research and Development. Operational duties of the RSC include, but are not limited to the following.

a. Set radiation safety policies and criteria for the use of radioactive materials for all Michigan Division and Midland location corporate Research and Development facilities.

b. Receive, review and act on all applications for the use of unsealed radiation sources and materials in the Midland location used by Dow employees in which a radiation hazard may exist. The authority for interim approval may be delegated to the RSO for up to Type C laboratory levels [as set by International Atomic Energy Agency (IAEA) Safety Series No. 1, 1973 and listed in the enclosed table in Section III.c.].

c. Receive and review periodic reports from the Industrial Hygiene Laboratory on monitoring, contamination and personnel exposure.

d. Establish isotope user categories and certify employees who may receive and work with radioactive materials or radiation sources. Interim certification may be granted by the Industrial Hygiene Laboratory, Radiation Safety Staff. Certifications will be reviewed annually.

e. Develop administrative procedures for properly safe-guarding against hazards assoicated with radiation sources and radioactive materials.

f. Evaluate all incidents or defects which may cause a substantial safety hazard and report if necessary.

g. Carry out correspondence with the NRC and State of Michigan on incident reports, license applications and license amendments.

2. Procedures and Criteria for Evaluation of Uses of Radioactive Materials

The RSC evaluates each new type of use where medium and high levels of loose radioisotopes as defined by the classification system outlined in Section III.c. The RSO is authorized to give interim approval for new uses of low levels (IAEA, Type C or less) of loose radioisotopes. The RSO is authorized to approve new uses of C-14 up to 50 mCi, H-3 up to 50 mCi, P-32 up to 10 mCi and I-125 up to 10 mCi per laboratory experiment.

For each new use of loose radioisotopes, the criteria that will be considered for approval of facilities, equipment and operating procedures include the following: the degree of radiotoxicity, quantity of material and nature of the operation; the adequacy of the facilities and equipment, operating, handling and emergency procedures will be evaluated for each new use; the requirements for facilities and equipment will be specified by the RSC and RSO in the Laboratory Isotope Use Approval form. Laboratory approvals will be maintained for repetitive studies of a similar nature with annual review by the RSC and RSO.

The RSO and Radiation Safety personnel (industrial hygiene specialists) are delegated the responsibility to verify that operating procedures, facilities and equipment are being utilized as specified in the Laboratory Isotope Use Approval form.

a. Criteria that will be considered for approval of facilities and equipment include the following examples but specific requirements will be established as deemed necessary by the RSO for each use situation.

1) General Considerations

a) Specific areas for handling radionuclides are identified.

b) Work should be planned to separate different levels of radioactivity (e.g., areas where stock solution dilutions are made should be separate from low level dilution work).

2) Floors, Walls and Work Surfaces

Floors, walls and work surfaces should be such that they are easily cleaned.

3) Waste Disposal

Disposal of radioactive wastes are in accordance with NRC rules and regulations specified in 10 CFR part 20. Specific consideration will be given to dedicated waste containers, labeling, segregation of waste type and inventory control.

4) Ventilation

Adequate room ventilation will be provided such that the maximum permissible concentration (MPC) for work areas and the environment will be in compliance with the rules and regulations from Appendix B, 10 CFR part 20. Specific consideration for adequate flow rates to control radioisotopes in enclosures and minimum room air changes (e.g., minimum of six changes per hour) will be considered.

Considerations for Maximum Permissible Concentrations (MPCs) of radioisotopes in the laboratory and the environment will be reviewed.

5) Personal Protective Equipment

Adeqate protective clothing will be used commensurate with the level of radioactivity being handled, and the nature of the radioisotope to meet a goal of essentially zero personnel contamination. For example, laboratory coats and disposable PVC gloves would be required for low level laboratories.

6) Radiation Monitoring Equipment

Appropriate equipment will be provided for radiation surveys of personnel, equipment and work surfaces.

7) Personal Protective Measures

Work procedures are reviewed to minimize the spread of radioactive materials (e.g., no mouth pipetting, use of drip pans, use of plastic backed absorbent paper). No food/beverage materials or smoking are allowed in radioactive material use areas.

b. Criteria for the approval of custom gauge/device fabrication and service.

1) Custom gauge/device fabrication and service approval criteria require facilities for shielding of sources and equipment for handling the source to minimize extremity and whole body dose.

2) Radiation survey instruments are required to monitor the radiation levels during all development and construction phases. Personal dosimetry use criteria will be followed which include film badge and finger ring for all operations when handling sealed sources (refer to item 12 attachment and Section III.I. for additional information on criteria for personnel dosimetry). Wipe testing and inventory records for each sealed source must be maintained with RSO review semi-annually.

3) Sealed sources are stored in secured areas with access limited and area posted.

3. Training of Radioisotope Users

All users of radioisotopes are required to have training commensurate with the level of hazard prior to approval to use radioisotopes. Prior to use of radioisotopes, individuals must contact the radiation safety office staff for radiation safety training.

a. The RSC requires that appropriate training be provided to the following groups.

   1) custom gauge fabrication and service personnel
   2) sealed source device owners
   3) loose isotope users (greater than exempt quantities)
   4) emergency response personnel (medical, fire and security)
   5) support services (maintenance, incinerator operators, etc.) who work in the vicinity of radioactive materials but do not handle radioisotopes directly

   The variation in potential radiation hazard to employees within a particular group has required the development of three distinct levels of training. These training levels are identified as Class I, II and III; where Class I is the lowest level and Class III is the highest level of training. The levels of training are not rigid but are subject to the evaluation of the RSO. The training criteria as minimum guidelines include the following for each class of training.

b. <u>Class I Training</u>

   Minimum required for support service personnel, not direct users of radioisotopes or sealed sources.

   Radiation topics include radiation emissions, interactions and properties; background and man-made sources of radiation; biological effects of ionizing radiation; radiation protection standards; contamination protection techniques; training estimated to be 30 minutes to 1 hour.

   This type of training program is required for plant supervision where production sealed source gauges are used. (Additional details are available in Section IV.A.) The training topics covered may include any of the above topics but are normally targeted at the specific hazards of the individual sealed source device and the administrative responsibilities.

c. Class II Training

Minimum required for low level loose isotope users.

Training will include all subjects for Class I in greater detail plus radioactive decay, radiation units and quantities, radiation protection techniques, radiation instrumentation, external protection, contamination surveys, decontamination, radioactive materials transportation, radioactive waste disposal and emergency procedures. Training time to be 3 to 4 hours depending on scope of work and radioisotopes.

d. Class III Training

For medium and high level users of loose isotopes, sealed source device fabrication and service instrument personnel and radiation safety support staff.

Training to include all areas discussed for Class I and II, but in greater detail plus details on personnel dosimetry, treatment of contaminated injuries, air monitoring, bioassay considerations, etc. Approximate training time is eight hours with a closed book written exam requiring a 75% correct score for passing grade. Additional training and review of problem areas are performed with re-examination for those scoring below 75%. Failure of the exam excludes any individual from use of isotopes.

Interim approval to use unsealed radioisotopes is given by the RSO when classroom training is complete. (This assumes that the planned work has been approved by the RSC for medium and high level laboratories.) The isotope user works under the direction of an experienced radioisotope user or supervisor until competency has been demonstrated in the laboratory. The laboratory supervisor's signature is added to the isotope use approval record sheet as a record of competency. The isotope use approval form is submitted for final approval to the RSC at the next regularly scheduled meeting (or sooner if necessary). The isotope use approval form details the isotopes and level of radioactivity authorized for use.

If additional isotopes, increased quantities of isotopes (sufficient to require medium or high level laboratory precautions) or operational changes are made, then the isotope user is required to obtain new isotope use approval from the RSO and RSC. This will be granted only after completion of appropriate training and review of the laboratory use approval requirements.

The RSO is authorized to approve sealed source owners for use of sealed source devices used as part of production and research operations. Approval of individuals for use of sealed sources for fabrication of devices or servicing requires the approval of the RSC.

e. The employee training will be performed by the RSO or one of the radiation safety personnel (industrial hygienists) who has completed Class III training and additional specialized training in radiation safety techniques.

   Training will be performed by: G. W. Engdahl, M.S., Environmental Health, University of Minnesota; T. W. Parsons, M.S., Health Physics, Purdue University; or other industrial hygienists with a minimum of a bachelor's degree and significant technical training in health physics.

4. Procedures used for controlling and maintaining inventories, procurement of radioactive materials, possession limits and transfers of radioactive materials.

   a. An inventory control system approved by RSC and maintained by the RSO is used to track the movement of all radioactive materials. Tracking of radioactive material occurs from initiation of order through disposal. The record of all movement is maintained through the use of the Radioactive Material Transaction Form (loose isotopes) and Change Notice Form (sealed sources and devices) which are summarized for computerized recordkeeping. The recordkeeping summaries are verified and reported to the RSC. The typical procedures followed are as follows (Radioactive Materials Transaction Form is in Annex II, Number 2).

Isotope User - Requistions for Radioisotopes

↓

Purchasing Department → To User

↓

Purchase Order Copies → Radiation Safety Officer

↓

Supplier

↓

Shipment to Central Receiving, Ag Research Center or Larkin Lab

- phone notification to user and Industrial Hygiene on arrival

↓

Isotope User

Isotope user logs in inventory record and completes material transaction form

↓

Radiation Safety Officer

- add to computer inventory record for isotope owner supervisor

Use and/or transactions include shipments to other approved isotope user in Dow; shipments to outside Dow; shipments of radioactive waste to the incinerator; shipments of radioactive waste to commercial waste disposal facility. All transactions are coordinated through the radiation safety office and communicated on paper with the Radioactive Materials Transaction Form or Sealed Source Change Notice Form to the RSO.

b. Inventory Control Review

The RSC reviews summaries of all transactions and material inventories for each isotope. An example of this is in Annex II, Number 3. Each owner verifies his inventory with the RSO. A summary of all isotopes in loose and sealed form is prepared for the review and approval of the RSC to verify compliance with license possession limits. This document serves as a working control document to check and approve isotope orders for quantity limits as delegated to the RSO. Any discrepancies found must be reported to the RSC and rectified in the inventory records by the isotope owner and RSO.

5. Methods employed for maintaining records of the RSC proceedings and safety evaluations of proposed uses of radioactive materials.

   The RSO maintains Minutes of each RSC meeting in the Industrial Hygiene Laboratory files. New types of uses of radioactive materials are infrequent and handled on an individual basis. The RSO and the isotope user present information about the nature and level of radioactivity to be used for the new type of study. The RSC requires that information be supplied regarding the adequacy of facilities and equipment, and operating, handling and emergency procedures. The laboratory isotope use approval record is maintained to document isotope level approval and conditions of use. Personal dosimetry and contamination control monitoring requirements are also specified in the laboratory isotope use approval form.

6. Periodic review of the radiation protection program.

   Annually, the RSC reviews the radiation safety program to ensure personnel exposures and operations are maintained within the regulations set forth by the NRC and the conditions of this license. Records reviewed include the following summaries and records: statistical summary of personal dosimetry results; cumulative inventories for unsealed (loose) and sealed sources of each radioisotope versus the possession limits; number of individuals authorized to use isotopes; training provided for isotope users and support personnel; bioassay data collected and results of subsequent action when deemed necessary by the RSC; cumulative totals of radioactive waste disposed by noncommercial incineration and commercial waste disposal at contractor facilities; summary of all transactions by each approved isotope owner.

   Also reviewed by the RSC will be the results of NRC inspections, written safety procedures and overall adequacy of the management control system that is in place.

   Each isotope user's approval status will be reviewed annually.

ANNEX II to Section I of Radiation Protection Program

1. Curriculum Vitaes for: O. U. Anders
   F. A. Blanchard
   D. J. Ducommun
   G. W. Engdahl
   W. H. Lee
   L. W. Rampy

2. Radioactive Materials Transaction Form

3. Example of a Computer Report for Loose Isotopes

ANNEX II, NUMBER 1

LARRY WILSON RAMPY

Personal

Home: [redacted]

Telephone: [redacted]

Birthdate: [redacted]
Birthplace:
Home Territory:

Business: Dow Chemical U.S.A.
1803 Building
Midland MI 48640
Telephone: 517/636-6260

Married: [redacted]
Children:

Education

1966: Ph.D., Medical Chemistry
The University of Michigan, Ann Arbor MI
Thesis: The total synthesis of B-homoestrone and approaches to azaestrone

1963: M.S., Medicinal Chemistry
The University of Michigan, Ann Arbor MI

1961: A.B., Chemistry
Indiana University, Bloomington IN

Employment

The Dow Chemical Company (1966-Present)

Present: Director, Industrial Hygiene Laboratory, Information Center/Quality Assurance, and Analytical and Environmental Chemistry Research
1983-84: Director, Industrial Hygiene Laboratory and Information Center
1978-82: Manager, Industrial Hygiene Laboratory
1973-78: Group Leader, Inhalation Toxicology Research Laboratory
1971-73: Research Toxicologist, Toxicology Research Laboratory
1968-71: Assistant to Director, Human Health R&D, Midland MI
1967-68: Manager, Patent Department, Human Health R&D, Indianapolis IN
1966-67: Chemist, Michigan Division Special Assignments, Midland MI

1962-65: E. Mead Johnson Memorial Fellow
American Foundation for Pharmaceutical Education
The University of Michigan, Ann Arbor MI

1961-62: Research Fellow, College of Pharmacy
The University of Michigan, Ann Arbor MI

Professional Memberships

American Chemical Society
American Industrial Hygiene Association
Michigan Industrial Hygiene Society

Professional Certifications

1980: Diplomate, American Academy of Industrial Hygiene (Certificate #1962)
1980: Diplomate, American Board of Toxicology

Publications: Available upon request.

June 1984

CURRICULUM VITAE: OSWALD U. ANDERS

Research Scientist
The Dow Chemical Company
Midland, MI 48640

Education

1952: B.S., Georgetown University
1957: Ph.D., Chemistry, University of Michigan

Experience: The Dow Chemical Company, Midland, Michigan

1957: Radiochemist, Neutron Activation Analysis
1963: Associate Scientist, Radiochemistry Research
1967: Supervisor, 100 KW Triga Reactor
1978 - Present: Research Scientist

Other Experience

Carried additional responsibilities for hot cell work, industrial and nuclear decontamination and neutron activation plant stream analyzers. Authored more than 30 scientific papers.

1965-1965: Advisory Board, Analytical Chemistry
1968-1976: Organizing Committee for International Conference - Modern Trends in Activation Analysis
1972-1975: ANS, Executive Committee, Division of Isotopes and Radiation
1975-1976: ANS, Treasurer, Division of Isotopes and Radiation
1976-1977: ANS, Vice Chairman, Division of Isotopes and Radiation
1977-1978: ANS, Chairman, Division of Isotopes and Radiation
1977-Present: Advisory Board, Radioanalytical Chemistry
1979-1981: Secretary, AAS/NRC Subcommittee on Nuclear and Radiochemistry

Memberships

American Chemical Society
American Institute of Chemists
American Nuclear Society
SIGMA XI

CURRICULUM VITAE

NAME:
Fred A. Blanchard

DATE COMPLETED:
Revised 1/13/83

BIRTHPLACE:

BIRTHDATE:

EDUCATION:

School	Degree	Subject	Date
Univ. of Cincinnati	--	Chemical Engr.	1941-43
Louisiana State Univ.	BS	Mech. Engr.	1944
Univ. of Cincinnati	MS	Physics	1948
Univ. of Cincinnati	PhD	Physics (Biophysics)	1951

Additional Studies:

EMPLOYMENT: (LIST MOST RECENT LAST)

Employer	Time Period	Major Responsibility
Cincinnati General Hospital	Jan.-Sept. 1941	Research assistant in cardiology
Hilton Davis Chem. Co.	1941-1943	Co-op chemist in control lab
U.S. Army	1943-1947	Engineering school, draftsman, personnel
Dow Chemical Company		
Radio. Chem.	1951-1970	Applications of radiotracers to industrial and biological problems
Chem. Physics	1970-1971	
Anal. Lab.	1971-1974	
Env. Sci. Res.	1974-present	Environmental Studies

MEMBERSHIPS: (SOCIETIES, ETC.)

American Chemical Society
Sigma XI
AAAS
Society of Environmental Toxicology and Chemistry

SPECIAL ASSIGNMENTS:

Dow Task Force on use of process steam from Nuclear Power Plant

CURRENT JOB TITLE:
Associate Scientist

DR. FRED A. BLANCHARD

Dr. Blanchard attended the University of Cincinnati in Chemical Engineering from 1941 to 1943. He received his undergraduate degree in Mechanical Engineering from Louisiana State University in 1944 and graduate degrees from the University of Cincinnati, an M.S. in Physics in 1948, and a Ph.D. in Physics (biophysics program) in 1951. He was selected to the Tau Beta Pi and Sigma Xi.

In July, 1951, he joined the Dow Chemical Company as a Radiochemist in the Spectroscopy Laboratory, working on a variety of radiotracer applications to industrial analytical problems. He was promoted to Project Leader in the Radiochemistry Laboratory in 1961; was named a Senior Research Chemist in the Analytical Laboratory in 1971, Analytical Specialist in 1972, and Senior Analytical Specialist in 1974.

He is currently in the Environmental Sciences Research Laboratory of the Health and Environmental Research Department of Dow Chemical U.S.A. His principal field of work has been in the applications of radioisotopes to biological, chemical and industrial tracer problems. He has worked extensively with adsorption effects, polyelectrolytes, aqueous gel permeation chromatography, trace amounts of extractives from paper products, residues of cleaning operations, uptake and translocation of herbicides, penetration of wood preservatives, residues of food

additives, bioconcentration effects in fish, biodegradation of organic chemicals, migration of chemicals in soil, and systems for low level monitoring for trace activity in steam and chemical products.

PUBLICATIONS

"Technique for Growing Plants with Roots in a Sterile Medium," Plant Physiology, Vol. 25, No. 4, pp. 767-769 (1950), F. A. Blanchard, V. M. Diller.

"Uptake of Aureomycin Through the Roots of Phaseolus Lunatus," Am. Jrnl. of Botany, Vol. 38, No. 2, pp. 111-112, Feb. 1951, F. A. Blanchard, V. M. Diller.

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"Effect of Soft X-Rays on Aureomycin," The Ohio Jrnl. of Science, Vol. LIII, No. 6, November 1953, F. A. Blanchard, V. M. Diller, H. Kersten.

"Uptake Ditribution, and Metabolism of Carbon-14 Labeled Trichloroacetate in Corn and Pea Plants," Weeds, Vol. III, No. 3, July 1954, F. A. Blanchard.

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"Synthesis of Carbon-14 Labeled Dalapon and Trial Applications to Soybean and Corn Plants," Ag. and Food Chem., Vol. 8, No. 2, pp. 124 (1960), F. A. Blanchard, W. Muelder, G. N. Smith.

"Use of Submicron Silica to Prevent Count Loss by Wall Adsorption in Liquid Scintillation Counting," Analytical Chemistry, Vol. 33, pp. 975 (June 1961), F. A. Blanchard, I. T. Takahashi.

"A Computer Program for Automated Testing and Reduction of Liquid Scintillation Counting Data," Int. Jrnl. of Applied Rad. and Isotopes, Vol. 14, pp. 213-219 (1963), F. A. Blanchard.

"Liquid Scintillation Counting: Automated Mathematical Fitting and Use of Channels Ratio Methods by Computer Program," Advances in Tracer Methodology, Vol. 4 (1968), F. A. Blanchard, M. R. Wagner, and I. T. Takahashi.

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"Counting Quenched Liquid Scintillation Samples Using an Outside-the-Instrument Gamma Source and an External Standard Channels Ratio Method," Anal. Biochem., Vol. 35, pp. 411 (1970), I. T. Takahashi, and F. A. Blanchard.

"Quench Correction in Cerenkov Counting: Channels Ratio and External Source Channels Ratio Methods," Anal. Biochem., Vol. 44, pp. 369-380 (1971), A. J. Kamp and F. A. Blanchard.

"Biodegradation of ^{14}C-Phenol by Activated Sludge," At symposium on Processing of Phenolic Wastes; Division of Fuel Chemistry, National ACS meeting, Atlantic City, NJ, September 11, 1974, H. C. Alexander, F. A. Blanchard, and I. T. Takahashi.

"Biodegradability of Methylcellulose by Activated Sludge," Applied and Envir. Microbiology, 32 (4) pp. 557-560 (1976), F. A. Blanchard, I. T. Takahashi, H. C. Alexander.

"Uptake, Clearance and Bioconcentration of ^{14}C-Sec-Butyl-4-Chlorodiphenyl Oxide in Rainbow Trout," F. A. Blanchard, I. T. Takahashi, H. C. Alexander, E. A. Bartlett, Aquatic Toxicology and Hazard Evaluation, ASTM STP634, F. L. Mayer and J. L. Hamelink, Eds., American Society for Testing and Materials, 1977, pp. 162-177.

CURRICULUM VITAE

Dale J. Ducommun, M.D.
Senior Industrial Physician
Dow Chemical U.S.A.
Michigan Division Medical Department
607 Building
Midland, Michigan
(517)636-9795

Home:

Education	Degree
DePauw University	B.A.
University of Iowa	M.S.
University of Iowa	M.D.

Internship

Munson Medical Center, Traverse City, Michigan
Twelve months rotating internship from July 1, 1958 to June 30, 1959

Residencies

Licensure(s)

Michigan
Iowa
Wisconsin
California
New York

Professional Experience and Workplace(s)

Date	Workplace
1959 - 1967	Harrison Radiator Division of General Motors Corporation, Lockport, New York (Assistant Medical Director)
1967 - Present	Dow Chemical U.S.A., MI Division Medical Department

Professional Affiliations

American Academy of Dermatology - Affiliate Member
Aerospace Medical Association - Associate Fellow
Civil Aviation Medical Association - Board of Trustees Member
American Occupational Medical Association - Fellow
Society of Medical Consultants to the Armed Forces - Member
Assocation of Military Surgeons of the U.S. - Member
American Medical Association - Member
Michigan State Medical Society - Member
Midland Medical Center Medical Staff - Member (currently a member of the Pharmacy and Therapuetics Committee)

Publications

The Effect of Hetrazan Upon Experimental Infectious of *Trichinella spiralis* in the Golden Hampster and Swiss Albino Mouse, Master's Thesis, University of Iowa, 1953.

Civil Aviation Medical Association Bulletin, Editor - 1978 - 1980

Military Service

1959 - 1961 United States Navy, active duty. (Served one year as Research Medical Officer, Naval Unit, Fort Detrick, Frederick, Maryland; the second year as Medical Officer and Industrial Health Officer, Naval Research Laboratory, Washington, D.C. Rank: Lieutenant.) Active in the Naval Reserve previously serving as Commanding Officer of three different medical units. Currently affiliated with PERSMOBTEAM 1713, Naval Reserve Center, Southfield, MI. Rank: Captain. Twenty-seven years satisfactory Federal service.

Public Services

Board of Directors, Visiting Nurse Association of Midland County (Serving second term as Vice President.)

Influenza Coordinating Committee of Midland County - Member, 1976

Board of Directors, Mildand County Chapter of the American National Red Cross - Member, 1968 - 1971

Tri-City Council of the Navy League - Director

Berryhill Post 165 of the American Legion - Member

Quarantine Branch Contract Physician for the Port of Bay City, MI under Center for Disease Control, Atlanta, GA, since 1972.

Federal Aviation Administration - Senior Aviation Medical Examiner

Administrative Board, First United Methodist Church - Member

Naval Reserve Association, Reserve Officers Association, and the National Rifle Association - Life Member of all three associations.

Master Number: [ ]

Marital Status: [ ]

Date of Birth: [ ]

Date Hired: 5/1/67

Spouse' Name: [ ]

Dow Work Experience

Publications

Presentations

1968 - 1969 Multiple presentations to Dow-Midland location pipe coverers about the medical effects of asbestos exposure

April, 1970 "Circadian Rhythm and Long Distance Air Travel" talk given at Dow Physicians' Meeting in Houston, TX

May 6, 1971 "Orf" talk at Dow Physicians' Meeting in Ironton, OH

Through the years have given plant talks on "Exercise and Physical Fitness" and "Coronary Risk Factors", others.

Promotions

Staff Physician to Senior Industrial Physician in 1975

Transfers

DJD/srm
typed 8/31/82

RESUME

Personal:

Name: William H. Lee

Address:

Telephone: Home:
Business: (517) 636-3652

Age:

Height:

Weight:

Physical Condition:

Martial Status:

Wife:

Children:

Work History:

Present
December 1979
Michigan Division

Manager - Distribution, Safety, Security & Services and member of General Manager's Staff

Responsible for Division Traffic, Emergency Response, In-Plant Services, Garages, Shipping and Warehousing, Railroad Operations, Road Maintenance, Stock and Receiving, Loss Prevention, Business Insurance, Security, Safety, Laundry, Mail and Sanitation Services. Approximately 430 salaried and hourly employees.

December 1979
September 1978
Michigan Division

Manager - Traffic, Distribution and General Services and member of Major Manager's Staff

Responsible for Division Traffic (rate negotiations for rail, truck and marine scheduling and shipment of product). Emergency Response, In-Plant Services, Garages, Shipping and Warehousing of product, Railroad Operations and Road Maintenance. Approximately 340 salaried and hourly employees.

September 1978
July 1, 1975
Michigan Division

Director of Safety and Health and member of General Manager's Staff

Responsible for the safety and health functions for the Michigan Division - 7,500 employees. These responsibilities include Emergency Planning, Fire Department, Fire Protection Engineering, Safety, Industrial Hygiene, Capital Insurance, Workers' Compensation, Medical, Loss Prevention, Plant Protection and Security. Approximately 240 professional, salaried and hourly employees with an annual operating budget of $7 million.

July 1, 1975
June 1974
Rocky Flats Division

Production Manager and Major Building Superintendent and member of Division Management Information Board

Responsible for all production at the Rocky Flats Division as well as various supporting functions such as design

engineering and fabrication of tools, jigs, gages and fixtures. The function included responsibility for the rolling, casting, forming, machining and assembling of unique and highly sophisticated parts and components within extremely close tolerances of a wide variety of specialized metals and other materials. Approximately 400 technical, supervisory and hourly employees with an annual operating budget of approximately $8 million.

Major Building Superintendent function included accountability for environmental, health and safety conditions associated with the successful operation of a 200,000 square foot, $50 million complex, with special emphasis on utilities (such as the design, construction and operation of air control including filtration, temperature and humidity control).

June 1974 March 1972 Rocky Flats Division	Fabrication Manager and Major Building Superintendent and member of Division Management Information Board Responsible for one of the major production units within the Rocky Flats Division, as well as the supporting design engineering and fabrication of tools, jigs, gages and fixtures. The function included responsibility for the rolling, casting, forming and machining of unique and highly sophisticated parts and components within extremely close tolerances of a wide variety of specialized metals and other materials. Approximately 350 technical, supervisory and hourly employees with an annual operating budget of approximately $7 million. See above for Major Building Superintendent responsibilities.
March 1974 August 1971 Rocky Flats Division	Administration Manager and member of the Rocky Flats Operating Board Responsibility for Management Systems (Computer Operation for all Rocky Flats), Nuclear Materials Control, Security (Document Accountability and Plant Protection), Purchasing and Traffic. The Purchasing and Traffic functions included responsibilities for procurement, expediting and traffic control of all operating supplies and capital equipment for new construction and additions to the existing plant. Approximately 325 technical, supervisory and hourly employees.
August 1971 February 1970 Rocky Flats Division	Environment Control Manager and member of the Rocky Flats Operating Board Responsible for Health Physics, Industrial Hygiene, Waste Management, Safety and Loss Prevention, Medical, Fire Department, Nuclear Safety and Utilities (steam, heating and ventilating, water treatment and distribution, and sewage plant). Approximately 400 supervisory, technical and hourly employees.
February 1970 July 1968 Rocky Flats Division	Product Engineering Manager Responsible for the final design and definition of manufactured product. Also responsible for technical sales and development activities with Design Agencies customers and other operating contractors. Approximately 100 supervisory and technical employees.

July 1968 October 1967 Rocky Flats Division	Albuquerque Plant Manager and member of Rocky Flats Division Operating Board Responsible for the acquisition of a production facility operated by ACFI and its orderly integration into the Rocky Flats operation. Was also responsible for the operations of the existing plant in Albuquerque, New Mexico, for seven months. Approximately 260 supervisory, technical and hourly employees.
October 1967 August 1964 Rocky Flats Division	Product Engineering Manager (See July 1968 to February 1970)
August 1964 May 1962 Rocky Flats Division	Production Control Superintendent Responsible for the scheduling, procurement, shipment and inventorying all production items and materials. Approximately 100 supervisory and hourly employees.
May 1962 February 1958 Rocky Flats Division	Production Control Supervisor Essentially the same responsibility as Production Control Superintendent but on a smaller scale.
February 1958 August 1951 Rocky Flats Division	Plant Engineering Employed as a mechanical engineer and supervisor with various responsibilities in the Plant Engineering Group. Responsible for mechanical design, construction coordination and preparation of proposals for work.

Note: All of the above work experience was with Dow Chemical, U.S.A.

June 1951 January 1951	United States Atomic Energy Commission, Control Branch, Wilmington, Delaware, Mechanical Engineer, Savannah River project.
January 1951 August 1950	United States Geological Survey, General Engineer, Topographic Division, Denver, Colorado

######

Personal

Home: [redacted]

Telephone: [redacted]

Birthdate: [redacted]
Birthplace: [redacted]

Business: Dow Chemical U.S.A.
1803 Building
Midland MI 48640

Telephone: 517/636-3205
Married: [redacted]
Children: [redacted]

Education

1972: B.S./Chemistry (Pre-Med)
Augustana College, Sioux Falls SD

1973: Master of Science/Environmental Health
University of Minnesota, Minneapolis MN

1979: Nonionizing Radiation Fundamentals
Sponsored by American Industrial Hygiene Association

1982: Agrigrowth Field Training Seminar
Agrigrowth Research

Herbicide Action Fundamentals
Purdue University

1984: Real Time Air Monitoring
American Industrial Association

Employment

1983-Present:	Dow Chemical U.S.A., Industrial Hygiene Laboratory, Midland MI
1982-83:	Dow Chemical U.S.A., Agricultural Research & Development Technical Service and Development, Minneapolis MN
1980-82:	Dow Chemical U.S.A., Agricultural Marketing, Minneapolis MN
1979-80:	Dow Chemical U.S.A., Michigan Division, Industrial Hygiene Services, Midland MI
1976-79:	Dow Chemical Europe, Industrial Hygiene Coordinator, Italian Area
1973-76:	Dow Chemical U.S.A. Industrial Hygiene Laboratory, Midland MI

Start date in Industrial Hygiene: September 1984

Professional Memberships

American Academy of Industrial Hygiene
American Industrial Hygiene Association
Michigan Industrial Hygiene Society

Professional Certifications

1979: Certified Industrial Hygienist, Comprehensive Practice

Publications: Available upon request.

Date: May 1984

II. Radiation Safety Officers - G. W. Engdahl and T. W. Parsons

A. Responsibilities, Duties and Authority of Radiation Safety Officers

1. The radiation safety officers have jurisdiction over the day-to-day operation of the radiation protection program. The RSOs have been delegated this authority by, and are answerable to, the RSC.

2. The RSO's program of confirmatory radiation surveys and program audits depend on the scope of each operation being evaluated. Radiation safety evaluations are performed initially for each new type of use of loose radioisotope involving medium and high level laboratories (and for low level laboratories when deemed necessary). In addition, each isotope laboratory is surveyed on a frequency commensurate with the level of radioisotopes being handling, e.g., for low level laboratories, annually; medium level laboratories, semi-annually; and high level laboratories, quarterly. The program is audited quarterly to review inventory quantities, transactions and isotope user radiation survey results. Each isotope user is required to audit radioisotope operations with complete radiation surveys (e.g., monthly for low level laboratories) at frequencies deemed necessary (by the RSO) under the conditions of use and radioisotopes involved.

3. Approval of isotope users and the use of radioisotopes is under the direction of the RSOs on a day-to-day basis following the guidelines set forth by the RSC. Prior to the use of radioisotopes, individual users contact the RSO to discuss planned use of radioisotopes and to schedule a classroom training date.

   The level of training is commensurate with the level of hazard as determined by the RSO. Interim approval to use specific isotopes and quantity limits are stipulated in the isotope use approval form. Initial work with isotopes must be under the supervision of an experienced radioisotope user until competency has been demonstrated. The isotope user supervisor signs the Radiation Training Record/Isotope Use Approval form (see Annex III, Number 3) which is submitted by the RSO to the RSC for final approval.

4. If isotope operations involve new procedures, techniques or isotopes, the adequacy of facilities and equipment, and operating, handling and emergency procedures will be evaluated. The operating procedures, equipment, facilities, personnel monitoring, radiation surveys, etc., required will be specified by the RSO in the Laboratory Isotope Use Approval form. The Laboratory Isotope Use Approval form is submitted to the RSC for final approval.

5. The current radiation safety personnel consists of 2 health physicists who coordinate the RSO requirements for the U.S. Area Research and Development and Michigan Division operations involving radioisotopes. Additional radiation safety support personnel includes professional industrial hygienists who perform wipe testing and necessary training for production sealed source gauge (device) owners. One college co-op is used for radiation safety support activities and works under the direct supervision of the U.S. Area RSO. Training of the radiation safety support personnel is commensurate with the hazard as judged by the RSOs. Additional radiation safety training courses are utilized outside the company for more indepth training where deemed necessary by the RSOs and/or the RSC.

6. Additional Responsibilities and Authority for Radioisotope Operations

    a. General surveillance of all activities involving radioactive materials and radiation sources including both personnel and area monitoring.

    b. Consulting services to personnel at all levels of responsibility on all aspects of radiation protection and applicable regulations.

    c. Ensure specific procedures for use of radioactive material are developed and implemented including receipt and opening of all shipments of radioactive material and shipment of radioactive materials.

    d. Audit individual radioisotope user's records, techniques and procedures.

    e. Routinely monitor all machines and material capable of producing hazardous amounts of penetrating radiations.

    f. Distribute personnel monitoring equipment, determine the need for, and evaluation of, bioassays, and keep records of internal and external personnel exposure.

    g. Notify individuals of significant radiation exposures.

    h. Instruct personnel in proper radiation safety procedures, and applicable regulations for the use of radioactive materials prior to use, at periodic intervals (refresher training) and as required by changes in procedures, equipment, regulations, etc.

i. Coorindate the disposal of radioactive waste which includes the keeping of waste disposal records at the Midland location.

j. Evaluate and coordinate storage of all radioactive materials not in current use.

k. Ensure the required leak tests and surveys are performed on sealed sources.

l. Maintain a continuing inventory of all radioactive materials for all licenses.

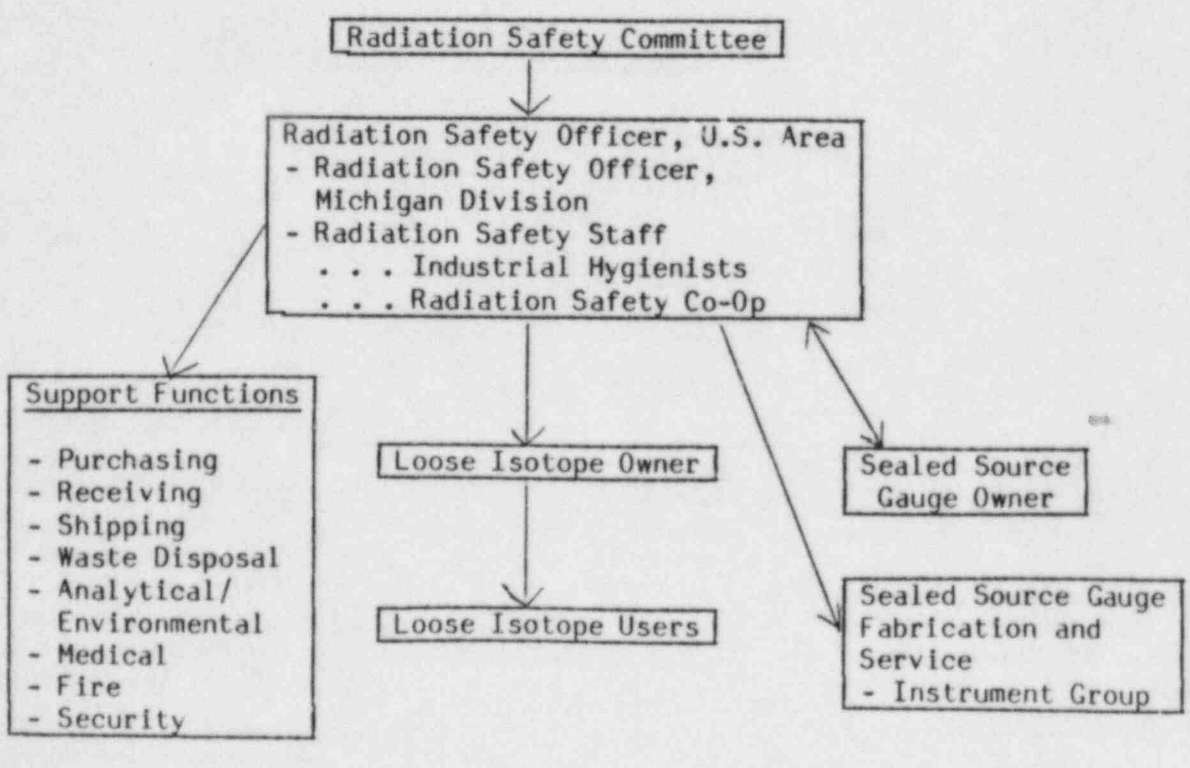
m. Supervise decontamination in cases of contamination accidents. This includes health physics supervision and training of laboratory, medical fire, and plant protection personnel who may be involved in the emergency.

n. Report radiation accidents and incidents to the RSC.

o. Ensure that all radiation survey instruments employed are calibrated.

p. Maintaining other records, e.g., receipt, transfer and survey records as required by ¶30.51, "Records", of 10 CFR Part 30.

B. Radiation Safety Organizational Structure



C. Experience and Training of the Radiation Safety Officers (RSOs)

1. Gordon W. Engdahl

a. Education

1973 - M.S., Environmental Health, the University of Minnesota, with specialties in radiological health and industrial hygiene.

1972 - B.A., Chemistry, Cum Laude, Augustana College.

b. Professional Qualifications: Employment

1983-Present:	Corporate Industrial Hygiene Laboratory
1979-80:	Michigan Division Industrial Hygiene
1976-79:	Dow Europe (Italy) Industrial Hygiene
1973-76:	Corporate Industrial Hygiene Laboratory
1979:	Certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene

Professionally trained in chemistry, environmental health, radiological health and industrial hygiene. Experience prior to Dow (1973) includes special projects at the Lawrence Livermore Radiation Laboratory, University of California (air monitoring for radioactivity) and the 3M Company (working with radioactive waste handling, evaluation of radioisotope laboratory ventilation, and beta-gauge safety evaluation. Seven years of experience working with the radiation safety program at Dow Chemical.

Member of the American Industrial Hygiene Association, American Academy of Industrial Hygiene, and was a member of the Health Physics Society from 1972 to 1980.

2. Tracy W. Parsons

a. Education

1980 - M.S., Health Physics, Purdue University.

1977 - B.S., Environmental Health, Purdue University.

b. Professional Qualifications: Employment

1983-Present:	Michigan Division Industrial Hygiene
1979-83:	Corporate Industrial Hygiene Laboratory
1977-79:	Graduate Instructor, Bionucleonics Department, Purdue University

III. Loose Radioisotopes - Radiation Protection Procedures

The following section pertains to those individuals who supervise and/or work with loose radioisotopes. It should be the goal of all individuals involved to provide a safe work environment, ensure public safety, and avoid contamination of equipment and facilities.

A. Isotope Owner Responsibilites
(In Advance of Any Isotope Work)

1. Attend a session on "Radiation Information for Supervisors" to gain familiarity with Nuclear Regulatory Commission regulations and supervisor responsibilities. (The amount of training will be as deemed necessary by the RSO.)

2. Outline in writing the procedure for each job (make the amount of detail commensurate with the hazard). When an experiment involves the use of medium or high level radioisotopes (as defined in Section III.c.) a protocol of the experiment shall be submitted to the RSO of the Industrial Hygiene Laboratory for review and approval of the RSC. The protocol will be a requirement in addition to the Laboratory Isotope Use Approval form.

3. Stock the laboratory with plastic or PVC gloves, laboratory coats, warning tags and labels, wipes, appropriate survey/counting instruments, forms for necessary records, plastic bags and tape for waste disposal, absorbent paper, etc. The use of good procedures is greatly facilitated by having proper tools/supplies at hand.

4. Have available and use, when appropriate, remote handling devices, automatic pipettes or dispensers, tongs, etc., for the manipulation and transfer of radioactive preparations.

5. Obtain proper training for individuals who have access or work in restricted areas. Personnel such as janitors and building managers who have routine access to restricted areas are required to attend a Class I radiation training course conducted by the Industrial Hygiene Laboratory, Radiation Safety personnel, prior to working in the area. All radiation training can be arranged with the Industrial Hygiene Laboratory by calling 517-636-0860.

6. Provide for the instruction of those employees for whom they are responsible in the use of safe techniques and the application of approved radiation safety practices.

7. Contact the Industrial Hygiene Laboratory, RSO, whenever major changes in operational procedures, new techniques, alteration in physical plant (e.g., the removal of radiochemical fume hoods) or when new operations which might lead to personnel exposure are anticipated.

8. Comply with the regulations governing the use of radioactive material as established by the Nuclear Regulatory Commission and the Dow RSC for the following.

   a. Procurement of radioactive materials by purchase or transfer.

   b. Posting of notices to workers as required by 10 CFR 19.11.

   c. Posting of caution signs where radioisotopes are kept or used, or where radiation fields may exist.

   d. Record the receipt, transfer and disposal of radioactive materials in his/her area.

   e. Coordinate all radioactive waste disposal through the RSO of the Industrial Hygiene Laboratory.

   f. Prevent the transfer of radioactive materials to unauthorized individuals. This includes the proper disposition of radioactive materials possessed by terminating workers.

   g. Keep the stock of stored radioactive materials to a minimum within the work areas. Establish designated areas for storage of radioactive materials when not needed for current research.

   h. Furnish the Industrial Hygiene Laboratory with the following reports at the end of each calendar quarter.

      1) inventory report of radioisotopes
      2) survey summary report of all wipe testing and/or radiation surveys completed
      3) summary report of all radioisotope transactions

B. Isotope User Responsibilities

1. Prior to the use of radioactive material, obtain proper training given by the radiation safety staff of the Industrial Hygiene Laboratory for interim use approval under the supervision of an experienced isotope user. After competency for handling radioisotopes in the laboratory has been demonstrated, the supervisor will approve request for full approval from the RSC. Specific isotope and quantity limits will be specified in the isotope use approval.

2. Keep personal exposure to radiation as low as is reasonably achievable.

3. When ordering radioactive materials, order only the amount needed - not by unit price, if at all possible, to limit excess waste.

4. Designate and label a storage area for radionuclides. Keep isotopes in designated area when not in immediate use.

5. For hard beta/gamma emitting isotopes, measure and record the radiation levels (in mR/hr) in the work and storage area and adjacent noncontrolled areas with an appropriately calibrated detector (e.g., air ionization chamber). A GM or scintillation probe is useful to detect "hot spots". Provide sufficient shielding to keep radiation exposures as low as is reasonably achievable and always below established limits.

6. Designate and label the radioactive work area(s). Consider the consequences of leakage or equipment failure. Use nonporous benchtops. Cover work surfaces with absorbent paper that has plastic backing to protect furniture and facilitate cleanup. Use stainless steel or plastic trays to help confine liquids if spilled. All contaminated tools should be set aside for special attention when cleaning.

7. When working with radioactive matierals, wear a laboratory coat and plastic or rubber gloves for protection of clothes and skin. To avoid spread of contamination, remove gloves at work area before leaving laboratory. For medium and high levels of radionulcides (as defined in Section III.c.) additional protective clothing such as booties and hoods may be required if deemed necessary by the RSC and the RSO. Disposeable clothing would also be required for high contamination projects since facilities for handling radioactive laundry do not exist.

8. Where appropriate, wear personnel radiation monitors (TLD, film, dosimeter, etc.) on body and hands while working. Bioassay tests are the principal means for evaluating possible internal exposure to radionuclides such as C-14 and H-3. (See Section III.H.)

9. Confine work with gaseous, volatile or dust-forming radioactive material to hoods or glove boxes, if at all possible.

10. Confine radioactive solutions in covered containers clearly identified and labeled with name of compound, radionuclide, date, activity, and radiation level if applicable. Do not use glass containers if practicable. Never use glass to house strong alpha emitters due to weakening of glass. Aqueous liquid waste that is to be stored in a freezer should not be stored in glass containers.

11. Never pipette radioactive solutions by mouth. Mechanical devices shall be used.

12. Eating, drinking, smoking or applying cosmetics in radioisotope work areas are prohibited. Failure to do so can lead to accidental ingestion of radioactive material and is a violation of approved operating procedures.

13. Avoid extensive radiochemical work with medium and high levels of material until the procedure has been tested by a "dry run" to preclude unexpected complications. Aerosoling problems should be addressed if applicable.

15. Hands, feet and clothing should be checked with a thin window GM meter for contamination after handling radioactive materials, other than C-14 and H-3, at the end of the day and <u>always</u> before eating. Radioactive work areas should be surveyed as necessary.

16. In case of spill or other accident, alert nearby personnel, confine spill, block off and mark area, decontaminate, and monitor before moving temporary signs or barricade. If personnel contamination is involved, remove contaminated outer clothing, wash and monitor skin, and report to the Medical Department. Report all accidents and injuries involving radioactive material to the Industrial Hygiene Laboratory and laboratory supervisor.

17. The individual responsible for a spill is responsible for decontamination. Do not use custodial personnel unless specifically assigned the task by the laboratory supervisor.

18. Keep "hot" vials and syringes in shielded containers. Always use protective barriers when the radiation emitted warrants shielding.

Specific details concerning required protective equipment, radiation monitoring equipment, radiation survey frequency, designated radioactive waste storage area, operating procedures, emergency procedures and personnel monitoring for laboratory experiments will be specified in the laboratory isotope use approval form as determined by the RSO and approved by the RSC.

C. Classification of Laboratory Areas

1. Since the laboratories within buildings vary widely with regard to maximum activity, physical and chemical form of radionuclides, and the various procedures involving by-product material, it is proper to attempt some classification. The purpose of classification is to determine how frequently the laboratory should be surveyed and the level of control that is necessary to minimize potential employee exposures. The method of classifying laboratories was taken from International Atomic Energy Agency Safety Series No. 1, "Safe Handling of Radionuclides, 1973 Edition, which designates 3 levels (low, medium, high) of work area limitations based on radionuclide, activity, and use. The table in Annex III, Number 5, lists the activity ranges for each work level category. These classifications are based on the relative radiotoxicity of each radioisotope as listed in Annex III, Number 6.

D. Survey Frequency Criteria for Removable and Fixed Surface Contamination

Routine monitoring for radioactive contamination that could be present on surfaces of floors, walls, laboratory furniture and equipment is a necessary part of the radiation protection survey program. The goal of contamination surveys is to minimize the external and internal exposure of personnel to radiation.

The contamination survey program uses the laboratory classification system and modifying factors to determine the required survey frequency for each laboratory area for individual operations or experiments. The RSO will review each Laboratory Isotope Use Approval to establish specific requirements using the following criteria.

Isotope Users	Frequency
Low level areas	Not less than once per month
Medium level areas	Not less than once per week
High level areas	Not less than once per day during processing of radioactive materials

For low level areas, surveys will be required at the completion of each experiment or as deemed necessary by the RSO and specified in the Laboratory Isotope Use Approval Form.

Radiation Safety Personnel	Confirmatory Survey Frequency
Low level areas	Annually, quarterly review of user surveys
Medium level areas	Semi-annually, quarterly review of user surveys
High level areas	Quarterly, quarterly review of user surveys

See Annex III, Number 7.

E. Survey Methods

Routine surveys shall be carried out in two parts to determine both radiation levels and removable contamination levels.

1. Radiation levels

   This may be waived when using C-14 and H-3, however, spot checking for contamination does apply. Monitor areas with a radiation survey meter sufficiently sensitive to detect 0.1 mR/hr. The results of this survey should be recorded on a standard form which should show the following.

   a. Location, date, and type of equipment used.

   b. Identification of person conducting the survey.

   c. Drawing of area surveyed, identifying relevant features such as active storage areas, active waste areas, etc.

   d. Measured exposure rates, keyed to location on drawing (point out rates that require corrective action).

   e. Corrective action taken in the case of excessive exposure rates, reduced exposure rates after corrective action and any appropriate comments.

The survey frequency for radiation levels are commensurate with the frequency of operations and specific requirements will be set by the RSO. Criteria specified in Table 1 of Regulatory Guide 8.21 will be considered in setting survey frequency for external radiation.

2. Contamination levels

A series of wipe tests should be taken in all areas where activity is handled in unsealed form. The location of wipe tests should be indicated on the above mentioned survey form and should be chosen for maximum probability of contamination, e.g., areas where individual doses are drawn up, incoming packages received, frequent pipetting carried out.

A standardized method for wipe testing a relatively uniform 100 cm^2 surface area shall be used to aid in comparing contamination at different times and places. A dry filter paper or cotton swab will be used for wipe testing (apply as much pressure as can be without tearing the filter paper or breaking the cotton swab).

Floors, particularly adjacent to doorways, lead syringe shields, refrigerator handles, and door and drawer handles should also be wipe tested frequently. Care should be taken that cross contamination does not occur.

A thin window GM or gas flow proportional counter normally may be used for assaying beta emitters at or above C-14 energies; low energy beta emitters will require liquid scintillation counting. A proper efficiency correction factor shall be applied to obtain an actual count value (dpm) per wipe.

A gamma scintillation counter (e.g., NaI well counter), should be used for pure gamma emitters. Make sure that the analyzer threshold is set below the lowest gamma energy used in the laboratory (usually I-125).

Record a background count of 5 to 10 minutes using the same counting conditions used with the wipes.

In the case of wipes contaminated with gamma emitters, the radionuclide can be identified from successive counts with different analyzer settings if the settings have been calibrated with known energy standards.

F. Airborne Radioactivity Monitoring Criteria

Due to the potential for inhalation exposures to airborne radioactive materials, the use of radioactive materials without enclosure or ventilation control will require special procedures and precautions as deemed necessary by the RSO (and approved by the RSC) depending on the following information.

1) the radioisotope
2) the volatility
3) the amount used
4) frequency of use
5) how the material is used
6) duration of the project

1. Air Monitoring Criteria

Based on the initial evaluation of operations involving the use of radioisotopes if it is judged by the RSO that it is possible that 10% of the MPC maybe exceeded, air sampling will be done in order to document actual concentrations.

Air sampling will follow standard industrial hygiene methods to calibrate sampling pumps with the appropriate sampling trap in line prior to sampling. Samples will be collected in the work areas which best represent breathing zone concentrations. Time of exposure will be documented during exposures to calculate time weighted concentrations as well as short-term excursion concentrations.

2. Frequency of Air Monitoring

When the quantity of radioisotope handled in a single experiment or cumulatively during a three month period exceeds the action level set by the RSO and approved by the RSC air sampling will be completed. If air samples collected during process operations are found to be less than 10% of the acceptable MPC and less than 1% of the quarterly MPC based on exposure time and no major changes in operating procedures, no additional air sampling is required.

If air sampling results are from 10% of the MPC to 50% of the MPC (Appendix B, Table 1 of 10 CFR Part 20) and total exposure is greater than 1% but less than 25% of the quarterly MPC based on exposure time, then quarterly monitoring will be required in conjunction with corrective actions to reduce air concentrations until they are less than 10% of the acceptable MPC.

If air concentrations exceed the MPC, immediate corrective actions will be implemented and weekly air samples collected until values are less than 10% of the MPC. Appropriate bioassay measurements would also be required.

Note: If approved local exhaust ventilation and/or complete enclosure are provided during the use or handling of radioactive materials, the user must be sure releases to unrestricted areas from the exhaust ventilation system are minimal and within the limits specified in Table 2 of Appendix B, 10 CFR Part 20.

G. Acceptable Radiation Dose and Contamination Limits

1. Radiation dose limits

a. Noncontrolled area

Personnel must not receive >2 mRem in any one hour, or >100 mRem in 7 consecutive days, or >500 mRem in any one year.

b. Controlled area

An employee's total exposure must be <1.25 Rem/13 weeks. On a basis of 40 hours/week of exposure, the maximum exposure rate would have to be <2.5 mR/hour. In practice, the radiation levels should be kept as low as is reasonably achievable (ALARA) and always below applicable limits. The goal of the radiation protection program is to maintain radiation exposures below 10% of the occupational exposure guidelines.

c. Personnel dose limits

	Rems/Calendar Quarter	
Area of Exposure	NRC Limit	ALARA Goal
Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	1.25	0.125
Hands and forearms; feet and ankles	18.75	1.875
Skin of whole body	7.50	0.75

d. Air and Water Effluent Concentrations Limits

The limit for air and water concentrations must be kept below the levels listed in 10 CFR 20, Appendix B, Table I, Column 1, "Standards for Protection Against Radiation". In keeping with the ALARA concept air and water concentrations will be kept below 10% of the applicable NRC limits as an operating goal of the RSO and RSC.

2. Contamination Action Levels

a. Removable and fixed surface contamination shall not be allowed to exceed the guidelines set forth in Table 1 from NRC Regulatory Guide 8.23 (Radiation Safety Surveys at Medical Institutions) found as Annex III, Number 1.

H. Biological Monitoring Criteria

Biological monitoring criteria are discussed under Item 12.

I. Personnel Monitoring Minimum Criteria

Personnel monitoring criteria are discussed under Item 12.

J. Documentation and Recordkeeping Considerations

The following documents or records shall be preserved in order to meet the Nuclear Regulatory Commission requirements.

1. Radioisotope Inventory

While the Industrial Hygiene Laboratory maintains an overall inventory of isotopes for the Midland location license, each isotope owner is responsible for keeping an accurate inventory of isotopes possessed. To obtain an accurate balance of isotopes in an owner's possession, records of the quantity and date of the isotope received, transferred, shipped, and disposed of as waste, should be kept. All transactions regarding the owner's inventory should be reported to the Industrial Hygiene Laboratory so that the overall inventory can be updated (Material Transaction Form).

2. Records of Radiation Surveys and Monitoring Results

All records of radiation surveys and wipe test results shall be preserved for a period of 75 years from the day of the survey.

3. Records of Radiation Dose and Radioactive Waste Disposal

   Results of personnel air sampling, bioassay, radiation surveys which are used to determine radiation dose, and results of surveys to determine radioactive effluents to the environment are to be kept indefinitely or until the Nuclear Regulatory Commission (NRC) has authorized their disposal.

4. Protocols (for medium and high level) which have been reviewed by the Industrial Hygiene Laboratory shall be kept until after the last NRC inspection date.

5. Documentation of environmental releases shall be kept indefinitely or until the NRC has authorized their disposal.

K. Posting Requirements for Working with Radioactive Materials

Posting and labeling will comply with the requirements set forth in 10 CFR 20.

L. Criteria for Use of Ventilation Equipment and Surveys

When chemical laboratory fume hoods are used to minimize the release of loose radioisotopes and protect isotope users, normally fume hoods will be equipped with an inclined manometer to indirectly indicate flow rates of air through the hood at all times during operation. Initially, prior to use of the hood for the control of radioactive materials, the face velocity will be determined with the sash in the operating position. Minimum acceptable average face velocity is 100 ft/min.

Corrective action shall be made immediately if the face velocity falls below 100 ft/min. The air flow should be monitored (inclined manometer) daily by isotope users during experiment processing and periodically the radiation safety personnel will verify actual face velocities with a calibrated thermoanemometer or velometer. A velocity survey should also be made when changes occur in the system that might affect air flow. The ventilation system shall provide a minimum of six air changes per hour in the room where loose radioactive material is processed unless otherwise specified by the RSO.

<u>Monitoring and Changing of HEPA Filters and/or Charcoal Traps</u>

When the HEPA filter and/or charcoal traps are used to remove radioactive material from the exhaust air several precautions must be considered.

1. Each HEPA filter should be equipped with a device to measure pressure drop across the filter or trap. A level for pressure drops across the filter should be set to indicate when filters need changing.

2. Contaminated filters require special handling procedures to contain any potential loose contamination and monitoring equipment (e.g., G-M monitors, ion chambers, and air samples) shall be used to monitor and minimize personnel exposures. Disposal of filters or traps will be consistent with the radioactive disposal guidelines for other types of waste.

M. Procedures for Ordering, Receiving, Unpackaging and Transferring of Radioactive Materials

1. Ordering

Because of NRC license limitations, the RSO should be informed before any orders are placed for radioactive materials.

The initiator must be sure that requisition and purchase order contain the following.

"Package containing radioactive material must bear a label: 'DO NOT OPEN. IN CASE OF EMERGENCY, CONTACT INDUSTRIAL HYGIENE LABORATORY, 517-636-0860, IMMEDIATELY UPON RECEIPT, CONTACT END USER ________ AT TELEPHONE __________.'"

A copy of the purchase order must be sent to the Industrial Hygiene Laboratory, 1803 Building.

If the order is phoned in, contact the Industrial Hygiene Laboratory with the amount of material ordered and when it will arrive.

Route all shipments through the Receiving Department. (For the campus area including 1803 Building, all shipments shall be routed to C. T. McClure, 1712 Building, unless specific exception has been grated by the RSO.)

2. Receiving

Only approved individuals may receive and use radioactive material.

Promptly upon receipt of any package identified as containing radioactive material, Receiving will call the Industrial Hygiene Laboratory, 517-636-0860, and the end user.

Wipe testing may be required within three hours of arrival; refer to Annex II, Number 2.

The end user or designated approved isotope user shall go to the Receiving area with an appropriate survey meter to visually inspect and survey the outside of the box. If no contamination is apparent, the package shall be transported to the end users work area for unpackaging.

If leakage of radioactivity is excessive or if excessive levels (>22,000 dpm/100 cm^2, >200 mR/hr contact, or 10 mR/hr at 3 ft.) of radiation are measured on incoming packages, a report must be made promptly to the NRC. Reporting shall be done only by the RSO with the agreement of the RSC chairman.

3. Unpackaging

Procedures for opening packages should follow NRC rules and regulations 10 CFR 20.205, Table 2; see Annex II.

NRC regulations require that procedures be established and followed, with proper consideration for special instructions from the supplier. To assure the safety of Dow employees and compliance with regulations, the RSO must be advised of all packages received, before they are opened.

a. Opening Small Packages Less Than Upper Limit of Exempt Quantity in Table 2

1) Visual Inspection

Any visual evidence of damage is a reason to make a wipe test for leakage, before proceeding.

2) Supplier's Instructions

Any special instructions for opening must be read before opening and must be followed carefully.

3) Survey the package and document the results.

4) Open the package carefully in an acceptable hood.

5) Inspect the package at each layer of packaging for visual evidence of leakage. Do not proceed if leakage is suspected. Call the RSO, 517-636-0860. Keep the package and associated materials isolated in the hood.

6) Remove the isotope container and place it in storage.

7) Send a completed copy of the material transaction form to the RSO of the Industrial Hygiene Laboratory to document the receipt and completion of wipe tests for each shipment.

b. Type A - Opening Large Packages Greater Than Upper Limit Exempt Quantity in Table 2 (See Annex III, Number 2)

1) All procedures outlined for opening small packages apply.

2) Provide plastic sheet or other contamination protection, adequate for packaging materials to be removed.

3) Provide wipe test, personnel monitoring and survey equipment appropriate to task.

4) Provide for storage container and site.

5) Proceed to open, following supplier's instructions and the RSOs precautions.

6) Wipe test for contamination if any leakage is suspected at each layer of packaging. Do not proceed without the RSOs approval if there is detectable contamination.

7) Remove the sample and store as prearranged in Step 4.

8) Survey storage site and document survey results.

9) Clean up area and package all radioactive waste for disposal.

10) Monitor area by wipe test to assure cleanliness.

11) Monitor all participants.

4. Transferring Radioactive Material

a. Internal - Midland

Radioisotopes shall be transferred only to other approved isotope users. The users who are to receive the radioisotopes must also have been approved for the type of work and quantity of radioactivity involved. The RSO shall be contacted to approve all transfers unless a systematic transfer program is established for an

individual user where routine transfers are made to specific individuals (e.g., to the Toxicology Laboratory for testing). A Radioactive Material Transaction form is required from the sender and receiver for all transactions. A copy of the transaction form is sent to the RSO and one copy is kept in the individual users files.

Transfers will be made only in closed, tight containers. If the transfer involves transport on public roads, the RSO shall be contacted to ensure that proper packaging and shipping papers are completed to meet Department of Transportation (DOT) Regulations. Radioactive materials shall not be transported in personal vehicles.

b. External - Outside Midland

Transfers to individuals outside of Midland require that applicable DOT and NRC Regulations are followed. The RSO will coordinate all shipments of radioactive material from Midland with the assistance of the Distribution Safety and Services Department. Prior to shipment, individuals who want to transfer materials shall obtain a copy of the NRC or Agreement state license of the party who is to receive the radioactive material. The RSO shall be contacted to obtain additional details concerning shipping and transfer. A Radioactive Material Transaction form must be completed and sent to Industrial Hygiene to document the transfer. Inventory records shall be adjusted to reflect the transfer of materials.

N. Radiation Protection Instructions to Isotope Users

The RSC and RSO have established the Laboratory Isotope Use Approval Form to communicate the basic instructions to be followed when using radioactive materials in each laboratory area. The areas considered include the following.

1. Procedures for obtaining permission to use radioactive materials.

2. Authorized quantity limits for radioisotopes per experiment.

3. Laboratory areas authorized for radioactive material use.

4. Type of experimental operations approved.

5. Protective clothing and equipment required.

6. Limitations and conditions relative to use of radioisotopes.

   a. When use of fume hoods is required.
   b. Operations limited to fume hoods.
   c. Shielding and remote handling equipment.

7. Routine survey and monitoring procedures.

8. Emergency procedures for,

   a. Spills, fires, release of material, accidental contamination, medical.

   b. Decontamination procedures and who to contact.

9. Transfers of radioisotopes between rooms and isotope users.

10. Storage requirements.

11. Labeling requirements.

12. Where and how contaminated articles and glassware are to be handled and stored.

13. Personnel monitoring requirements (as supplied by RSO).

    a. Film badge, extremity TLD (ring) dosimeter, pencil dosimeters.

    b. Bioassay requirements.

14. Waste disposal procedures.

15. Recordkeeping requirements.

O. Emergency Procedures

Specific emergency procedures are outlined for individual isotope users and use groups as part of the radioisotope user training. Response to individual emergencies is coordinated through the Dow Midland Central Dispatcher Network (517-636-4400) using trained security personnel. In addition, medical and fire departments are trained for emergency response to radiation emergencies. The radiation safety personnel of the Industrial Hygiene Laboratory shall be contacted in the event of any emergency involving radioisotopes.

The radiation safety personnel will specify appropriate emergency response action for each emergency situation to minimize radiation exposures to personnel and spread of contamination.

P. Storage of Loose (Unsealed) Radioactive Materials

1. Storage of stock solutions, process intermediates, and isolated products of experimental study shall be kept in designated storage areas in each laboratory approved for isotope use. When numerous laboratories are used for various phases of a study or a large isotope user group exists, efforts will be made to consolidate all radioisotopes held for storage in one designated area.

2. Each storage area should be ventilated, posted with warning signs and access limited to approved isotope users.

3. Designated refrigerators and freezers are acceptable storage for materials requiring cold storage. The ventilation requirement may be waived for designated freezers and refrigerators.

4. Radioisotopes which are no longer needed should be disposed using the appropriate disposal method approved by the RSO and RSC.

5. Removable contamination surveys (wipe tests) of storage areas shall be taken routinely and documented (referencing floor plan diagrams).

6. The frequency of wipe testing shall be determined by the RSO using the laboratory classification criteria.

7. Air monitoring of storage areas will be considered where volatile materials are stored. The frequency of sampling and need will be established by the RSO.

8. Radiation surveys will be made routinely for hard beta and gamma emitting radioisotope storage areas. The frequency will be determined as outlined in Section III.E. The minimum frequency will be quarterly unless otherwise established by the RSO.

9. Radioactive waste shall be packaged according to the requirements set forth in the waste disposal criteria established by the RSO and RSC. Radioactive waste storage shall be in designated areas and with the same limitations and conditions set forth above and approved by the RSO. Disposal of wastes shall be made as soon as reasonable and coordinated through the RSO.

Q. Respiratory Protection Policy

Normal operating procedures require containment of radioisotope operations including use of ventilated fume hoods or glove boxes where appropriate to maintain air concentrations within acceptable MPC guidelines, 10 CFR 20, Appendix B, Column 1, on a quarterly basis. No credit for respiratory safety factors will be used for normal operations to achieve compliance with NRC airborne concentration limits. Evaluation of operations, engineering controls, and air monitoring will be used to ensure that compliance with airborne concentration limits is achieved.

ANNEX III to Section III of the Radiation Protection Program

1. Table 1, Action Levels for Removable Surface Contamination, U.S. Nuclear Regulatory Commission, Regulator Guide 8.23, "Radiation Surveys at Medical Institutions"
2. Table 2, Exempt (Limited Quantity) and Type A Quantities, Nuclear Regulatory Commission Rules and Regulations, 10 CFR Part 20.205
3. Laboratory Isotope Use Approval
4. Radiation Training Record/Isotope Use Approval
5. Information for Classifying Laboratories
6. Radionuclides Classified to Relative Radiotoxicity Per Unit Activity
7. Acceptable Frequencies for Surveys

IV. Sealed Source Radiation Protection Procedures

A. Training Criteria

1. Sealed source device owners

Prior to obtaining and using sealed source devices, one must be trained by the radiation safety staff located at the U.S. Area Industrial Hygiene Laboratory or the Michgian Division Industrial Hygiene Services. The training consists of at least a Class I level (radiation properties) along with a specific review of owner responsiblities as specified below. A signed "Certificate of Responsibility" is documentation of this training.

After the initial training, a semi-annual review of resonsibilities is conducted by Industrial Hygiene.

2. Custom made gauge fabrication and service personnel

Prior to working directly with sealed sources and devices (not to be construed to mean riggers, electricians or those not working on the device itself) one must obtain approval from the RSC. This is accomplished by successfully completing a radiation training course given by the radiation safety staff. A signed "Radiation Training Record" is documentation of this training. The level of training required is commensurate with the hazard as determined by the RSO. A Class III training with additional laboratory training exercises is normally considered as the minimum (about 8 hours of classroom). Work will be supervised by an experienced source user until competence has been demonstrated. The supervisor will sign the Radiation Training Record form recommending full sealed source use approval be granted by the RSC.

Trained Custom Made Gauge fabrication and service personnel may transfer sealed sources and/or devices within the Midland location with notification of the RSO.

3. Sealed source device installation and removal personnel

Personnel who install, transfer or remove sealed source devices receive on the job instructions from the industrial hygienist supervising the transfer operation. These personnel usually consist of riggers, electricians, etc., who are responsible for nonradioactive concerns of sealed source device transfer operations. Since sealed source devices will be "locked out" (shutters closed) during all transfers, training instructions consist of a review of radiation levels and NRC exposure limits. Any other specific hazards unique to each job will also be reviewed.

B. Responsibilities

1. Sealed Source Device Owners

a. Complying with the requirements outlined in the Radiation Protection Manual and/or the Michigan Division Safety Standard S-477.

b. Assuring that devices are present in location described at all times.

c. Assuring that proper warning signs are permanently affixed to the device and are legible at all times.

d. Assuring that a shutter mechanism is in proper working order. If the shutter does not work, notify Industrial Hygiene immediately. If the unit is not in use, leave the shutter in a locked position.

e. Assuring that inventory and wipe test of device are conducted as required by our license and results are recorded on the Radiation Record Sheet.

f. Obtaining, in advance, approval from Industrial Hygiene before device is moved, removed from service, serviced or its configuration is changed in any way. This is to assure that a qualified health physicist has reviewed the change to assure safety and compliance with NRC, State and Dow policies.

NOTE: If a device is no longer useful, it should be removed promptly to storage.

g. Assuring that, in event of an emergency that involves any device, Plant Protection has notified someone on the emergency call list.

h. Notify Industrial Hygiene immediately of any event which could possibly be construed as a substantial safety hazard (as required by 10 CFR 21).

i. Understanding this responsibility cannot be delegated to another person. Arrangements must be made in advance with Industrial Hygiene for formal transfer of responsibility to other individual or the RSOs successor before leaving that job.

2. Custom Made Device Fabrication and Service Personnel

a. Individual User Responsibilites

Individual device owners are responsible for ensuring that the sealed source device owner's responsibilities are followed. Individual users are further responsible for the following.

1) Prior to the use of radioactive material, obtain training given by Industrial Hygiene. After competency for handling radioactive material has been demonstrated, the supervisor will approve a request for complete authorization by the RSC. Specific isotope and quantity limits will be in accordance with license limits. Periodic review and retraining is necessary to maintain RSC authorization.

2) Keep his/her exposure to radiation as low as reasonably achievable (ALARA) by utilizing the concepts of time, distance and shielding.

3) The Code of Federal Regulations, Title 10, Chapter 1, Part 20.101 requires the following external occupational dose limits to be observed.

Part of Body	Quarterly Dose (rems) Limit	Annual Dose (rems) Limit	ALARA Dose Goal (rems/yr)
Whole body, gonads, active blood-forming organs, head and trunk, lens of eyes	1.25	5	0.5
Skin of whole body	7.5	30	3
Hands and forearms, feet and ankle	18.75	75	7.5

4) Each user must have approval from the RSO before exceeding a daily whole body dose of 50 mRem.

5) Designate and label a storage area for radioisotopes not in immediate use.

6) Designate and label a radioisotope work area.

7) As deemed necessary by the RSO, measure and record the radiation levels (mr/hr) in the work and storage areas. Verify that radiation levels in unrestricted areas do not exceed the levels specified in 10 CFR 20.

8) Wear appropriate personal radiation dosimeters on body (whole body film badge or TLD) and hands (extremity TLD finger ring).

9) Ensure that source storage containers are plainly identified and labeled with at least the radioisotope, activity, date of activity determination and Dow source number.

10) Use protective barriers and other shields wherever possible.

11) Use mechanical devices to maximize the distance between you and the sealed source.

12) Plan each job so the time spent near the source is minimized.

13) Immediately report to Industrial Hygiene any defect or incident which could cause a safety hazard.

14) Ensure that a calibrated radiation survey meter is available and used when appropriate.

b. Supervisor's Responsibilities

Supervisors are responsible for ensuring that the preceding individual responsibilities are discharged by those under their supervision, and are further responsible for the following.

1) Assure adequate planning has been done by the Class III approved users before an experiment or job is performed, to determine the types and amount of radiation or radioactive material to be used. This will generally give a good indication of the protection required. In many cases, before the procedure is actually performed with radiation, it should be rehearsed so as to preclude accidents, minimize exposures and unexpected circumstances. In any situation where there is appreciable radiation hazard, the RSO shall be consulted before proceeding.

2) Assure that those employees for whom they are responsible have proper training in the use of safe techniques and the application of approved radiation safety procedures.

3) Furnish the RSO with information concerning individuals and activities in their areas, particularly pertinent changes in their personnel rosters. This requires immediate notification of new or terminating personnel.

4) Contacting the RSO whenever major changes in operational procedures, new techniques or when new operations which lead to personnel exposure are anticipated.

5) Ensuring that all personnel have obtained a signed "Radiation Training Record" prior to working with radioisotopes. Contact Industrial Hygiene for training sessions.

6) Complying with the regulations governing the use of radioactive materials, as established by the NRC and the Dow RSC for the following.

   a) Correct procedure for the procurement of radioactive samples.

   b) Proper posting of work areas where radioactive materials are kept or used or where radiation fields may exist. This may include caution signs and general postings such as NRC Form 3.

   c) Ensuring that all radioactive waste material is disposed of properly.

C. Procurement, Receipt, Use, Transfer and Disposal of Sealed Source and Devices

1. Procurement of Sealed Sources and Devices

Radioactive sealed sources or devices may be obtained in two ways, (1) ordering from another company and (2) internal transfers.

a. Ordering From Another Company

Because of NRC license limitations, Industrial Hygiene must be informed before any orders for radioactive materials are initiated. If an order is phoned in, contact Industrial Hygiene prior to placing the order.

The initiator must be sure that his requisition and purchase order contain the following statement.

1) For U.S. Area: "DO NOT OPEN. IN CASE OF EMERGENCY AND UPON RECEIPT, CONTACT INDUSTRIAL HYGIENE 517-636-0860 IMMEIDATELY. CONTACT (YOUR NAME) AT (TELEPHONE)."

   Copies of the requisition and purchase order must be sent to the RSO, 1803 Building. Route all shipments through Central Research Receiving, 1712 Building (Central Receiving Areas for Ag Research and Larkin Laboratory)

2) For Michigan Division: "DO NOT OPEN. CONTACT INDUSTRIAL HYGIENE, 517-636-6663 IMMEDIATELY UPON RECEIPT. CONTACT (YOUR NAME) AT (TELEPHONE)."

   Copies of the requisition and purchase order must be sent to Industiral Hygiene, 474 Building. Route all shipments through Michigan Division Receiving, 995 Building.

3) Internal Transfers - This method of procurement is discussed in the following transfer section.

2. Receipt and Survey of Sealed Sources and Devices

   a. Only approved individuals may receive and use radioactive material.

   b. A radiation survey will be conducted for each source package at the time of arrival. If radiation measurements exceed >200 mR/hr at contact or >10 mR/hr at 3 feet from the surface of the package, a report will be made promptly to the NRC. Reporting will be done by the RSO or a member of the RSC.

   c. When received, sealed sources are put into service, the minimum installation requirement is an available wipe test for removable radioactive contamination within the past six months. Additional radiation profile surveys may also be necessary at that time.

d. If the user is not prepared to put the sealed source device into service, the device is placed in a secure storage area administered by the RSO for inventory control until the user requests the device.

3. Transfer of Sealed Source Devices

a. Contact Industrial Hygiene in advance for approval to move a sealed source device. If not previously authorized, the new device owner will need radiation safety training.

b. Contact the individuals needed to remove, move or install the device (i.e., electricians, riggers, service station, etc.). Industrial Hygiene should be informed of the time and date of the move. Industrial Hygiene will supervise the move for radiation protection considerations and inventory control.

c. In the event that the device is being installed for the first time, it will be necessary to contact Industrial Hygiene so that the device can be removed from storage and surveyed (wipe tested and radiation level determination).

d. If the source device is being moved from a process area, lock the source shutter with a padlock.

Prior to removing the device, close and lock the shutter and survey (radiation safety staff) before loading on vehicle and moving to the new location. If the survey results indicate greater than 5 mR/hr at 1 foot from any point on the surface of the source additional shielding may be required.

e. For new device applications, install and survey source device being certain the new owner is aware of device's presence. Document the survey results in Industrial Hygiene sealed source records. Document the change in device location and owner on the change notice form for Industrial Hygiene records.

The device should be removed from storage and installed in the same day. Under no circumstances shall a device be left unattached and uncontrolled overnight.

4. Use of Sealed Sources and Devices

If sealed radioactive sealed sources and devices are handled properly, they pose no hazard to the user. Failure to follow safe handling procedures could result in a serious injury, a citation, fine, and loss of our NRC license.

Most sealed sources and sealed source devices can produce measurable external radiation levels. It is necessary to know how to measure the radiation levels near a source and the regulations for posting requirements. Contact Industrial Hygiene for specific instructions in your area.

a. Radiation surveys, both radiation level and wipe test, are performed at six month intervals for all sources and devices except as follows. Sources or devices containing Po-210, H-3, N-63 and C-14 are only wipe tested. Sources or devices containing Kr-85 are only surveyed. Finally, sources in storage are not leak tested but are inventoried at six month intervals. Also, commerically available gauges may be wipe tested in accordance with the manufacturer's recommendations which may be less frequent than every six months.

   Leak testing is performed by a trained staff under the direction of the RSOs. Sources or gauges with removable contamination greater than 0.005 microcuries are immediately removed from service.

b. The general procedures for using sealed sources and sealed source devices are as follows.

   1) Personnel monitoring shall follow the criteria discussed under Item 12.

      Personal monitoring is usually not provided for employees who use or work near production type gauges used for routine analyses because of the near certainty that 25% of the quarterly allowed dose (10 CFR 20.101) will not be exceeded.

      No calculations or documentation are maintained because: (1) the sources are shielded to keep radiation levels below 5 mR/hr at 30 cm from the gauge surface, (2) all direct radiation beam areas are identified and posted to prevent major portions of the work shift using or even location near the gauges.

2) All sealed sources and sealed source devices must be appropriately labeled and posted.

   a) Each sealed source (or device) must display the "2 x 2" source identification tag which identifies the isotope, activity, date of activity determination and Dow source number.

   b) Posting of sealed sources and sealed source devices will meet the requirements set forth in 10 CFR 20.

5. Storage of Sealed Sources and Sealed Source Devices

Sealed source devices are stored in two areas, one for inactive holding and a second for disposal and special radiation safety staff needs. The first area is in the Receiving area and consists of an isolated fenced room with a locked door. Access is limited to the radiation safety staff and the trained supervisor for receipt of radioactive sealed source devices. All movement of devices into and out of this area are coordinated by the radiation safety personnel.

Storage of sealed sources for instrument application uses also are stored in limited numbers in designated areas in the instrument application facilities. Access to the sealed sources is limited to approved isotope users.

Storage areas are surveyed periodically (at least semi-annually) to verify radiation levels are in accordance with guidelines specified in 10 CFR 20. This includes changes in configuration or quantities of stored sources which could affect radiation levels in adjacent work areas.

An inventory of sealed sources in storage and awaiting disposal is maintained by the RSO and reported to the RSC.

6. Removal and Disposal of Sealed Sources and Devices

   a. Because of possible health hazards and federal regulations, all radioactive sources need special attention when they are no longer useful. No radioactive source should be removed from a plant without contacting Industrial Hygiene. Industrial Hygiene can advise you of the safety and regulatory aspects of source removal.

   b. In addition to Industrial Hygiene, the various crafts required to remove the source need to be arranged. These crafts could include electricians, carpenters, riggers, service station, etc.

   c. The shutter needs to be locked out in the off position before any work is done on the source. A trained industrial hygienist will survey the source before the removal and supervise the operation.

   d. Sources removed for disposal must be packaged in accordance with NRC and DOT Regulations. For most production-type sealed source devices, the source must be bolted to a wooden disk and braced inside a 55 gallon recovery drum (see Annex III). For other types of sealed sources, contact Industrial Hygiene for specific packaging requirements.

   e. Unless a specific use for the sealed source or device can be identified, it will be disposed of via a waste disposal vendor authorized by the NRC (or appropriate agreement State) or returned to the sealed source manufacturer. Disposal will be coordinated by the RSOs from Industrial Hygiene.

ANNEX IV to Section IV of Radiation Protection Program

1. Mounting Configuration for Sealed Source Shipments

2. Liquid Scintillation Analysis Method for Sealed Source Wipe Test Analyses

BASIS FOR INCINERATION LIMITS FOR RADIOACTIVE MATERIALS

MICHIGAN DIVISION INCINERATOR

DOW CHEMICAL U.S.A.
MICHIGAN DIVISION
MIDLAND, MICHIGAN

I. Background Information

A. Effluent flow rates

Stack height: 200 ft
Inside diameter of stack: 12 ft

1. air effluent exhaust rate: 30,000 to 38,000 ft^3/min (scfm)

   27,000 ft^3/min = <u>1.1×10^{12} ml/day</u> (conservative value)

   The effluent flow rate value of 1.1×10^{12} ml/day will be used for all subsequent stack effluent concentration calculations.

2. ash effluent generation rate: 600 $yd^3/month$

   600 $yd^3/mo \times 2/3$ ton/yd^3 = 400 ton/month*

   13.3 ton/day = <u>1.21×10^7 g/day</u>

   This effluent generation rate will be used for all subsequent ash effluent concentration calculations.

3. water effluent generation rate;

   a. ash trough rinse: 60 gpm

   b. quench water following after burner, 700-800 gpm (most likely high concentration point)

      650 gpm = <u>3.54×10^9 ml/day</u>

      This effluent flow rate will be used for all subsequent quench water effluent concentration calculations.

   c. total scrubbing water effluent = 2000 gpm

B. U.S. Nuclear Regulatory Commission (NRC) Rules and Regulations Title 10, Chapter 1, Code of Federal Regulations (CFR), Part 20

*This is approximately 5% of total material tons put into Incinerator

1. Maximum Permissible Concentrations (MPCs)

   a. 10 CFR 20, Appendix B, Table II
   MPCs for air and water (also applies to ash) are specified for each radioisotope for unconditional release to the environment. Pursuant to ¶20.106 "concentrations may be averaged over a period not greater than one year".

   b. MPCs for selected isotopes

Radioisotope	MPC air, µCi/ml	MPC water, µCi/ml
C-14	1×10^{-7} (sol)	8×10^{-4} (sol)
H-3	2×10^{-7} (sol)	3×10^{-3} (sol)

   Any other isotope

   Example

Sn-113	2×10^{-9} (insol)	8×10^{-5} (insol)
	1 x 10[illegible] (sol)	9×10^{-5} (sol)

2. Dilution factor from stack to point of maximum ground concentration, calculated annual average.

   Personal exposures to radioactive material in adjacent buildings to the incinerator and offsite have been considered. Due to the low concentrations of radioactive material generated and the multiple dilutions that occur, the exposures would be many fold below acceptable guidelines.

   (The following dilution factor is based on standard diffusion calculations and local environmental data.)*

   A dilution factor of 459,037 from the stack to the point of maximum fence line concentration occurs.

C. Department of Natural Resources (DNR) Permits Issued to the Michigan Division for Disposal of Radioactive Waste

Copies of DNR permits 93-73I and 471-79 are attached.

*This is based on calculations made by the Michigan Department of Natural Resources which are available in the U.S. Area, Industrial Hygiene Laboratory files.

II. Criteria and Supporting Calculations for Determination of Incineration Guidelines for Radioisotopes to Meet As Low As Reasonably Achievable (ALARA) Goal of 10% of Unrestricted MPCs

A. Basis for calculation of potential concentrations in air, ash, and quench water of the incinerator

The daily incineration criteria goal for each radioisotope is based on 10% of the MPCs for each effluent route. The most restrictive route is chosen to set the daily burn quantity criteria.

Calculation of limiting effluent concentrations assume that all the incinerated radioisotopes may go either to ash, quench water or air except for carbon-14 (C-14) and hydrogen-3 (H-3). In the case of C-14 and H-3, a minimum combustion efficiency of 95% is applied for hypothetical maximum ash effluent concentrations. This assumes that a minimum of 95% of the incinerated material containing C-14 and H-3 is released as gaseous effluent CO_2 and water or water vapor effluent, respectively, for these isotopes. This is conservative since combustion efficiencies of 99+% have been measured for those compounds tested (as determined by the Michigan DNR and Dow physical analysis).

The incineration guide for each isotope is calculated as follows to determine the hypothetical effluent concentrations.

MPC x 10% = Effluent Concentration

Effluent Concentration x Effluent Flow Rate = Daily Incineration Guide

The lowest microcurie (µCi) per day value generated for each of three effluent routes is the criteria guideline used for daily incineration.

1. Calculation of hypothetical effluent concentrations for C-14.

Route of Release	MPC, µCi/ml	Hypothetical Effluent Concentration, µCi/ml	Incineration Guide, µCi/day
If released to air, sol	1×10^{-7}	1×10^{-8}	1.1×10^{4}
If released to ash, sol*	8×10^{-4}	8×10^{-5}**	1.9×10^{4}
If released to quench water, sol	8×10^{-4}	8×10^{-5}	2.8×10^{5}

*For C-14 and H-3, an additional factor of 5% is applied to the ash effluent values to account for a combustion efficiency of 95%.

**Units for ash effluent are in µCi/g.

Using air as the most restrictive effluent it was calculated that as a guideline goal 1.1×10^4 µCi/day could be incinerated for C-14. Incineration of this amount would lead to maximum hypothetical release concentrations for each effluent route as follows.

a. Air Concentration

$C = 1 \times 10^{-8}$ µCi/ml (10% of MPC)

(From calculated effluent values in previous table.)

b. Ash Concentration (Maximum Hypothetical)

$$C = \frac{1.1 \times 10^4 \ \mu Ci/day}{1.21 \times 10^7 \ g/day} \times 5\% = 4.55 \times 10^{-5} \ \mu Ci/g \ (6\% \text{ of MPC})$$

(5% factor based on 95% combustion efficiency)

c. Quench Water Concentration (Maximum Hypothetical)

$$C = \frac{1.1 \times 10^4 \ \mu Ci/day}{3.54 \times 10^9 \ ml/day} = 3.1 \times 10^{-6} \ \mu Ci/ml \ (0.4\% \text{ of MPC})$$

2. Calculation of hypothetical effluent concentrations for H-3.

Route of Release	MPC, µCi/ml	Hypothetical Effluent Concentration, µCi/ml	Incineration Guide, µCi/day
If released to air, sol	2×10^{-7}	2×10^{-8}	2.2×10^4
If released to ash, sol*	3×10^{-3}	3×10^{-4}**	7.3×10^4
If released to quench water, sol	3×10^{-3}	3×10^{-4}	1.1×10^6

Using air as the most restrictive effluent it was calculated that as a guideline 2.2×10^4 µCi/day could be incinerated for H-3. Incineration of this amount would lead to maximum hypothetical release concentrations for each effluent route as follows.

*For C-14 and H-3, an additional factor of 5% is applied to the ash effluent values to account for a combustion efficiency of 95%.
**Units for ash effluent are in µCi/g.

a. Air Concentration

$C = 2 \times 10^{-8}\ \mu Ci/ml$ (10% of MPC)

(From calculated effluent values in previous tables.)

b. Ash Concentration (Maximum Hypothetical)

$$C = \frac{2.2 \times 10^{4}\ \mu Ci/day}{1.21 \times 10^{7}\ g/day} \times 5\% = 9.1 \times 10^{-5}\ \mu Ci/g \text{ (3\% of MPC)}$$

(5% factor based on 95% combustion efficiency)

c. Quench Water Concentration (Maximum Hypothetical)

$$C = \frac{2.2 \times 10^{4}\ \mu Ci/day}{3.54 \times 10^{9}\ ml/day} = 6.2 \times 10^{-6}\ \mu Ci/ml \text{ (0.2\% of MPC)}$$

3. As an example of other isotopes which may require incineration, the incineration quantity criteria is based on 10% of unrestricted MPCs (10 CFR 20, Appendix B, Table II).

Example: tin-113 (Sn-113)

Route of Release	MPC, µCi/ml	Hypothetical Effluent Concentration, µCi/ml	Incineration Guide, µCi/day
if release to air, insol	2×10^{-9}	2×10^{-10}	220
if release to air, sol	1×10^{-8}	1×10^{-9}	1100
if release to ash, insol	8×10^{-5}	8×10^{-6}*	97
if release to quench water, sol	9×10^{-5}	9×10^{-6}	3.2×10^{4}

Using ash as most restrictive effluent, it was calculated that as a guideline 97 µCi/day could be incinerated. Incineration of this amount would lead to maximum hypothetical release concentrations for each effluent route as follows.

a. Ash Concentration

$C = 8 \times 10^{-6}\ \mu Ci/g$ (10% of MPC)

(From calculated effluent values in previous table.)

*Units for ash effluent concentration are in µCi/g.

b. Quench Water Concentration (Hypothetical Concentration of Sn-113)

$$C = \frac{97\ \mu Ci/day}{3.54 \times 10^{9}\ ml/day} = 2.7 \times 10^{-8}\ \mu Ci/ml \quad (0.03\%\ of\ MPC)$$

c. Stack Concentration (Hypothetical Concentration of Sn-113)

$$C = \frac{97\ \mu Ci/day}{1.1 \times 10^{12}\ ml/day} = 8.8 \times 10^{-11}\ \mu Ci/ml \quad (4.4\%\ of\ MPC)$$

B. Criteria for Incinerator Effluent Monitoring

Action Level for Monitoring

Ash and quench water effluents will be sampled if the maximum hypothetical concentration in either effluent stream is likely to exceed 25% of the MPCs from 10CFR20, Appendix B, Table 2. For comparison, blank samples from a normal (no added radioactive material) burn will also be collected. This action will be coordinated by the RSO.

Routine Monitoring

Annually, ash and quench water effluents will be sampled during a normal radioactive waste burn. For comparison, blank samples from a normal (no added radioactive material) burn will also be collected. This sampling will be done to confirm that operating conditions and controls are maintaining effluent concentrations at acceptable levels. This will be coordinated by the RSO.

Sampling Audit to Confirm Administrative Controls

A stack sample will be collected to confirm the incinerator system evaluation that combustion gases leave the stack at barely detectable radioassay levels (e.g., C-14 at $\leq$ 10% of the MPC and for other radioisotopes at very small fractions of their MPCs). For this reason, a one-time sampling of stack air will be analyzed to confirm that the concentration will not exceed the MPC for each radioisotope during a radioactive material burn.

C. Sampling Protocol Guidelines for Incinerator Effluent Monitoring (These guidelines may be modified to meet specific needs.)

1. Ash Effluent

Samples of ash for radioisotope content analysis will be taken as a subsample from a larger composite ash sample collected over time (24 hours).

a. The composite sample will be collected by randomly sampling 12, approximately one pint (about 16 ounces) samples of ash generated during 24 hours of incinerator operation (at the ash consolidation location).

b. The composite sample will be mixed and subsamples of approximately 1000 grams will be isolated for appropriate analysis.

2. Quench Water Effluent

Samples of quench water for radioisotope analysis will be taken as a subsample from a larger composite water sample collected over time (24 hours).

a. The composite water sample will be collected using an Isco or similar type of composite sampler in the effluent line.

b. A one liter subsample from the composite sample will be isolated for appropriate analysis.

3. Air Sampling

A representative composite gaseous sample will be collected using standard stack sampling equipment in the effluent gas stream. Samples will be collected in a scrubber solution or on a solid absorbent depending on the radioisotope. The collected sample will be analyzed as specified for the specific radioisotope. Examples for C-14 and H-3 sampling are as follows.

a. Sampling for C-14

Collection in NaOH solution using a scrubber device.

(1) Non-Radioactive CO_2 Yields

Typically generate 1.2×10^7 g ash/day and if 5% of total burned is ash

then $1.2 \times 10^7/0.05 = 2.4 \times 10^8$ g incinerated material/day

if 50% is Carbon (C), then 1.2×10^8 g C/day is generated

$$\text{Concentration} = \frac{1.2 \times 10^8 \text{ g/day}}{1.1 \times 10^{12} \text{ ml/day}} = 1.09 \times 10^{-4} \text{ g C/ml air}$$

$$\text{which is } \frac{1.09 \times 10^{-4} \text{ g C/ml air} \times 1000 \text{ mg/g}}{12 \text{ mg/mM*}} = 9.09 \times 10^{-3} \frac{\text{mM* } CO_2}{\text{ml air}}$$

(2) Trap Collection Limit

If collected in NaOH with $CO_2 \longrightarrow NaHCO_3$, $9.09 \times 10^{-3} \frac{\text{meq. } CO_2}{\text{ml air}}$

*Millimole

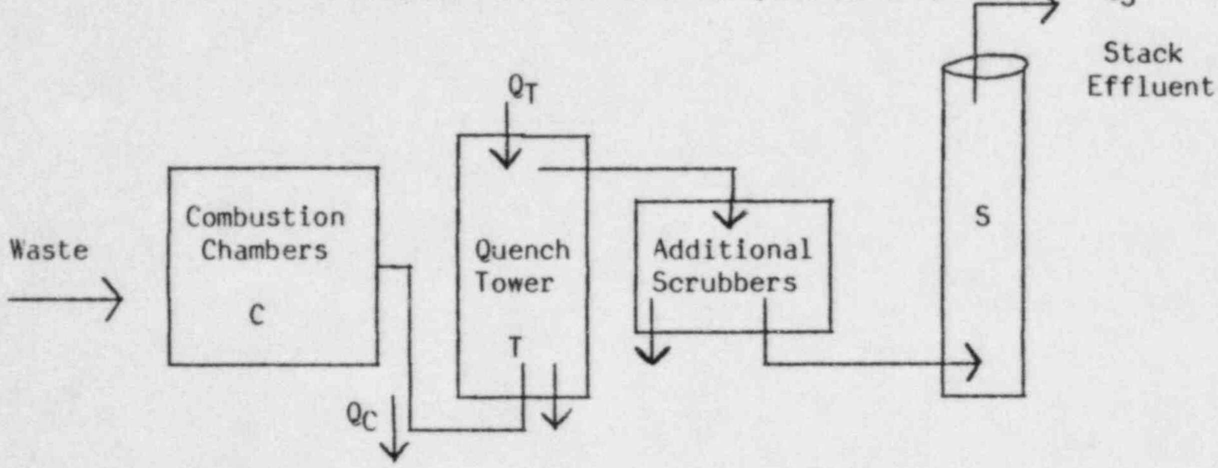
or there is $\frac{1}{9.09 \times 10^{-3} \text{ meq. } CO_2/\text{ml air}} = 110$ ml air/meq CO_2

(3) Trap Limit - 1 ml of 1 normal NaOH can trap approx. 110 ml air

b. Sampling for H-3

Incinerator System Analysis as Related to H-3 Sampling

INCINERATOR FLOW DIAGRAM (SIMPLIFIED)



C = Combustion Chambers
T = Quench Tower
S = Stack

<u>Expected Stack Gas Concentrations of H-3</u>

Calculation of combustion water quantities and radioactivity based on total material burned.

Carbon burned/day = 1.2×10^8 g of C/day
(see C-14 sampling calculations)

Expect similar amount of water to be found on a molar basis in the combustion chamber.

$$\text{Flow rate at point C} = Q_C = \frac{1.2 \times 10^8 \text{ g of C/day}}{12 \text{ g C/mole C}} \times 18 \text{ g/mole } (H_2O) \times 1 \frac{\text{mole } H_2O}{\text{mole C}}$$

$$Q_C = 1.8 \times 10^8 \text{ g of } H_2O/\text{d}$$

or 125 kg H_2O/min

or approximately 1.25×10^5 ml/min

Hypothetical H-3 radioactivity in combustion chamber = A_C (see Item II.A.2.)

$$A_C = 2.2 \times 10^4 \ \mu Ci/d$$

or 15.3 µCi/min

Specific activity (SpA_C) at point C $= \dfrac{15.3 \ \mu Ci/min}{1.25 \times 10^5 \ ml/min}$

$$SpA_C = 1.22 \times 10^{-4} \ \mu Ci/ml \text{ of } H_2O$$

This is 4.1% of MPC for water $\left[\dfrac{1.22 \times 10^{-4} \ \mu Ci/ml}{3 \times 10^{-3} \ \mu Ci/ml}\right]$

The added quench water quantity, Q_T = 650 gpm
= 2460 kg/min (see page 1)

Air and Water Quantitation in Stack Gas

Total air flow = Q_{air} = 27,000 cfm (page 1)
= 765 M^3/min
= 7.65×10^5 L/min

if stack gas contains 5% H_2O vapor, then

Q_S (vapor) = 7.65×10^5 L/min x 0.05
= 3.8×10^4 equivalent L of H_2O vapor/min

assuming approximately 30 L/mole (for evaluated stack gas temperature)

$$Q_S = \frac{3.8 \times 10^4 \ L/min}{30 \ L/mole} = 1274 \text{ moles } H_2O/min$$

$$1274 \text{ moles/min} \times 18 \text{ g/mole} = 2.29 \times 10^4 \text{ g } H_2O/min$$

Q_S (liquid) = 23 kg H_2O/min

Stack Gas Effluent Radioactivity

It is assumed that combustion water (vapor) blends with total water flow in the quench tower. No consideration has been given for additional dilution that occurs in the later scrubber stages (venturi, mixer chamber and wet electrostatic percipitator) which means that the actual H-3 concentration in the stack will be less then calculated as follows.

It is assumed that for water, the specific activity at point T (SpA_T) = the specific activity at point S (SpA_S)

$$SpA_S = \left[\frac{Q_C}{Q_C + Q_T}\right] \times \text{specific activity at point C}$$

$$= \left[\frac{125 \text{ kg } H_2O/\text{min}}{125 \text{ kg } H_2O/\text{min} + 2460 \text{ kg } H_2O/\text{min}}\right] \times 1.22 \times 10^{-4} \ \mu\text{Ci/ml } H_2O$$

$$= 5.9 \times 10^{-6} \ \mu\text{Ci/ml } H_2O \times 1 \ \frac{\text{ml } H_2O}{\text{g } H_2O}$$

$$= 5.9 \times 10^{-6} \ \mu\text{Ci/g } H_2O$$

Total stack release rate = $SpA_S \times Q_S$

$$= 5.9 \times 10^{-6} \ \mu\text{Ci/g } H_2O \times 2.3 \times 10^4 \text{ g } H_2O/\text{min}$$

$$= 0.136 \ \mu\text{Ci/min in } H_2O$$

$$\text{Stack air concentration} = \frac{0.136 \ \mu\text{Ci/min}}{7.65 \times 10^8 \text{ ml air/min}}$$

$$= 1.8 \times 10^{-10} \ \mu\text{Ci/ml air}$$

This is 0.09% of MPC for air $\left[\frac{1.8 \times 10^{-10} \ \mu\text{Ci/ml}}{2 \times 10^{-7} \ \mu\text{Ci/ml}}\right]$

A portion of the stack gas effluent will be isokinetically sampled through a dry ice cooled scrubbing device. The collected water will be removed and submitted for analysis.

c. The sampling strategy for other radioisotopes will vary depending on physical characteristics of the radioisotopes.

4. Sampling protocol requires 48 hours of incinerator operation without radioisotope waste incineration prior to the collection of 24 hour composite background samples to determine the level of naturally occurring radioisotopes in incinerator effluents. Samples collected to determine radioactivity content during radioisotope waste incineration would be collected in a 24 hour period including the period of the burn.

D. Analysis Methods Protocol
(These methods may be modified to meet specific needs.)

1. Ash analyses

   a. For C-14 and H-3 analysis:

      Measure out replicate 500 mg aliquots from the field sample submitted, analyze by combustion of the sample in a Harvey or other oxidizer with analysis of combustion trap material by liquid scintillation* (LS). Assuming appropriate efficiencies for the LS method and and using the calculated maximum hypothetical concentration in the ash, the following estimates are obtained.

      (1) for C-14

      ash concentration = 4.55×10^{-5} μCi/g
      = 101 disintegrations per minute (dpm)/g
      (maximum hypothetical from Item II.A.1.b.)

      101 dpm/g x 0.5 g (sample) = 50 dpm

      50 dpm x 65% efficiency = 33 cpm

      which is measurable above a background of 35 cpm**
      assuming 5% of total burn goes to ash

      (2) for H-3

      ash concentration = 9.1×10^{-5} μCi/g
      = 202 dpm/g
      (maximum hypothetical from Item II.A.2.b.)

      202 dpm/g x 0.5 g = 101 dpm

      101 dpm x 25% efficiency = 25 cpm

      which is measurable above a background of 25 cpm**,
      assuming 5% of burn goes to ash

   b. For other isotopes analyzed, the type of radiation emitted must be considered. For example, in the case of Sn-113:

      Sn-113 decays to In-113 with 1.66 hour half life ($t^{1/2}$)

      In-113 emits 391 Kev X-ray (with 100% yield)

*Planchet counting of ash itself for Beta/gamma analysis by Geiger counter or proportional counter is not recommended because of uneven particle size of ash, self-absorption and geometry effects on counting analysis efficiency and possible interferences due to naturally occurring isotopes.

**Approximate naturally occurring background radiation for specific instruments that will be used for these analyses.

ash concentration = 8×10^{-6} µCi/g
= 17.8 dpm/g
(maximum hypothetical from Item II.A.3.a.)

For analysis, use sufficient ash mass to fill a sample container of approximately 500 ml from the field sample submitted. Analyze by Ge(Li) detector with 15 min counting time (this is a standard analysis method for X-ray and gamma ray emitting isotopes).

For Beta emitting isotopes other than C-14 and H-3, LS counting would generally be used for analysis. For gamma or X-ray emitting isotopes, the Ge(Li) detector is recommended (or NaI detector if Ge(Li) is not available) with energy discrimination to identify and quantify the isotopes present.

2. Quench Water Analyses

a. For C-14 and H-3 Analysis:

Measure out replicate 5 ml aliquots from the field sample submitted; analyze by LS analysis. Assuming appropriate efficiencies for the LS method (water will have some suspended solids and acidity) and using the calculated maximum hypothetical effluent concentration, the following estimates were obtained:

(1) for C-14,

water concentration = 3.1×10^{-6} µCi/ml
= 6.9 dpm/ml
(maximum hypothetical from Item II.A.1.c.)

6.9 dpm/ml x 5 ml = 34.4 dpm

34.4 dpm x 65% efficiency = 22 cpm

which is measurable above background of 20 cpm*, if all radioactivity burned goes to quench water.

(2) for H-3,

water concentration = 6.2×10^{-6} µCi/ml
= 13.8 dpm/ml
(maximum hypothetical from Item II.A.2.c.)

*Approximate naturally occurring background radiation for specific instruments that will be used for these analyses.

13.8 dpm/ml x 5 ml = 69 dpm

69 dpm x 25% efficiency = 17 cpm

which is measurable above background of 10 cpm*, if all radioactivity burned goes to quench water.

b. For other isotopes, the type of radiation emitted must be considered in choosing the analytical method. For example, in the case where Sn-113 might need to be analyzed. The In-113 daughter product has a 1.66 hour $t^{1/2}$ and emits a 391 KeV X-ray (100% yield). For analysis approximately 500 ml of water sample would be used and analyzed with a Ge(Li) detector.

for Sn-113,

water concentration = 2.7×10^{-8} µCi/ml
= 0.06 dpm/ml
(maximum hypothetical from Item II.A.3.b.)

For Sn-113 the concentration is only 0.03% of the MPC and is not likely to be detectable without concentrating the sample prior to analysis.

3. Air Analysis

a. For C-14 and H-3

Measure approximately 3 ml aliquots from the field sample submitted; analyze by LS analysis. Assuming appropriate efficiencies for the LS method and using the maximum hypothetical effluent concentration, the following estimates were obtained:

(1) for C-14,

Stack Exhaust Concentration = 1×10^{-8} µCi/ml
based on 11 mCi/day burn
(from Item II.A.1.a.)

Collection in NaOH with Liquid Scintillation (LS) Analysis

Collectible Activity

$$1 \times 10^{-8} \ \mu\text{Ci/ml air} \times \frac{110 \text{ ml air}}{\text{ml NaOH}} = 1.1 \text{ pCi/ml NaOH}$$

$$= 2.44 \text{ dpm/ml}$$

*Approximate naturally occurring background radiation for specific instruments that will be used for these analyses.

Analyze approximately 3 ml sample, get

$$2.44 \text{ dpm/ml NaOH} \times 3 \text{ ml} \times 65\% \text{ efficiency} \left[\frac{\text{CPM}}{\text{DPM}}\right] = 4.76 \text{ cpm}$$

which is barely detectable above background of 10 cpm*, (but not quantifiable) if all radioactivity burned goes to stack gases over a 24-hour burn

(2) for H-3

Stack Exhaust Water Concentration = 5.9×10^{-6} μCi/g of water

= 5.9 pCi/g
(from Item II.A.3.b.)

Assuming approximately 75 L (approximately STP) of stack gas is sampled through a cold trap to collect approximately 3 ml of water sample. Then by measuring the 3 g (3 ml x 1 g/ml) of water

the total water activity = 3 g x 5.9 pCi/g x 2.22 dpm/pCi
= 39 dpm

which when analyzed by LS and corrected for counting efficiency equals the following cpm value

$$39 \text{ dpm} \times 25\% \text{ efficiency} \left[\frac{\text{cpm}}{\text{dpm}}\right] = 10 \text{ cpm}$$

which is detectable but not quantifiable.

b. For other isotopes, the type of radiation emitted must be considered in choosing the analytical method.

For example, in the case where Sn-113 might need to be analyzed. The In-113 daughter product has a 1.66 hour $t_{1/2}$ and emits a 391 KeV X-ray (100% yield). For analysis, approximately 60 liters of air sample might be collected for analysis (on a solid absorbent or in a scrubbing solution). Analysis would be by Ge(Li) detection.

*Approximate naturally occurring background radiation for specific instruments that will be used for these analyses.

for Sn-113,

air concentration = 8.8×10^{-11} µCi/ml (maximum hypothetical from item II.A.3.c.)

$= 2.0 \times 10^{-4}$ dpm/ml

2.0×10^{-4} dpm/ml $\times 6 \times 10^{4}$ ml = 12 dpm

which would not be measurable with a 30-minute count even if all radioactivity burned goes to stack gas.

E. Maximum Dose Off-Site (at the point of maximum fence line concentration)

NRC Exposure Dose Limit (for unrestricted areas) = 170 mrem/yr

Assuming MPC will deliver 170 mrem/yr

1. Maximum Dose Estimate due to C-14 and H-3

If annual average stack concentration = 1/10 MPC

$$\frac{0.1 \text{ MPC}}{459{,}037 \text{ dilutions}} = 2.2 \times 10^{-7} \text{ MPC}$$

$(2.2 \times 10^{-7}$ MPC$) \times 170$ mrem/yr $= 3.7 \times 10^{-5}$ mrem/yr

Technical references* have established that the radiation dose received by individuals from naturally occuring C-14 in their bodies is about 1 mrem/year. This is 27,000 times greater than the calculated dose per year at the point of maximum fence line concentration (annualized) from C-14 at current incineration criteria levels in the Michigan Division incinerator. The calculated values also compare very favorably with the known natural occurring background radiation dose in Michigan of 70-90 mrem per year from all natural sources (excludes medically related radiation dose).

III. Inventory Control for Incineration of Radioisotopes

A. Flow Diagram of Radioactive Materials

*Example: Eisenbud, M. Environmental Radioactivity, 2nd Edition, Academic Press, 1973.

In the attached Figure 1, the current flow diagram for radioactive materials in the Midland, Michigan, areas of Dow Chemical U.S.A. and Michigan Division Research and Development (R&D) Laboratories are outlined. At the present time, loose radioisotopes are used exclusively in the R&D Laboratories. The following controls exist for radioisotopes going to the incinerator. Only C-14 and H-3 isotopes are currently being burned.

1. Generator of radioisotope wastes

   Each area using radioisotopes has a radioisotope owner/coordinator who oversees the general inventory and wipe testing program for approved radioisotope users in their area. Radioisotope wastes generated in experiments are placed in labeled waste fiber paks.

   a. When several fiber paks are full or an experiment is completed, the radioisotope owner contacts the incinerator control room to see that the unit is operating. Secondly, the owner contacts the Radiation Safety Office to schedule times for the radioactive burn not to exceed 11 mCi of C-14 or 22 mCi of H-3 per day. (If the waste contains both isotopes, the fractional ratios of each based on the burn limits cannot exceed unity.)

   b. The waste fiber paks must be wipe tested to meet guidelines for removable contamination (49 CFR 173.443). Any fiber paks found to be contaminated must be cleaned or repackaged to meet acceptable contamination regulation limits. Each fiber pak is labeled with "Caution Radioactive Materials" warning tape to alert all personnel handling fiber paks of the presence of radioactivity. A Dow Incinerator Burner Tag is attached to each fiber pak or drum. A Radioactive Materials Shipment Form is completed to meet DOT requirements for shipping if the package will be transported on public roads.

   c. Service station personnel or the generator uses a Dow vehicle to transport waste fiber paks to the waste incinerator. At the incinerator, the radioactive waste fiber paks are given priority so that they are placed on the conveyor line for same day disposal.

Service station personnel who transport low level radioactive waste containers are given periodic training on the nature of C-14, H-3 and any other radionuclide wastes handled. Included are the details of handling any spill and the importance of isolation and containment until radiation safety staff support arrives. [A very limited number (approximately 5) of service station personnel are used to transport of radioactive waste to the incinerator.]

2. Incinerator Personnel

a. Incinerator personnel receive annual training on the nature of C-14, H-3, and any other radionuclide wastes handled plus appropriate radiation protection fundamentals. Included are the details of handling any spill and the importance of isolation and containment until radiation safety staff support arrives.

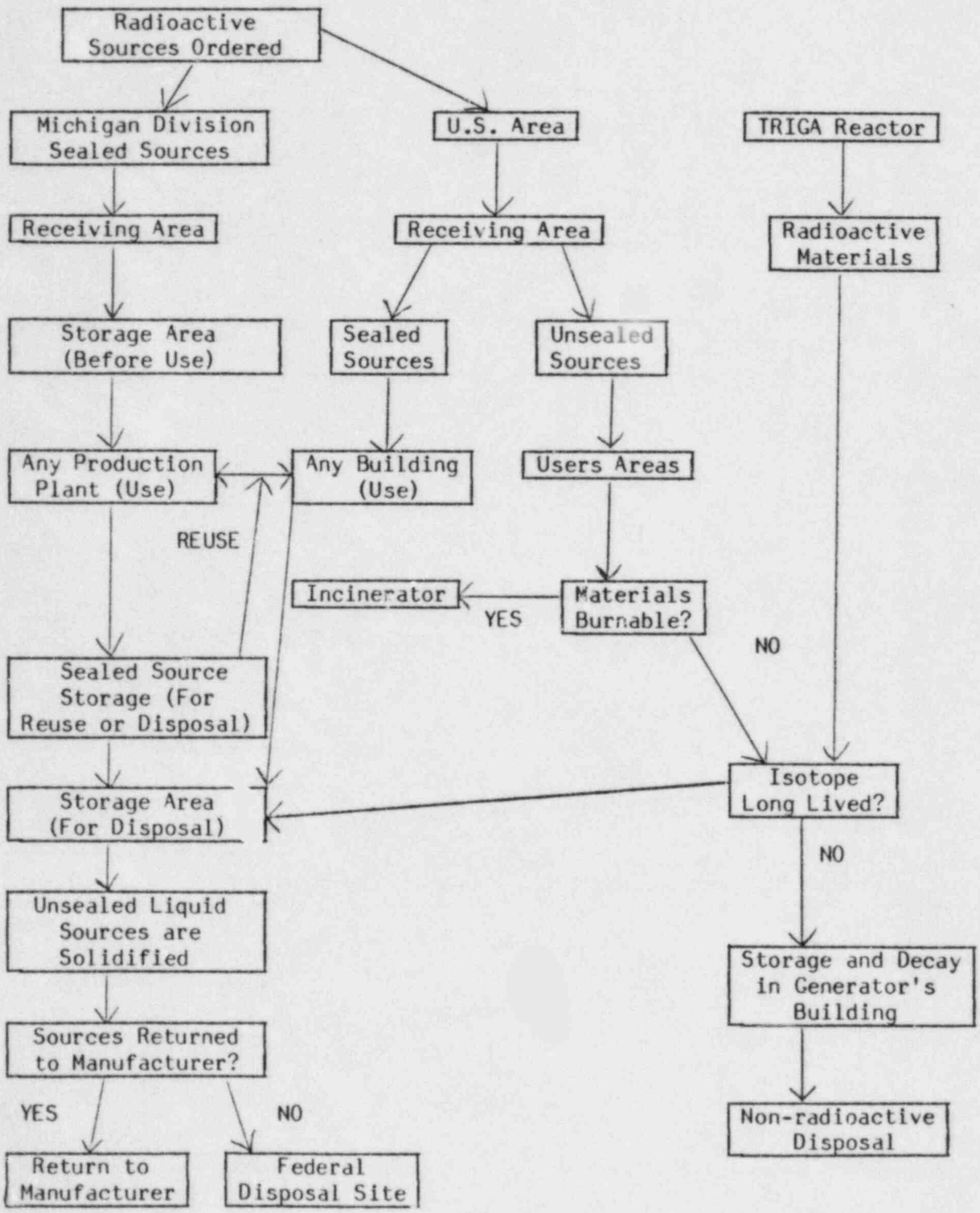
Since the incineration operation is automated and the radionuclide levels are low, no special precautions, other than normal safety procedures (i.e., protective clothing, gloves, safety glasses, etc.), are required of incinerator operators. Exceptions will be dictated as necessary by the RSO of the Industrial Hygiene Laboratory.

b. When radioisotope wastes are received, they are logged into fiber pak log records in case follow ups are required.

B. Material Transaction Form

The radioactive material transaction form is used to track all movement of loose radioisotopes within The Dow Chemical Company, Midland, Michigan. The owner of a radioisotope inventory is responsible for completing this form each time any radioactivity is received, transferred or shipped to the incinerator for disposal. An example of the transaction form is attached. The data from this form is recorded in the computer data base for loose isotopes and the original copy of the form is kept for one year in the Health Physics files of the Industrial Hygiene Laboratory. Quarterly summaries of all radioactive material transactions are printed from the computer data base. The printed copy is stored for long term retention.

Figure 1. MIDLAND RADIOACTIVE MATERIALS FLOW DIAGRAM



RADIOACTIVE MATERIALS TRANSACTION FORM

Name ______________________________

Master Number _ _ _ _ _ _ Name of Inventory Owner ______________
(If different from above.)

Date of Transaction ______________________________

Isotope ______________________________

Amount (mCi) ______________________________

Description ______________________________

☐ RECEIVED

Received From ______________________________

Purchase Order Number (if applicable) ______________

Package Wipe Tested? _____ Wipe Results: ____ (DPM)

☐ TRANSFERRED - Within Midland

Within Dow, Midland (give name) ______________

Shipping Papers Completed? _____

☐ SHIPPED - Outside Midland

Outside Dow, Midland (give name) ______________

NRC/State License Available ______________

Shipping Papers Completed? _____

☐ WASTE

☐ Burner - Number of Packages _____ Packages Wipe Tested _____

☐ Environmental Release (hood) Wipe Results _____ (DPM)

☐ Off-Site

Shipping Papers Completed? _____ or Not Applicable _____

KEEP ONE COPY FOR YOUR RECORDS AND SEND ONE COPY TO

INDUSTRIAL HYGIENE, 1803 BUILDING

Table 1. MAXIMUM CONCEIVABLE RADIONUCLIDE CONCENTRATIONS IN EFFLUENTS IN RELATION TO MAXIMUM PERMISSIBLE CONCENTRATION LIMITS

MICHIGAN DIVISION INCINERATOR

Radionuclide	C-14	H-3	Any By-Product Material Licensed to Dow Example: Sn-113 (tin)
*Radioactivity Incinerated/Day (μCi/Day)	1.1×10^{4}	2.2×10^{4}	97
AIR EFFLUENT			
**MPC (μCi/ml)	1×10^{-7} (sol.)	2×10^{-7}	2×10^{-9} (Insol.) 1×10^{-8}
In-Stack Concentration (μCi/ml)	1×10^{-8}	2×10^{-8}	8.8×10^{-11}
% of MPC	10	10	4.4 (Insol.) 0.9 (sol.)
+Offsite Concentration (μCi/ml)	2.2×10^{-14}	4.4×10^{-14}	2×10^{-16}
Offsite % of MPC	0.00002	0.00002	0.00001
ASH EFFLUENT			
MPC (μCi/ml)	8×10^{-4} (sol.)	3×10^{-3} (Insol.)	8×10^{-5} (Insol.)
Ash Concentration (μCi/g)	4.55×10^{-5}	9.1×10^{-5}	8×10^{-6} (Insol.)
% of MPC	6	3	10
QUENCH WATER EFFLUENT			
MPC (μCi/ml)	8×10^{-4} (sol.)	3×10^{-3} (sol.)	9×10^{-5} (sol.)
Water Concentration (μCi/ml)	3.1×10^{-6}	6.2×10^{-6}	2.7×10^{-8}
% of MPC	0.4	0.2	0.03

*Based on the goals of the ALARA concept of 10% of the allowable MPC at the effluent source, actual burned quantities may be significantly less for the most restrictive effluent route.

**Maximum Permissible Concentration (MPC) for unrestricted release.

+Point of maximum fence line concentration (annualized average) calculated using stack concentration divided by 459,037 dilutions.

#471-79- INCINERATOR

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
BOX 30028
LANSING, MI 48909
HOWARD A. TANNER, Director

Mr. John A. Tomke, Manager
Environmental Services
Dow Chemical U.S.A.
628 Building
Midland, Michigan 48640

JUN 01 1982

Dear Mr. Tomke:

This letter is in reference to your Permits to Install issued on February 27, 1974, and July 6, 1981, for the rotary kiln incinerator facility, located at the 703 Building, Midland, Michigan.

The Michigan Air Pollution Control Commission has granted your request to burn low level radioactive wastes at its May 18, 1982, meeting. Accordingly, the supplements to Permits to Install Nos. 93-73I (Dow 148) and 471-79 (Dow 334) have been revised.

Approval of these permits is now based upon and subject to compliance with all administrative rules of the Commission and conditions stipulated in the attached revised supplements.

If you have any further questions concerning these permits, please contact John Shaffer at (517) 322-1339 or myself at (517) 322-1333.

Sincerely,

W. Charles McIntosh

W. Charles McIntosh, Engineer
Permit Unit
Air Quality Division

WCM:kb
Enclosures
cc: Mark Reed

R1025 1/80

JUN 0 1 1982

25. Applicant shall not operate the rotary kiln unless the venturi scrubber and packed scrubber are on line and operating properly.

26. Thirty days after start up of the electrostatic precipitator, applicant shall not operate the rotary kiln unless the electrostatic precipitator is on line and operating properly.

27. The exhaust gases from the rotary kiln shall be discharged unobstructed vertically upwards to the ambient air from a stack with a maximum diameter of 12 inches at an exit point not less than 200 feet above ground level.

28. Applicant may incinerate any wastes containing byproduct material as defined and licensed to the applicant by the U.S. Nuclear Regulatory Commission, in accordance with the conditions of said license and all applicable federal regulations, including 10 CFR 20.

WCM:kb

JUN 0 1 1982

25. Applicant shall not operate the rotary kiln unless the venturi scrubber and packed scrubber are on line and operating properly.

26. Thirty days after start up of the electrostatic precipitator, applicant shall not operate the rotary kiln unless the electrostatic precipitator is on line and operating properly.

27. The exhaust gases from the rotary kiln shall be discharged unobstructed vertically upwards to the ambient air from a stack with a maximum diameter of 12 inches at an exit point not less than 200 feet above ground level.

28. Applicant may incinerate any wastes containing byproduct material as defined and licensed to the applicant by the U.S. Nuclear Regulatory Commission, in accordance with the conditions of said license and all applicable federal regulations, including 10 CFR 20.

WCW:kb

THE UNIVERSITY OF MICHIGAN
Ann Arbor

October 12, 1978

Maynard E. Chenoweth, M.D.
Research Scientist
Bio-Medical Research
Dow Chemical U.S.A.
607 Building
Midland, Michigan 48604

Dear Dr. Chenoweth:

This letter is in reply to your request to the University of Michigan Human Research Review Committee to consider the review of protocols generated by the Dow Bio-Medical Research Laboratory. I have discussed this with Dr. George DeMuth in the Dean's office and with the members of my committee. We would be happy to review your protocols provided that there is not an inordinate number at any one time and provided that there is no time deadline for completion of the review process.

Enclosed in the accompanying envelope is a dozen or so of our research forms which we ask to be completed and submitted with a copy of the research protocol and the written informed consent documents.

I would be happy to meet with you and Dr. Saunders to discuss any of the procedural details. Perhaps the best time would be sometime early in November. If you would call my secretary we could arrange a time at our mutual convenience.

With very cordial regards,

Sincerely yours,

W. W. Coon

William W. Coon, M.D., Chairman
Committee to Review Grants for
Clinical Research and Investigation
Involving Human Beings
Phone: (313) 764-6121

WWC:s

June 15, 1982

Mr. Richard J. Nolan
1803 Building
Dow Chemical Company
Midland, Michigan 48640

Dear Mr. Nolan:

Your request for review of research protocols in which radioisotopes are to be administered to human beings was discussed by this committee (Radioactive Drug Research Committee No. 45, University of Michigan) on May 28, 1982. We understand that these protocols will also be submitted to the University of Michigan Committee to Review Grants for Clinical Research and Investigation Involving Human Beings (IRB), Dr. William oon, Chairman. We also understand that you will be sending us only one or two protocols per year.

We will be glad to help you with this matter. Please submit our copy of the protocols to:

Mr. Arthur Solari
Radiation Control Service
1101 North University Building
University of Michigan
Ann Arbor, Michigan 48109

Sincerely yours,

Ronald C. Bishop

Ronald C. Bishop, M.D.
Chairman, RDRC #45

cc: Dr. C. Overberger
Mr. A. Solari

RCB/sv

ANNEX I, NUMBER 2

CUSTOM MADE GAUGE (DEVICE) REVIEW FORM

1. Identification of sealed source

Isotope:
Activity:
Date of Manufacture:
Manufacturer:
Model Number:
Dow Source Number:

The Source is:

☐ capsule

☐ disk

☐ plated

☐ foil

☐ other - describe ______________________________

____

2. Intended use: (check all that apply)

☐ X-ray fluorescence	☐ measurement	☐ level
☐ static elimination		☐ thickness
☐ specific analyses		☐ density
☐ beta transmission		☐ flow
☐ X-ray transmission		
☐ gamma transmission		
☐ neutron absorption		
☐ neutron scattering		
☐ neutron activation		
☐ prompt gamma		

☐ Other - describe ______________________________

____

3. Construction

a. Is gauge designed to protect radioactive material and minimize radiation hazards?

☐ Yes ☐ No

b. What special design features are incorporated?

☐ shutters

☐ fail-safe on/off mechanism

☐ interlocks

☐ excess shielding

☐ other - describe ______________________________

c. Is it possible to insert any portion of the human body into the direct radiation beam?

☐ Yes ☐ No

4. Radiation Profile

What are the maximum radiation levels (mR/hr) at the following distances from the gauge?

	Shutter/Sample Holder	
	Open	Closed
a. contact		
b. 30 cm		

These radiation levels are: ☐ estimates

☐ calculations

☐ actual measurements

Attach a diagram of the gauge with radiation dose rates at various distances and operating positions, i.e., shutter open and closed.

5. Labeling and Signs (attached to gauge)

☐ source identification tag

☐ "Radioactive" tag

☐ "Caution Radioactive Material" tag or sign

☐ custom made gauge label

☐ other - describe ______________________________

6. Operating Environment/Operational Considerations

- [ ] Unusual operation conditions:
  - [ ] excessive vibration
  - [ ] corrosion
  - [ ] excess temperature extremes
  - [ ] impact
  - [ ] other - describe ______________________________
- [ ] Operations Manual - incorporating radiation protection considerations.

7. A copy of the instrument design drawing or blue print must be attached.

Approvals:

______________________________ ______________
Supervisor, Instrument Development Group Date

______________________________ ______________
Radiation Safety Officer Date

______________________________ ______________
Radiation Safety Committee, Chairman Date

ANNEX II, NUMBER 2

RADIOACTIVE MATERIALS TRANSACTION FORM

Name ____

Master Number _ _ _ _ _ _   Name of Inventory Owner ______________
(If different from above.)

Date of Transaction ______________________________________

Isotope ____

Amount (mCi) ____

Description ____

☐ RECEIVED

Received From ______________________________________

Purchase Order Number (if applicable) ______________________

Package Wipe Tested? ____   Wipe Results: ____ (DPM)

☐ TRANSFERRED - Within Midland

Within Dow, Midland (give name) ___________________________

Shipping Papers Completed? ____

☐ SHIPPED - Outside Midland

Outside Dow, Midland (give name) __________________________

NRC/State License Available ________________________________

Shipping Papers Completed? ____

☐ WASTE

☐ Burner - Number of Packages ____   Packages Wipe Tested ____

☐ Environmental Release (hood)   Wipe Results ____ (DPM)

☐ Off-Site

Shipping Papers Completed? ____   or Not Applicable ____

KEEP ONE COPY FOR YOUR RECORDS AND SEND ONE COPY TO

INDUSTRIAL HYGIENE, 1803 BUILDING

ANNEX II, NUMBER 3

LOOSE ISOTOPE INVENTORY STATUS
AND TRANSACTION FOR LAST QUARTER
(ACTIVITY IN MCI)

OWNER: M.D. DRYZGA
BUILDING: 1803
LAB: 172

PRESENT ACTIVITY & QUARTERLY TRANSACTIONS

C-14 27.495 09/30/83
TRANSACTION 0.002 07/07/83 WASTE TO INCINERATOR
TRANSACTION 0.226 09/15/83 RECEIVED FROM LENNON MCKENDRY
TOTAL DECAY THIS QUARTER 0.001

H-3 2.001 09/30/83
TRANSACTION 2.000 09/20/83 RECEIVED FROM NEW ENGLAND NUCLEAR
TOTAL DECAY THIS QUARTER 0.003

TL-204 0.070 09/30/83

TOTAL DECAY THIS QUARTER 0.003

PLEASE CHECK THIS REPORT AGAINST YOUR RECORDS AND IF ACCURATE RETURN A SIGNED COPY TO ME. IF THERE ARE DISCREPENCIES, NOTIFY ME IMMEDIATELY.
ALSO, PLEASE DESCRIBE SURVEY DATES AND RESULTS IN THE SPACE PROVIDED BELOW. SURVEYS MUST BE CONDUCTED A MINIMUM OF ONCE PER MONTH.

G. W. ENGDAHL
IH LAB - 1803 BLDG

SURVEY DATES	SURVEY RESULTS
7-26-83	Contamination was located in a hood (4) and decontaminated
9-6-83	A-OK (August Wipe Test)
9-23-83	A-OK

Mark D Dryzga
1-13-84

ANNEX III, NUMBER 1

U.S. Nuclear Regulatory Commission,
Regulatory Guide 8.23,
"Radiation Surveys at Medical Institutions"

Table 1. ACTION LEVELS FOR REMOVABLE SURFACE CONTAMINATION

	Type of Radioactive Material**					
	Alpha Emitters		Beta or X-Ray Emitters		Low Risk Beta or X-Ray Emitters	
Type of Surface	(uCi/cm^2)	(dpm/100 cm^2)	(uCi/cm^2)	(dpm/100 cm^2)	(uCi/cm^2)	(dpm/100 cm^2)
1. Unrestricted areas	10^{-7}	22	10^{-6}	220	10^{-5}	2,200
2. Restricted areas	10^{-6}	220	10^{-5}	2,200	10^{-4}	22,000
3. Personal clothing worn outside restricted areas	10^{-7}	22	10^{-6}	220	10^{-5}	2,200

*As adapted from Table 1 of Reference 10. Averaging is acceptable over nonliving areas of up to 300 cm^2 or, for floors, walls, and ceiling, 100 cm^2. Averaging is also acceptable over 100 cm^2 for skin or, for the hands, over the whole area of the hand, nominally 300 cm^2.

**Beta- or X-ray emitter values are applicable for all beta- or x-ray emitters other than those considered low risk. Low risk nuclides include C-14, H-3, S-35, Tc-99m, and others whose beta energies are less than 0.2 MeV maximum, whose gamma- or X-ray emission is less than 0.1 R/h at 1 meter per curie, and whose permissible concentration in air (see 10 CFR Part 20, Appendix B, Table 1) is greater than 10^{-6} uCi/ml.

ANNEX III, NUMBER 2

NUCLEAR REGULATORY COMMISSION RULES AND REGULATIONS 10 CFR PART 20.205

"RADIATION AND CONTAMINATION SURVEY ACTION LEVELS FOR RADIOACTIVE PACKAGES"

Table 2. EXEMPT (LIMITED QUANTITY) AND TYPE A QUANTITIES

DOT 49 CFR 173.391 Transport Group	Upper Limit of Exempt Quantity (in millicuries)	Type A Limit (in curies)
I	0.01	0.001
II	0.1	0.050
III	1	3
IV	1	20
V	1	20
VI	1	1000
VII	25,000	1000
Special Form	1	20

EXCEPTIONS

Isotope	Form	Upper limit of exempt quantity (mCi)
C-14	Normal	<10
H-3	Normal	<10
I-125	Normal	<10
Sealed Source	Special	<20,000
Any isotope with $t_{1/2}$ of <30 days	Normal	<100

Isotopes received in amounts greater than or equal to upper limit of exempt quantity in Table 2 above (exceptions listed above) must be wipe tested within three hours of arrival. Additionally, if the isotope content is greater than Type A, the external surface must be surveyed.

Note: Transport Group 1 - includes Am-241, Ra-226, Po-210
Transport Group 2 - includes Sr-90, MF-P
Transport Group 3 - includes Cs-137, Co-60, Fe-55, I-125, Kr-85, Th (Nat.)
Transport Group 4 - includes Cd-109, Ni-63, Pm-147, C-14, H-3

This form, as approved by the Dow Radiation Safety Committe (RSC) and the Radiation Safety Officer (RSO), 517-636-3205, specifies the limitations and conditions of use for radioisotopes in this work area. Only the approved isotope users listed are approved to perform specified operations involving radioisotopes.

Radioisotope Laboratory Classification

☐ I - Low Level ☐ II - Medium Level ☐ III - High Level

RSO Approval	______ RSO ______ Date	Copies Dow Radiation Safety Office and Isotope Owner
RSC Approval	______ Dow RSC Chairman ______ Date	

Isotope Use Approval

Approval to use radioisotopes can be obtained through laboratory supervision and completion of specific training as dictated by the RSO, 517-636-3205. Final approval is granted by the RSC.

Approved Users: ______________________

____

____

Authorized Areas for Use of Radioisotopes

____

____

AUTHORIZED RADIOISOTOPES AND QUANTITIES

Radioisotopes	Quantity Limit per Experiment/Operation	Storage Limits
1.		
2.		
3.		

Type of Experimental Operations Approved

☐ Wet Chemical Other: ______________________

☐ Dry or Dispersible Chemicals ______________________

☐ Animal Metabolism Studies ______________________

Protective Clothing Requirements	Dow RSO Comments:
☐ None ☐ Other 1. ______	______
☐ Laboratory Coat 2. ______	______
☐ Coveralls 3. ______	______
☐ Hood/Caps	______
☐ Gloves (Rubber/Cotton)	______
☐ Booties (Rubber/Plastic)	______

Limitations and Conditions of Use

Operations requiring use of fume hood: ____________________

____

Shielding and remote handling requirements: ____________________

____

Other: ____________________

____

Radiation Survey and Monitoring Requirements

Removable Contamination (Wipe Testing) Survey - Areas: ____________________

Frequency: during processing of radioisotopes ☐ Daily ☐ Weekly ☐ Monthly ☐ At completion of study

Other: ____________________

(Note: Record data on diagram of work area)

Radiation Surveys: ☐ None ☐ As below (for hard beta/gamma and X-ray emitters)

Areas: ____________________

Frequency: ____________________

Air Monitoring Requirements

Monitoring equipment needed:

☐ Surveys Instruments ____________________

☐ Contamination Instruments ____________________

☐ Other ____________________

Personal Dosimetry Requirements

☐ TLD Finger Ring ☐ Film Badge ☐ Other ______	☐ Other Requirements 1. ______ 2. ______ 3. ______

Bioassay Requirements - type: ____________________

frequency: ____________________

special considerations: ____________________

In case of a spill or other suspected inhalation, ingestion or absorption of radioisotopes, bioassay is required.

Emergency Procedures: Call Emergency Response 1-2-3 (for Larkin Laboratory and Ag Research areas, call 147)

In the event of fires, spills or uncontrolled release of radioisotopes - isolate and contain spill.

Ventilation: ☐ Stop fans ______________________

☐ Do not stop fans ______________________

Building Evacuation Requirements: ______________________

Emergency Response Call: ______________________

For accidental contamination: isolate area and decontaminate with RSO supervision (call 517-636-3205)

Decontamination procedures: bag contaminated clothes and other materials for disposal as radwaste. Wash with soap and water, save rinse for waste disposal consideration.

For medical emergenices: Severe Injury - go to Medical via ambulance, notify personnel of presence of radioisotope

Moderate and Minor - remove contaminated clothing and isolate contaminated wound prior to going to Medical. Use Dow vehicle or ambulance only.

(Midland Hospital for Larkin Laboratory and Ag Research Farm)

Transfer of Radioisotopes to Other Rooms and Areas

Transfer between rooms - capped containers in catch container, shielded (approved use rooms only)

Transfer to other areas within Dow:

- transfer only to other areas approved for use of isotope, quantity and operation
- notify RSO with Material Transaction Form
- package to meet DOT shipping requirements and complete radioactive shipping form if going on public roads

Transfer outside of Dow - coordinate through RSO

Storage Requirements for Radioisotopes

Inventory Log: ______________________

Ventilation Requirements: ______________________

Quantity Limits: ______________________

Survey Requirements: ______________________

Other: ______________________

Handling Procedures for Contaminated Articles and Glassware

Dispose of unnecessary materials in designated radioactive waste containers.

To clean glassware, etc., use good isolation techniques to contain contamination.

Wash water shall be caught in a drip container and packaged for disposal if radioactivity is greater than _____ dpm/ml for isotopes _________. Drip pans and articles shall be wiped clean (less than 50 dpm removable/100 cm^2) and the wipe materials disposed of as appropriate.

Other: ______________________

Labeling and Posting Requirements

Label all areas where radioisotopes are handled and any rooms (including refrigerators or freezers) containing greater than _________ of _________. All containers shall be labeled which contain greater than mCi of ________.

Posting requirements: ______________________

____

____

Radioactive Waste Disposal Procedures

1. Segregate liquid and solid radioactive waste; label all containers.
2. Store waste in designated areas.
3. Use only approved (RSO) containers for disposal.
4. Line containers with plastic bags.
5. For liquids, add absorbent material sufficient to absorb 2x the liquid volume.
6. Keep record of isotopes and quantities in each container.
7. To dispose of radwaste, coordinate through RSO following radwaste disposal criteria.
8. Other specifics: ______________________________

____

Recordkeeping Requirements: ☐ Inventory Log of Radioisotopes kept by ______________________________

Radiation Survey Records: ______________________________

Material Transaction Records: ______________________________

Other: ______________________________

Prohibited Activities:

Pipetting by mouth, smoking, eating or drinking in areas where radioactive materials are used.

ANNEX III, NUMBER 4 - RADIATION TRAINING RECORD/ISOTOPE USE APPROVAL

Name ______________________________ Dow Phone No. ____________
(Last) (First) (Middle)

Department ______________________________ Building ____________

Charge Number ______________ Sex ________ Dow Master No. ____________

Social Security No. ______________________ Birthdate ____________

Radiation experience prior to Dow? ☐ Yes ☐ No

If yes, was personal dosimetry provided? ☐ Yes ☐ No

If yes, please include the following information (use reverse side if needed).

____
Employer Contact Person

____
Street Address City State Zip Code

Class of Training: ☐ I ☐ II ☐ III

Type of Radiation Source Approval and Limits:

☐ Unsealed ______________ Limits ______________

☐ Sealed __________ ☐ Radiation Machine __________ ☐ Other __________

Additional training and remarks: ______________________________

____

The fundamentals of radiation have been explained emphasizing the specific hazards of the radiation source used. I understand the procedures for ordering, receiving and disposing of radiation sources. My responsibilities have been explained according to 10CFR19.12 and Michigan Department of Public Health Rule 213.

Females only, I have read and understand Regulatory Guide 8.13 "Instruction Concerning Prenatal Radiation Exposure" and Michigan Department of Public Health Rule 203.
______ (Initials)

Interim Approval

Signed ______________________________ Date ______________
(Applicant)

Interim Approval for Use Under Supervision of ______________________.

Signed ______________________________ Date ______________
(Radiation Safety Officer)

- -

Final Approval

Signed ______________________________ Date ______________
(Supervisor Approval)

Signed ______________________________ Date ______________
(Radiation Safety Committee)

- -

For Office Use Only

Permanent ______ or Temporary (months) ______ Badge (type) & No. ________

Job Code __ License __ TLD Ring No. ___

For Loose Isotope Users: Name of Inventory Owner: ______________________

ANNEX III, NUMBER 5

INFORMATION FOR CLASSIFYING LABORATORIES*

Radiotoxicity of Radionuclides	Limitation on Radioactivity in Various Types of Work Areas or Laboratories and Survey Frequency Category		
	Low	Medium	High
1	<10 uCi	10 uCi to 10 mCi	>10 mCi
2	<0.1 mCi	0.1 mCi to 100 mCi	>100 mCi
3	<1 mCi	1 mCi to 1 Ci	>1 Ci
4	<10 mCi	10 mCi to 10 Ci	>10 Ci
Exceptions			
C-14**	<50 mCi	50 mCi to 1 Ci	>1 Ci
H-3**	<50 mCi	50 mCi to 10 Ci	>10 Ci
P-32**	<10 mCi	10 mCi to 1 Ci	>1 Ci
I-125**	<10 mCi	10 mCi to 100 mCi	>100 mCi

Proportional fractions are to be used for more than one isotope.

Modifying Factors****	Factors
Simple storage	x100
Very simple wet operations (e.g., preparation of aliquots of stock solutions)	x10
Normal chemical operations (e.g., analysis, simple chemical preparations)	x1
Complex wet operations (e.g., multiple operations or operations with complex glass apparatus)	x0.1
Simple dry operations (e.g., manipulation of powders) and work with volatile radioactive compounds	x0.1
Handling dosed animals	x0.1
Dry and dusty operation (e.g., grinding)	x0.01

The object is to determine the radioactivity limits for each laboratory and survey frequency. To do this, multiply the activity range under low, medium, and high by the appropriate modifying factor to construct a new set of mCi ranges for low, medium, and high survey frequency, activity limits and subsequent control requirements established by RSO and RSC.

Example

A laboratory in which 15 mCi of Group 3 radionuclide is used in normal chemical operations required medium level protective measures and monitoring frequency. However, if only simple storage is done, then a low level precaution and monitoring frequency is adequate (<1 mCi x 100 = <100 mCi new log range). But if a dry grinding operation is done, a high frequency is required (>1000 mCi x 0.01 = >10 mCi new high range).

*Patterned after the International Atomic Energy Agency, Safety Series No. 1, Safe Handling of Radionuclides (1973).

**Specific exception for low level quantities has been made because of experience of RSO and individual users in handling these isotopes.

***See Table on Annex II, Number 6.

****Modifying factors are applied by the RSO and RSC in the Laboratory Use Approval.

ANNEX III, NUMBER 6 - RADIONUCLIDES CLASSIFIED ACCORDING TO RELATIVE RADIOTOXICITY PER UNIT ACTIVITY

Group 1: Very High Radiotoxicity

Pb-210	Ra-226	Th-227	Pa-231	U-233	Pu-238	Pu-241	Am-243	Cm-244	Cf-249
Po-210	Ra-228	Th-228	U-230	U-234	Pu-239	Pu-242	Cm-242	Cm-245	Cf-250
Ra-223	Ac-227	Th-230	U-232	Np-237	Pu-240	Am-241	Cm-243	Cm-246	Cf-252

Group 2: High Toxicity

Na-22	Co-56	Zr-95	Sb-125	I-131	Ce-144	Hf-181	Bi-207	Ac-228	I-125
Cl-36	Co-60	Ru-106	Te^{m}-127	I-133	Eu-152 (13 yr)		Bi-210	Pa-230	
Ca-45	Sr-89	Ag^{m}-110	Te^{m}-129	Cs-134	Eu-154	Ta-182	At-211	Th-234	
Sc-46	Sr-90	Cd^{m}-115	I-124	Cs-137	Tb-160	Ir-192	Pb-212	U-236	
Mn-54	Y-54	In^{m}-114	I-126	Ba-140	Tm-170	Tl-204	Ra-224	Bk-249	

Group 3: Moderate Toxicity

Be-7	Sc-48	Zn-65	Sr-91	Ru-103	Te^{m}-125	La-140	Gd-153	W-187	Au-198	Th-23
C-14	V-48	Zn^{m}-69	Y-90	Ru-105	Te-127	Ce-141	Gd-159	Re-183	Au-199	Pa-23
F-18	Cr-51	Ga-72	Y-92	Rh-105	Te-129	Ce-143	Dy-165	Re-186	Hg-197	Np-23
Na-24	Mn-52	As-73	Y-93	Pd-103	Te^{m}-131	Pr-142	Dy-166	Re-188	Hg^{m}-197	
Cl-38	Mn-56	As-74	Zr-97	Pd-109	Te-132	Pr-143	Ho-166	Os-185	Hg-203	
Si-31	Fe-52	As-76	Nb^{m}-93	Ag-105	I-130	Nd-147	Er-169	Os-191	Tl-200	
P-32	Fe-55	As-77	Nb-95	Ag-111	I-132	Nd-149	Er-171	Os-193	Tl-201	
S-35	Fe-59	Se-75	Mo-99	Cd-109	I-134	Pm-147	Tm-171	Ir-190	Tl-202	
A-41	Co-57	Br-82	Tc-96	Cd-115	I-135	Pm-149	Yb-175	Ir-194	Pb-203	
K-42	Co-58	Kr^{m}-97	Tc^{m}-97	In^{m}-115	Xe-135	Sm-151	Lu-177	Pt-191	Bi-206	
K-43	Ni-63	Kr-87	Tc-97	Sn-113	Cs-131	Sm-153	W-181	Pt-193	Bi-212	
Ca-47	Ni-65	Rb-86	Tc-99	Sn-125	Cs-136	Eu-152 (9.2 h)		Pt-197	Rn-220	
Sc-47	Cu-64	Sr-85	Ru-97	Sb-122	Ba-131	Eu-155	W-185	Au-196	Rn-222	

Group 4: Low Toxicity

H-3	Co^{m}-58	Ge-71	Rb-87	Nb-97	Rh^{m}-103	Xe^{m}-131	Cs-135	Os^{m}-191	Th-232	U-238
O-15	Ni-59	Kr-85	Y^{m}-91	Tc^{m}-96	In^{m}-113	Xe-133	Sm-147	Pt^{m}-193	Th-Nat	U-Nat
A-37	Zn-69	Sr^{m}-85	Zr-93	Tc^{m}-99	I-129	Cs^{m}-134	Re-187	Pt^{m}-197	U-235	

IMAGE EVALUATION
TEST TARGET (MT-3)

150mm

6"

ANNEX III, NUMBER 7

(U.S. Nuclear Regulatory Commission, Regulatory Guide 8.21)

ACCEPTABLE FREQUENCIES FOR SURVEYS

(When routinely working with Radioactive Materials)

Radionuclide Group	External Radiation Surveys (nuclides with asterisks only)*		Amounts (Curies) in Process at Any One Time or Placed into Process in Any 3-Mo. Period Within Any Room Requiring Surveys					
			Air Sampling**			Surface Contamination		
	Weekly	Monthly	Weekly	Monthly	Quarterly	Weekly	Monthly	Quarterly
I. H-3, C-14, F-18*, K-42*, Cu-64*, Tc-99m*, In-113m*	If point source of activity could exceed 50 mrad/h at 1 meter	If point source of activity could exceed 0.5 mrad/h at 1 meter	≥ 10	≥ 1 < 10	< 1	≥ 100	≥ 10 < 100	< 10
II. Br-82, Cr-51*, Fe-55, I-123*, Hg-197*			≥ 1	≥ 0.1 < 1	< 0.1	≥ 10	≥ 1 < 10	< 1
III. S-35, Au-198, Ca-47, I-132, Ce-141, Mixed fission products*, Sr-85, La-140, Nb-95, Zn-65, Co-58*, Fe-59*, Na-24*, Co-57*, Se-75*, Mo-99*			≥ 0.1	≥ 0.01 < 0.1	< 0.01	≥ 1	≥ 0.1 < 1	< 0.1
IV: Hf-181, Pm-147, P-32*, Ba-140*, Th-234, Kr-85, Ir-192*, Cl-36, Y-91, Ta-182, Ca-45, Sr-89, Cs-137, Co-60*, Ce-144*, I-126, Eu-154, I-131*, I-125*, Tm-170, Na-22*, Mn-54*, Ag-110m*, Hg-203*, Rn-222*, Sn-113*			≥ 0.01	≥ 0.001 < 0.01	< 0.001	≥ 0.1	≥ 0.01 < 0.1	< 0.01
V. Tc-99, I-129, Ru-106			≥ 0.001	$\geq 10^{-4}$ < 0.001	$< 10^{-4}$	≥ 0.01	≥ 0.001 < 0.01	< 0.001
VI. Ra-223, Po-210, Th-227, Sr-90, Pb-210, Cm-242, U-233*			$\geq 10^{-4}$	$\geq 10^{-5}$ $< 10^{-4}$	$< 10^{-5}$	≥ 0.001	$\geq 0.10^{-4}$ < 0.001	$< 10^{-4}$
VII. Sm-147, Nd-144, Ra-226*, Cm-244, Ra-228, Pu-241			$\geq 10^{-5}$	$\geq 10^{-6}$ $< 10^{-5}$	$< 10^{-6}$	$\geq 10^{-4}$	$\geq 10^{-5}$ $< 10^{-4}$	$< 10^{-5}$
VIII. Am-243, Am-241*, Np-237, Ac-227, Th-230, Pu-242, Pu-238, Pu-240, Pu-239, Th-228, Cf-252			$\geq 10^{-6}$	$\geq 10^{-7}$ $< 10^{-6}$	$< 10^{-8}$	$\geq 10^{-5}$	$\geq 10^{-6}$ $< 10^{-5}$	$< 10^{-6}$

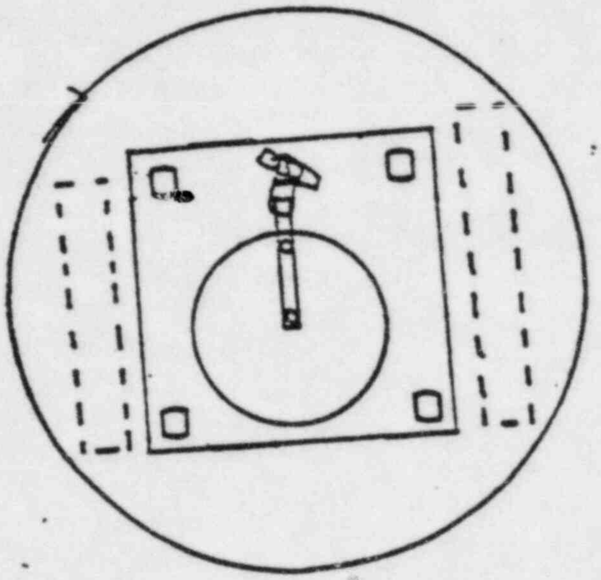
*Nuclides with asterisks are those more likely to require external radiation surveys.
**Assuming continuous sampling is unnecessary (see Section C.1.3.).

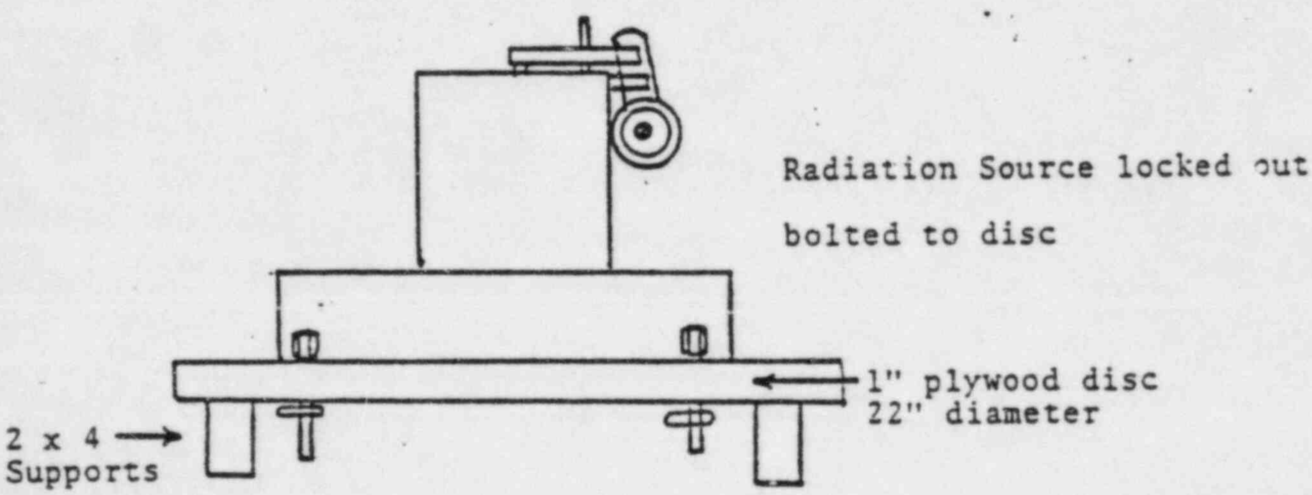
ANNEX IV, NUMBER 1

MOUNTING CONFIGURATION FOR SEALED SOURCE SHIPMENTS

(55 GALLON DRUM, DOT TYPE A CONTAINER)

TOP VIEW





SIDE VIEW

ANNEX IV, NUMBER 2

WIPE TEST RADIOASSAY USING THE BECKMAN LS-9800 LIQUID SCINTILLATION SPECTROMETER

Author:

John R. Darling

Date:

September 30, 1983

ABSTRACT

A method has been verified for counting wipe test swabs on the Beckman LS-9800 Liquid Scintillation Spectrometer. The method will be used to assay wipe test samples originating from leak test surveys of radioactive sealed sources and from laboratory surveys for loose contamination, in compliance with NRC regulations. Various isotopes covering a wide energy range (0.02 MeV to 2.2 MeV) were spiked on cotton swabs in order to establish average counting efficiencies in each of three energy windows. The counting efficiencies with the Beckman LS-9800 were similar to those found previously on Packard Tri-Carb Liquid Scintillation Spectrometers. A detection limit of at least as low as 2.2×10^{-5} µCi (50 dpm) was obtained for any isotope in this energy range in a 10 minute counting time. No differences were found between the counting efficiency for isotopes on swabs placed in the new 7 mL "mini-vials" or the standard 20 mL vials.

INTRODUCTION

The use of wipe test counting of cotton swabs to analyze for radioactive contamination has been practiced by Dow Chemical Company for several years. These wipe tests are performed on the external areas of radioactive sealed sources used in the company, on radioactive packages which are shipped or received and for radiotracer laboratory monitoring. In the past, the counting of the cotton swabs was accomplished using Packard Tri-Carb Liquid Scintillation Spectrometers (Ref. 2). In the winter of 1981, a new LSC counter was purchased by the Environmental Sciences Research Analytical/Radiotracer group; the Beckman LS-9800 Liquid Scintillation Spectrometer. This instrument has taken over nearly all of the liquid scintillation counting in this area, especially the wipe test counting. The purpose of this report is two-fold: 1) to verify the wipe test counting method on the Beckman LS-9800, and 2) to compare the counting efficiency of wipe tests in the standard 20 mL counting vials to new 7 mL counting vials (minivials).

Instrument:

The instrument to be verified for use is an ambient temperature Beckman LS-9800 Liquid Scintillation Spectrometer (See Ref. 2). This instrument is microprocessor controlled and has a 3 channel monitoring capability and a 300 sample capacity. The microprocessor program features employed in the study include:

1) Spectrum Search -- This is a Beckman program which divides the beta energy spectrum into 1,000 channels. It provides a printout of the gross counts in a user-defined increment of channels. This program was used to determine the maximum or peak energy channel (See Figure 1).

2) Spectrum Analysis -- This is a Beckman program which graphically presents the data provided in the spectrum search program. It was used to provide a visual display of a sample's spectrum (See Figure 2).

3) Wipe Program -- This is a user-generated program. It divides the energy spectrum into 3 blocks of counts, relating to 3 beta energy ranges. It provides an appropriate background subtraction and prints out the data in a user selected format. The format we use provides net counts in all three channels (See Figure 3).

EXPERIMENTAL

Calibration of Solutions

In order to analyze isotopes that were not previously calibrated and for which no standards were available it was necessary to establish a relationship between an isotope's counting efficiency and some measureable parameter in order to provide a way to find a sample's specific activity. It was found that the efficiency at which any isotope counted could be related to the most probable energy, or peak energy window. This is the area of the spectrum where the maximum number of counts occurred.

Using four calibrated standards, ^{3}H, ^{14}C, ^{63}Ni, ^{36}Cl (See Table I) it was possible to correlate the counting efficiency and the peak energy window (See Figure 4). Additional points were obtained for this plot by chemically "quenching" the calibrated standards with $CHCl_3$. This quenching produces a peak energy shift which lowered the counting efficiency.

This plot (Figure 4) provided a means for establishing a counting efficiency for any isotope by determining its peak energy. This allowed the calibration of all solutions. The solutions in Table II were used in the wipe study and were found to have the given activities by the above method.

Method:

The calibrated solutions as listed in Table II were used in the comparison and validation study. These solutions were diluted (if necessary) with HCl to contain between 5,000 and 50,000 disintegrations per minute (dpm) in a 25 μL spike of the sample.

A series of ten cotton swabs were each spiked with 25 μL of isotope in solution. These swabs were allowed to dry in the draft of a fume hood for 3 to 4 hours. Also, at the same time as swab preparation, 5 replicate 25 μL assays of each isotope solution were spiked directly into 15 mL of Aquasol[a] liquid scintillation (LSC) cocktail in standard size vials. After the swabs had dried they were indiscriminately assigned to five of the standard size vials and five of the mini-vials. The scintillator was added to the wipe samples (10 mL Econofluor[a] in standard vials, 4 mL in minivials). This procedure was repeated for each of the ten isotopes.

The assay solutions were counted over the full energy range (20-1,000 channel window) to obtain the total counts in 25 μL of a sample. The wipe swabs were counted on a 3 energy window program: Window 1, channels 20-450; Window 2, channels 220-700; Window 3, channels 420-1000. Background radiation counts in each window were determined by counting blank swab samples. These background counts were subtracted from the spiked swab counts to obtain net counts per minute (cpm) in each window.

Calculations:

The calculations employed here use the average net cpm in 5 replicate samples of the assays and the wipes to provide a measure of the counting efficiency. The window in which the most net counts occur is used to calculate the isotope's counting efficiency on the swabs.

[a]New England Nuclear-toluene based scintillators

The counting efficiency for each isotope on the swabs for both standard and mini-vials is reported (See Table III). These efficiencies are obtained by dividing the net cpm in the wipe sample by the dpm in the assay. The dpm in the assay were determined by dividing the net cpm in the assay by the counting efficiency of each isotope (See Calibration of Solutions).

Thus, the counting efficiency in percent is given by:

(1) $$\text{dpm on swab} = \frac{\text{net cpm observed in assay}}{\text{efficiency of solution counting}}$$

(2) $$\text{efficiency of swab counting (for each isotope)} = \frac{\text{net cpm in maximum channel for swab}}{\text{dpm on swab}} \times 100$$

RESULTS

A method has been verified for analyzing wipe swabs for trace radioactivity using the Beckman LS-9800 Spectrometer. This method is based upon a relation between an isotope's counting efficiency and it's maximum energy. Three energy windows are monitored for activity. The window settings divide a total beta spectrum into three energy regions; low (~0.015 meV), medium (~0.15 MeV), and high (~1 MeV) energy. The average counting efficiencies for the isotopes peaking in a given window are used to establish an approximate level of activity on actual samples. The purpose of counting swabs is chiefly to determine if any activity is present and roughly how much. A detection limit of 50 dpm for any isotope in this energy range is obtainable. A more detailed analysis may be performed if an exact quantitation is needed.

The efficiencies established for counting swabs are similar to efficiencies found in the past with the Packard Tri-Carb Scintillation Spectrometers. An isotope by isotope counting efficiency comparison

is given in Table IV. With the settings used, low energy counting is slightly less efficient with the Beckman LS-9800 while medium and high energy are nearly the same as the Packard Tri-Carbs.

The mini-scintillation vials were compared to the standard size for use on the Beckman LS-9800. A paired t-test comparison of the counting efficiencies for the different isotopes in the two vial types at a significance level of 0.05 showed that there was no difference between the two vials (See Figure 5). The mini-vials use only 4 mL of scintillator as compared to 10 mL in the standard vials. A decrease in scintillator used and less waste produced are incentives to use the mini-vials.

CONCLUSIONS

A method for counting wipe tests with the Beckman LS-9800 has been verified. This method is valid for a variety of isotopes of differing energies.

The method established for counting wipes on the Beckman LS-9800 is similar to methods used with the Packard Tri-Carb counters. The counting efficiencies found here are close to those found with the Packard Tri-Carb counters previously used. A detection limit of 50 dpm with a 10 minute count time is obtainable for any energy range. The mini-scintillation vials count with the same efficiencies as the standard vials. The smaller size of the mini-vials produces less waste and costs less in material usage. This should provide the incentive to use them.

References:

1. Lickly, L. C., Liquid Scintillation Counting Method for the Radioassay of Wipe Test Samples, CRI-801230, May 9, 1979.

2. Beckman, LS 9800 Series Liquid Scintillation Systems, Instructions 015-556331 Beckman Instruments, Inc., Scientific Instruments Division, Irvine, CA 92713.

Table I

Solutions Used in Preparing Calibration Curve

Isotope	Source	Activity
^{3}H water	New England Nuclear Lot No. N5239-016	2.54×10^{6}dpm/mL (4-5-82)
^{14}C toluene	New England Nuclear Lot No. 697-242	4.5×10^{5}dpm/mL
^{63}Ni chloride in HCl	New England Nuclear Lot No. 0685112481A	2.22×10^{6}dpm/mL
^{36}Cl chlorobenzene	New England Nuclear Lot No. 09-1641	4.17×10^{5}dpm/mL

Table II

Isotopes Employed in the Wipe Test Study

Isotope	Activity[a] dpm/mL	Peak Energy Channel	Counting Efficiency (%)
^{55}Fe chloride in HCl	1.770×10^6	205	39
^{3}H succinic acid in EtOH	4.13×10^5	245	55
^{63}Ni chloride in HCl	1.094×10^6	395	85
^{147}Pm chloride in HCl	1.126×10^6	505	95
^{14}C polyethylimine in H_2O	1.554×10^6	515	95
^{109}Cd chloride in HCl	1.055×10^6	555	97
^{60}Co chloride in HCl	8.54×10^5	625	100
^{137}Cs chloride in HCl	4.48×10^5	715	100
^{90}Sr chloride in HCl	4.23×10^5	725	100
^{210}Po chloride in HCl	1.91×10^5	755	100

[a]Activities on 5-20-83 as calibrated by solution counting for this report based on ^{3}H, ^{14}C, ^{63}Ni and ^{36}Cl standards from New England Nuclear.

Table III

Counting Efficiency Comparison Between Standard and Mini Counting Vials
Using the Beckman LS 9800

	Energy Range					
	Low Energy Window (channels 20-450)		Medium Energy Window (channels 220-700)		High Energy Window (channels 400-1000)	
Isotope	Std. Vial	Mini Vial	Std. Vial	Mini Vial	Std. Vial	Mini Vial
^{3}H	9.47	7.56				
^{55}Fe	9.40	8.70				
^{63}Ni	36.04	34.74				
^{14}C			72.99	74.64		
^{147}Pm			73.65	75.96		
^{60}Co			80.03	81.37		
^{109}Cd			81.68	81.05		
^{137}Cs					84.52	82.88
^{990}Sr					93.00	93.36
^{210}Po					99.83	98.16
Mean ± S.D.	18.30±15.36	17.00±15.37	77.09±4.41	78.26±3.46	92.45±7.67	91.47±7.81

Table IV

Comparison of Counting Efficiency Between the Packard Tri-Carbs and the Beckman LS-9800

		Packard Efficiency[c] (%)		Beckman Efficiency (%)	
			Mean Efficiency		Mean Efficiency
Low Energy Isotopes	^{3}H	40.08±6.18[a]		9.47±0.43[a]	
	^{63}Ni	39.87±1.11	32.45±13.06[b]	36.04±0.63	18.30±13.06[b]
	^{55}Fe	17.36±4.59		9.40±0.81	
Medium Energy Isotopes	^{14}C	65.31±1.93		72.99±2.35	
	^{147}Pm	76.71±3.24		73.65±2.49	
	^{60}Co	82.50±9.99	78.04±9.59	80.03±1.68	77.09±4.41
	^{109}Cd	87.64±0.77		81.68±0.53	
High Energy Isotopes	^{137}Cs	93.94±1.99		84.52±1.37	
	^{90}Sr	90.32±3.87	91.19±2.43	93.00±0.98	92.45±7.67
	^{210}Po	89.30±0.56		99.83±1.62	

[a]standard deviation of replicates

[b]standard deviation of isotopes in window

[c]See Ref. 1

Figure 1

Cumulative Count Readout in 10 Channel Increments, Example for Tritium Standard
(from Spectrum Search Program)

PAGE: 1

SPECTRUM SEARCH WED 27 JUL 1983 10:22
ID:3-H ASSAY PRESET TIME: 5.00 LIMIT SEARCH(%): 1.00
SAMPLE DPM:N RS232:N PRINT DATA:Y LL: 0 UL:1000 INCREMENT SUM:10

TOTAL COUNTS: 50585 CPM: 10117.00 2SIG: 0.89 TIME: 5.00 ERR
LIMIT SETTING: 384 H#: 48.0

PRINT DATA(0-1000)
COUNTS: 50585 CPM: 10117.00 2SIG: 0.89 TIME: 5.00

	0	10	20	30	40
0	58	30	39	55	94
50	115	189	268	359	504
100	634	819	945	1180	1310
150	1468	1694	1906	2068	2271
200	2459	2534	2627	2654	2753
250	2738	2737	2612	2423	2235
300	1833	1668	1339	1189	812
350	615	441	307	177	82
400	78	37	18	11	12
450	3	0	3	2	4
500	4	5	5	1	8
550	4	7	3	2	0
600	3	6	6	2	2
650	2	5	3	4	3
700	3	2	0	3	2
750	2	3	3	3	4
800	1	6	1	3	2
850	3	1	0	2	4
900	2	2	1	2	0
950	2	1	1	4	1

REMAINDER: 28

Figure 2

Sample of Beckman LS-9800 Spectrum Analysis Program for C-14 Standard

```
                                                                        PAGE: 1

SPECTRUM ANALYSIS
ID:14-C-REI
SAMPLE IPM:N               PRESET TIME:  5.00   2SIGMA:  0.00

SAMPLE:  1   POSITION:237
TOTAL COUNTS:     139704       CPM:     27940.80  2SIG: 0.54  TIME:  5.00     EFP

     LIMIT SEARCH   LIMIT SETTING
         1.00            597
         5.00            524
        10.00            496

     REGION(   0-1000)  INCREMENT SUM:20
     COUNTS:     139704       CPM:     27940.80  2SIG: 0.54  TIME:  5.00

SAMPLE SPECTRUM

X AXIS: CHANNELS
Y AXIS: COUNTS X 10 **  1
```

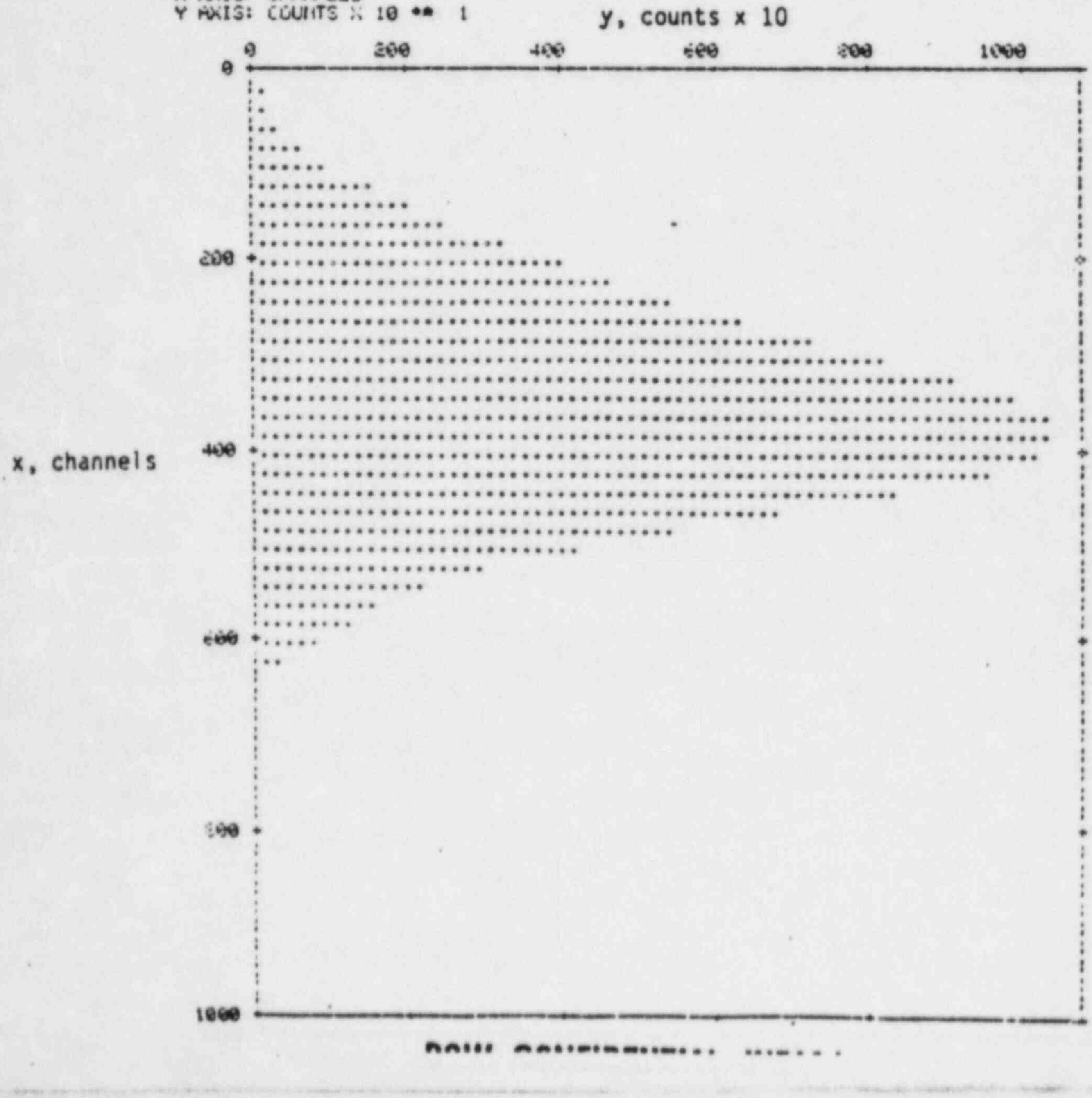


Figure 3

A User-Generated Program for Wipe Test Analysis Providing the Net Counts Per Minute for Channels 1, 2 and 3. This Example shows Results for 4 "Unknown" Samples.

PAGE: 1

```
USER:10 ID:WIFE PGM     PRESET TIME: 15.00           FRI 29 JUL 1983 08:13
SAMPLE REPEAT: 1 CYCLE REPEAT: 1 SCR:N   RS232:N
H#: 0 AQC:N QCF:N RCM:N 2 PHASE MONITOR:N
                            LSR-TIME: 10.00 INT:999.95
CHANNEL 1-LL: 20 UL: 450 2SIGMA: 2.00 BKG SUB:  24.72 BKG 2SIG:  0.00 LSR:  11
CHANNEL 2-LL:220 UL: 700 2SIGMA: 2.00 BKG SUB:  32.05 BKG 2SIG:  0.00 LSR:  35
CHANNEL 3-LL:420 UL:1000 2SIGMA: 2.00 BKG SUB:  29.28 BKG 2SIG:  0.00 LSR:  45
DATA CALC: CPM, UNKNOWN REPLICATES: 1   NORM FACTOR:Q 1.00000
HALF LIFE(DAYS):N
```

POS	TIME	CPM1	CPM2	CPM3	ERR
278	10.00	-5.82	-5.15	2.12	111 108
279	5.45	10774.36	9706.67	1806.50	
280	1.15	21610.06	24434.91	8775.94	
281	15.00	231.61	2364.02	3209.99	

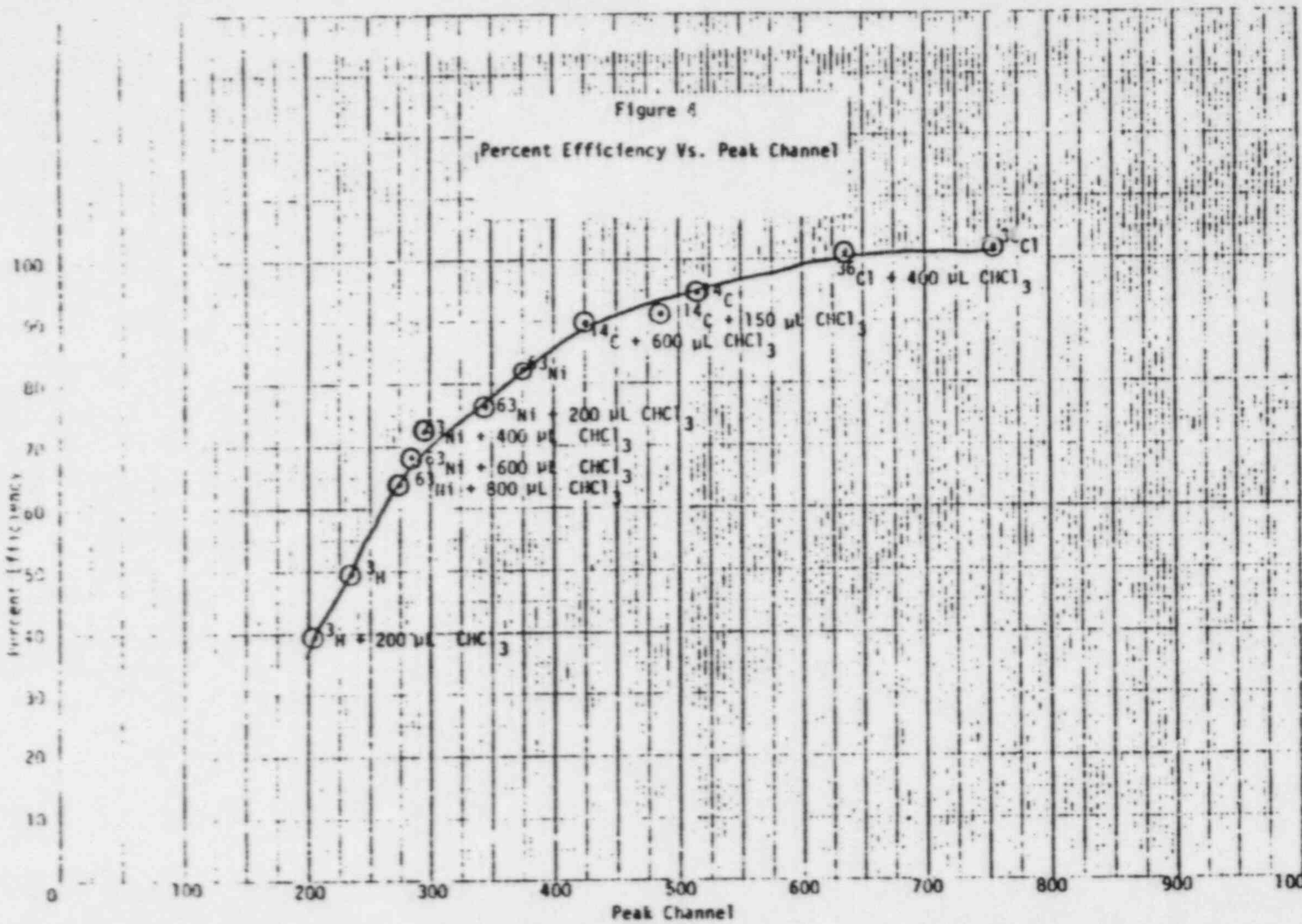


Figure 4
Percent Efficiency Vs. Peak Channel
Percent Efficiency
Peak Channel
0
100
200
300
400
500
600
700
800
900
1000
10
20
30
40
50
60
70
80
90
100
3H + 200 μL CHCl3
3H
63Ni + 800 μL CHCl3
63Ni + 600 μL CHCl3
63Ni + 400 μL CHCl3
63Ni + 200 μL CHCl3
63Ni
14C + 600 μL CHCl3
14C + 150 μL CHCl3
14C
36Cl + 400 μL CHCl3
Cl

Figure 5

Statistical Comparison of Counting Efficiencies for Mini-Vials and Standard Vials

```
COMPARE$ <GO>

ARE YOU COMPARING 1 OR 2 SAMPLES? 2$ <GO>
PLEASE ENTER A TABLEPORTION FOR SAMPLE 1: COL 2 OF TABLE WIP$ <GO>
PLEASE ENTER A TABLEPORTION FOR SAMPLE 2: COL 3 OF TABLE WIP$ <GO>

ARE YOU PERFORMING PARAMETRIC TEST(P), NONPARAMETRIC TEST(N),
OR ARE YOU UNDECIDED(U)? U$ <GO>

ARE THE DATA PAIRED? YES$ <GO>

TESTING SAMPLE DIFFERENCES
WILK-SHAPIRO TEST OF NORMALITY
MEAN OF HYPOTHETICAL NORMAL POPULATIONS = 0.218999
VARIANCE OF HYPOTHETICAL NORMAL POPULATIONS = 2.35641
CALCULATED W = 0.895723
SL = >.1
AT A SIGNIFICANCE LEVEL OF .05,
    THERE IS INSUFFICIENT REASON TO REJECT THE ASSUMPTION THAT THE
    POPULATION IS NORMAL.


ENTER TYPE OF COMPARISON: NOT EQUAL(N), GREATER THAN(G), OR LESS THAN(L):
N$ <GO
>



T-TEST: TWO SAMPLES WITH PAIRED OBSERVATIONS
TESTING THE HYPOTHESIS THAT THE MEAN OF THE DISTRIBUTION UNDERLYING
SAMPLE 1 IS NOT EQUAL TO THAT OF SAMPLE 2.
SAMPLE 1:
MEAN     = 64.061
STDEV    = 33.3762
N        = 10

SAMPLE 2:
MEAN     = 63.842
STDEV    = 33.8846
N        = 10

SAMPLE OF DIFFERENCES (1-2)
MEAN     = 0.218999
STDEV    = 1.53506
N        = 10

DF       = 9
T        = 0.451146

SL       = 0.662553

AT A SIGNIFICANCE LEVEL OF .05,
     THERE IS INSUFFICIENT EVIDENCE TO REJECT THE ASSUMPTION THAT
     THE MEAN OF SAMPLE 1 IS EQUAL TO THAT OF SAMPLE 2.
```

DOW CHEMICAL U.S.A.

September 27, 1983

MIDLAND, MICHIGAN 48640

Materials Licensing Branch
Division of Fuel Cycle and Material Safety
Office of Nuclear Material Safety and Standards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

'83 OCT -3 P3:01

LICENSE NUMBER 21-00265-06

Enclosed you will find the original and one copy of our type A broadscope byproduct material license renewal application. In the application we have incorporated the amendment changes which have been approved since the last license renewal which occurred in 1978. Three changes that do occur in the renewal application are the following.

1. Since the Michigan Division operations include production activities at Bay City and the use of radioactive materials are being anticipated at this location it has been included in the use location Section 5 of license application. This manufacturing site falls under the Midland administrative organization.

2. In reference to noncommercial waste disposal of loose isotopes by incineration, the activity limits for disposal of radionuclides other than H-3 (tritium) and Carbon-14 isotopes were reduced to 10% of the most restrictive values for air water and water concentrations specified in Appendix B, Table II from Title 10 Code of Federal Regulations Part 20. The incineration activity limits were previously approved and established at 10% of MPC values from Appendix B, Table II for Carbon-14 and H-3 (tritium) and will remain at that level.

3. The Radiation Safety Officer designation has been changed to G. W. Engdahl.

We look forward to hearing from you at your earliest convenience concerning the approval of the license renewal. If further information is required, feel free to contact the Radiation Safety Officer, G. W. Engdahl, at telephone number (517)636-3205.

L. W. Rampy

L. W. Rampy
Chairman
Radiation Safety Committee
Industrial Hygiene Laboratory
(517) 636-0602

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dld
Enclosures

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FORM NRC-313 I (1-79) 10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

1. APPLICATION FOR: *(Check and/or complete as appropriate)*

	a. NEW LICENSE
	b. AMENDMENT TO: LICENSE NUMBER
X	c. RENEWAL OF: LICENSE NUMBER 21-00265-06

2. APPLICANT'S NAME *(Institution, firm, person, etc.)*	3. NAME OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION
The Dow Chemical Company	G. W. Engdahl
TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION (517)636-0860	TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION (517)636-3205
4. APPLICANT'S MAILING ADDRESS *(Include Zip Code)*	5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED *(Include Zip Code)*
Midland, MI 48640	Midland, MI 48640 Bay City, MI 48706

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	Radioactive materials are to be used by or	under the direct supervision of individuals
b.	designated by the Radiation Safety Commit	tee; Chairman, L. W. Rampy
c.		

7. RADIATION PROTECTION OFFICER

G. W. Engdahl

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.

8. LICENSED MATERIAL

LINE NO.	ELEMENT AND MASS NUMBER A	CHEMICAL AND/OR PHYSICAL FORM B	NAME OF MANUFACTURER AND MODEL NUMBER *(If Sealed Source)* C	MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME D
(1)	See Attached			
(2)				
(3)				
(4)				

	DESCRIBE USE OF LICENSED MATERIAL E
(1)	See Attached
(2)	
(3)	
(4)	

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FORM NRC-313 I (1-79)

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3

[illegible] STORAGE OF SEALED SOURCES

[illegible] EACH SEALED	NAME OF MANUFACTURER B.	MODEL NUMBER C.

[illegible] RADIATION DETECTION INSTRUMENTS

[illegible]	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED (alpha, beta, gamma, neutron) E	SENSITIVITY RANGE (milliroentgens/hour or counts/minute) F

[illegible] ION OF INSTRUMENTS LISTED IN ITEM 10

[illegible]	☒ b. CALIBRATED BY APPLICANT *Attach a separate sheet describing method, frequency and standards used for calibrating instruments.* See Attached

[illegible] PERSONNEL MONITORING DEVICES

[illegible]	SUPPLIER (Service Company) B	EXCHANGE FREQUENCY C
[illegible]	R. S. Landauer Company Glenwood Science Park Glenwood, IL 60425	☒ MONTHLY ☐ QUARTERLY ☐ OTHER *(Specify)*:

[illegible] k were appropriate and attach annotated sketch(es) and description(s).

[illegible] TIES, FUME HOODS *(Include filtration, if any)*, ETC.

[illegible] AL SHIELDING *(fixed and/or temporary)*, ETC.

[illegible] ETC.

[illegible] ETC. See Item 15

14. WASTE DISPOSAL

[illegible] ICE EMPLOYED

[illegible] r Systems, Incorporated

[illegible] NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL [illegible] WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF [illegible] D DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

    c. Mathematics and calculations basic to the use and measurement of radioactivity.

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.—18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)* $150.00	b. CERTIFYING OFFICIAL *(Signature)* Lee Rampy
	c. NAME *(Type or print)* L. W. Rampy
(1) LICENSE FEE CATEGORY: 7B	d. TITLE Chairman, Radiation Safety Committee
(2) LICENSE FEE ENCLOSED: $ 150.00	e. DATE 27 Sept 83

FORM NRC-313 I (1-79)

Item 8. LICENSED MATERIAL

A. Element and mass number	B. Chemical and/or physical form	D. Maximum amount that licensee may posess at any one time under this license
1. Any byproduct materials with Atomic Numbers 1 through 83	1. Any	1. Not to exceed 1 curie per radionuclide and 75 curies total except: Hydrogen 3 100 curies Carbon 14 6 curies Cobalt 60 3 curies Nickel 63 3 curies Krypton 85 25 curies Cesium 137 300 curies
2. Any byproduct material	2. Mixed fission products	2. Not to exceed 25 curies total
3. Americium 241	3. Sealed Sources	3. Not to exceed 150 curies total
4. Polonium 210	4. Sealed Sources	4. Not to exceed 5 curies total
5. Curium 244	5. Sealed Sources	5. Not to exceed 5 curies total

C. Name of Manufacturer (Sealed Sources): Not Applicable

E. Describe Use of Licensed Material

1 through 5. For use in research and development as defined in Section 30.4(q), Title 10, Code of Federal Regulations, Part 30, except that carbon-14 may also be used in field studies of pesticides and herbicides and in human research.

FIELD STUDIES OF PESTICIDES AND HERBICIDES

The proposed field studies utilizing carbon-14 will be performed in research work on pesticides and herbicides. Typically 2-10 mCi will be applied to small field plots which will be fenced and posted. The location will be at Dow Midland Agricultural Research Center.

Application of the labeled material will be performed using a containment shield under the supervision of health physics. The contaminated shield will be treated as radioactive waste. Protective equipment will be worn by the applicator per health physics instructions. At the completion of the study, the tagged crops and soil will be removed, counted and treated as radioactive waste if necessary.

Before removing the fence the remaining soil will have an average carbon-14 concentration less than 8×10^{-4} uCi/g-soil.

RESEARCH STUDIES INVOLVING HUMANS

The human studies utilizing carbon-14 will be performed in research work on metabolic fate studies on chemicals where routine non-radioactive methods cannot be employed. Dow has experts in inhalation toxicology, pharmacokinetics, metabolism, medicine and analytical chemistry who routinely study the pharmacokinetics and metabolism of various industrial (non-pharmaceutical) chemicals in man and animals. Carbon-14 labeled test materials are frequently used in the animal studies as authorized in the NRC license 21-00265-06. Safe handling procedures and responsibilities of the users are outlined in Dow's Radiation Protection Manual, which is included as Item 15 of this application.

All studies involving carbon-14 and human volunteers will be conducted using the Dow Midland, Michigan, facilities. Dow possesses facilities for dose administration, sample collection and analysis, and clinical care of the human volunteers. Specific instructions regarding biological excreta collection, radiation safety precautions for the volunteers, diet exercise, alcohol and pharmaceutical consumption will be presented to the human volunteers.

All research protocols pertaining to the use of carbon-14 in humans would be subjected to scientific review by our technical staff, ethical review by the Dow Human Health Research Review Committee and review for radiation safety by the Dow Radiation Safety Committee. The protocols would then be forwarded to the University of Michigan, where two independent committees would review the proposed studies. The "Committee to Review Grants for Clinical Research and Investigation Involving Human Beings (IRB)" would provide ethical review as they have been for all of our non-radiotracer studies involving humans. When materials containing carbon-14 are to be studied, the "Radioactive Drug Research Committee (RDRC)" would review the protocols for radiation safety concerns. The RDRC will meet NRC requirements as it is registered with the Food and Drug Administration as RDRC No. 45. You will find enclosed letters from R. C. Bishop, M.D., Chairman, RDRC No. 45, and W. W. Corn, M.D., Chairman, IRB, which authorize Dow To submit protocols to the RDRC No. 45 and to the IRB for review.

Employees, identified as the designated users of the radioactive material, will be selected based on the following qualification criteria.

(a) Employee must have attended a Dow training class of at least Class II level.

(b) Employee must have experience in the use, handling, and administration of non-radioactive or radioactive materials in human studies.

(c) Employee must have supervised or conducted nonhuman studies involving the types and quantities of carbon-14 labeled compounds expected to be used in the human studies.

The use of licensed material in or on human beings shall be by, or under the supervision of, a physician as defined in 10 CFR 35.3(b).

Dow already has much experience in working safely with radioisotopes. The personnel are trained, the equipment and facilities are already in place and procedures exist for safe operation. Thus, no additional radiation safety precautions or procedures are necessary to work with samples from the human research studies.

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June 15, 1982

Mr. Richard J. Nolan
1803 Building
Dow Chemical Company
Midland, Michigan 48640

Dear Mr. Nolan:

Your request for review of research protocols in which radioisotopes are to be administered to human beings was discussed by this committee (Radioactive Drug Research Committee No. 45, University of Michigan) on May 28, 1982. We understand that these protocols will also be submitted to the University of Michigan Committee to Review Grants for Clinical Research and Investigation Involving Human Beings (IRB), Dr. William Coon, Chairman. We also understand that you will be sending us only one or two protocols per year.

We will be glad to help you with this matter. Please submit our copy of the protocols to:

Mr. Arthur Solari
Radiation Control Service
1101 North University Building
University of Michigan
Ann Arbor, Michigan 48109

Sincerely yours,

Ronald C. Bishop

Ronald C. Bishop, M.D.
Chairman, RDRC #45

cc: Dr. C. Overberger
Mr. A. Solari

RCB/sv

THE UNIVERSITY OF MICHIGAN
Ann Arbor

October 12, 1978

Maynard B. Chenoweth, M.D.
Research Scientist
Bio-Medical Research
Dow Chemical U.S.A.
607 Building
Midland, Michigan 48604

Dear Dr. Chenoweth:

This letter is in reply to your request to the University of Michigan Human Research Review Committee to consider the review of protocols generated by the Dow Bio-Medical Research Laboratory. I have discussed this with Dr. George DeMuth in the Dean's office and with the members of my committee. We would be happy to review your protocols provided that there is not an inordinate number at any one time and provided that there is no time deadline for completion of the review process.

Enclosed in the accompanying envelope is a dozen or so of our research forms which we ask to be completed and submitted with a copy of the research protocol and the written informed consent documents.

I would be happy to meet with you and Dr. Saunders to discuss any of the procedural details. Perhaps the best time would be sometime early in November. If you would call my secretary we could arrange a time at our mutual convenience.

With very cordial regards,

Sincerely yours,

W. W. Coon

William W. Coon, M.D., Chairman
Committee to Review Grants for
Clinical Research and Investigation
Involving Human Beings
Phone: (313) 764-6121

WWC:s

Item 10. RADIATION DETECTION INSTRUMENTS

RADIATION DETECTION INSTRUMENTS

Meter	Minimum Number	Intended Use	Window Thickness	Type of Radiation Detected	Scale
Eberline RO-2	2	Survey	7 mg/cm^2	β, γ, X	0.1 mR-5R
Victoreen 440	1	Survey	1/2 mill	β, γ, X	0.1-300 mR
Victoreen 470A (Panoramic)	2	Survey	17 mg/km^2	β, γ, X	0.1 mR-3000 R
Victoreen 740F (Cutie Pie)	1	Survey	3.5 mg/cm^2	α, β, γ, X	0.5 mR-25 R
Automess Teletector	1	Survey	NA*	β, γ, X	0.05 mR-1000 R
Nuclear Associates 05-571 (Mini Monitor II)	1	Survey	NA	β, γ, X	0.5 mR-1R
Xtex 305A, Reactor Experiments, or Digimaster	1	Survey	NA	β, γ, X	0.1 mR-99.9 R
Ludlum Model 3 (GM)	1	Contamination	NA	β, γ, X	0-500,000 CPM
Victoreen 491 (GM)	1	Contamination	NA	β, γ, X	0-150,000 CPM
Eberline RM-14 (HP 210 probe)	1	Contamination	NA	β, γ, X	0-50,000 CPM
Liquid Scintillation Counter	1	Wipe Test	NA	α, β, γ, X	NA

*Not Applicable

RADIATION METER CALIBRATION PROCEDURES

INTRODUCTION

Providing for the safe use of radiation and radioactive materials is the essential responsibility of a good health physics program. To fulfill this end, it is important to recognize that radiation monitoring is an important element of a radiation protection program. The Nuclear Regulatory Commission's (NRC) "Standards For Protection Against Radiation", 10CFR part 20, requires each license to make surveys to evaluate radiation hazards (10CFR 20.201). Furthermore, the NRC license issued to Dow requires that surveys be performed with a calibrated meter. This document provides general information as well as standard test procedures to ensure that Dow's radiation meters are operating properly and correctly calibrated.

Unless a defined calibration schedule is followed, the calibration of radiation meters may not be completed as required by Federal and State Laws. This can become both embarrassing and/or dangerous when a radiation meter is needed. It is embarrassing to take a meter into the field only to discover that it is not working. It is also extremely dangerous to rely on a meter that is "working" but is giving false readings. Therefore, radiation meter calibration is necessary not only to satisfy legal requirements, but also to protect human health.

CALIBRATION FREQUENCY

The calibration frequency is segregated into three month intervals. Quarterly or three month period calibration is required for some radiation meters. Annual or semi-annual calibration is required for other radiation meters. The individual conducting the meter calibrations during the three month interval is responsible to complete all meter calibrations required during that period.

PERSONAL DOSIMETRY

The individual performing the calibration must obtain and wear a personal radiation dosimeter. There is negligible probability of receiving a measurable radiation dose but a dosimeter is required to record doses in the event of unusual circumstances. Additionally, it is necessary to travel to other buildings and a film badge is required to enter some identified areas in these buildings.

BATTERIES

The item most likely to malfunction on each individual meter is the batteries. Batteries loose operating power over time, leak and are subject to temperature effects. Most meters are equipped with a "battery test" mode in which the current of the batteries is tested. In this mode, the test indicates the relative current of all the batteries but indicates nothing of the batteries individual currents. In many cases, a meter will have one battery with low current yet as a unit the meter still registers acceptable in the battery test mode. This meter is unreliable in the field. To eliminate this problem, a battery

tester is available in the Health Physics Instrument Section and should be used to test each meter's batteries individually. Depleted batteries should be replaced with new batteries as needed. Replacement batteries are available in the health physics supply closet. The individual responsible for meter calibration for the three month period is responsible for ensuring that an adequate supply of batteries is available for use during the next three month period. Additional supplies of replacement batteries may be ordered through the Michigan Division Stock Department (517)636-4726. Adequate supply means an extra four batteries of each type in addition to those necessary to ensure replacement of batteries in all the meters.

Since replacement batteries can be stocked in the supply closet for several months, it is always prudent to test new batteries before placing them into a meter. Additionally, some meters have replacement batteries located within the instrument carrying case that should be tested whenever the meter's batteries are tested.

CALIBRATION SPECIFICATIONS AND QUALITY CONTROL

An adequate calibration of a radiation meter cannot usually be performed with check sources. Frequent checks with check sources will be supplemented at periodic intervals using the two point calibration method. Each scale of the meter will be checked at two points; approximately 25% and 75% of full scale. A survey meter may be considered properly calibrated at one point when the exposure rate measured by the instrument differs from the true exposure rate by less than 10% of full scale (Regulatory Guide 10.5).

Each instrument will be calibrated for gamma radiation using the Eberline multiple source Gamma Calibrator Model 1000 (Appendix I). The Model 1000 calibrator is designed to provide a beam of ionizing radiation internal to a self-contained source shield. On December 12, 1974, the calibrator (Serial No. 112) contained 8 individual sources totaling 143.0998 Ci of Cs-137. The source quantity breakdown was as follows:

Postion Number	Source Serial Number	Test Date	Isotope	Quantity
1	422	12-12-74	Cs-137	88 uCi
2	407	12-12-74	Cs-137	8.2 mCi
3	393	12-12-74	Cs-137	322 mCi
4	254	12-12-74	Cs-137	7.5 Ci
5	410	12-12-74	Cs-137	3.5 mCi
6	399	12-12-74	Cs-137	166 mCi
7	386	12-12-74	Cs-137	3.1 Ci
8	253	12-12-74	Cs-137	132 Ci
			TOTAL	143.0998 Ci

The exposure rate (mR/hr) for each source versus height (inches) in the calibration chamber is given in Table 1. Annually, the values contained in Table 1 must be updated to account for radioactive decay of the sources (2.284% change per year). Refer to the technical manual for source decay correction procedures. The actual calibration curves for each source and positions is found in the back portion of the technical manual for the Model 1000 (Serial No. 112) provided by Industrial Reactor Laboratories, Incorporated, of Plainsboro, New Jersey, the manufacturer. A description of the initial calibration procedure performed by Industrial Reactor Laboratories is also found in the technical manual. Instructions for operating the calibrator are found in Appendix I.

Periodically, the calibrator, itself will be checked using a secondary standard, the Victoreen Condensor R-meter Model 570. This quality control check of the calibrator measures exposure rates for the various sources at a set height. The R-meter is used in conjunction with the Victoreen Model 621 chamber which has a range of 0-100 R, with ±5% accuracy for energies 800-1300 keV (effective). The procedures for the quality control measurements and results are kept on file in the Industrial Hygiene Laboratory, 1803 Building.

Calibration procedures for the meters are located in Appendix II.

* If an instrument does not read within ±10% of the full scale deflection, the reading may be corrected by adjusting the meter's potentiometer(s) or calibration pod(s). The potentiometers are located in different locations for each meter. Some are located within the instrument housing or on the outside of the meter and some meters have no potentiometers readily avaliable. If a meter reading cannot be adjusted, the instrument will have to be returned to the manufacturer (or similar service) for repairs or adjustment and calibration.

BETA CORRECTION FACTOR (BCF)

The BCF is used when surveying beta radiation sources to correct for the meter's insensitivity to beta radiation. A BCF for the meters is obtained by using a depleted uranium source which give a constant reading of 220 mR/hr. The BCF calculation is outlined in Appendix II.

CALIBRATION TAG

A sticker indicating the calibration date, battery condition, silica gel condition (if applicable) and the initials of the individual who calibrated the instrument will be attached to the side of the meter housing. This practice provides a convienent mechanism for spot checking radiation meters for adequate calibration dates.

METER MALFUNCTIONS

Identify all radiation meters that are malfunctioning. If the instrument cannot be repaired or the malfunction corrected, the meter and a written explanation of the problem will be sent to the manufacturer. The manufacturer will repair, recalibrate, and return the instrument. It is the responsibility of the individual in charge of meter calibrations for the 3 month period to identify all meters that are in need of repair.

METER LOAN-OUT SHEET

A loan-out sheet is posted on the bulletin board near the radiation meter cabinet. It is used wherever a meter is reserved in advance for a particular day or whenever a meter is loaned to Dow employees, returned to manufacturer etc. It is not only beneficial to know the location of a meter but it may also prevent a meter from becoming an "accidental" permanent loan. If a group or individual needs a meter continually, a meter will be temporarily loaned but the involved party should buy one for their own use.

CONTRACTED METER CALIBRATION

In addition to calibrating the health physics meters, Industrial Hygiene personnel also performs meter calibration services for many other groups, some at the Midland location and some away. For those groups in the Midland location, a charge number is available. Groups away from the Midland location must furnish a purchase order.

CONCLUSION

In summary, it is important to reiterate that radiation meter calibration is vital function of Dow's radiation protection program. Use of a faulty meter is not only dangerous but could consitute a violation of Dow's radioactive materials license.

APPENDIX I

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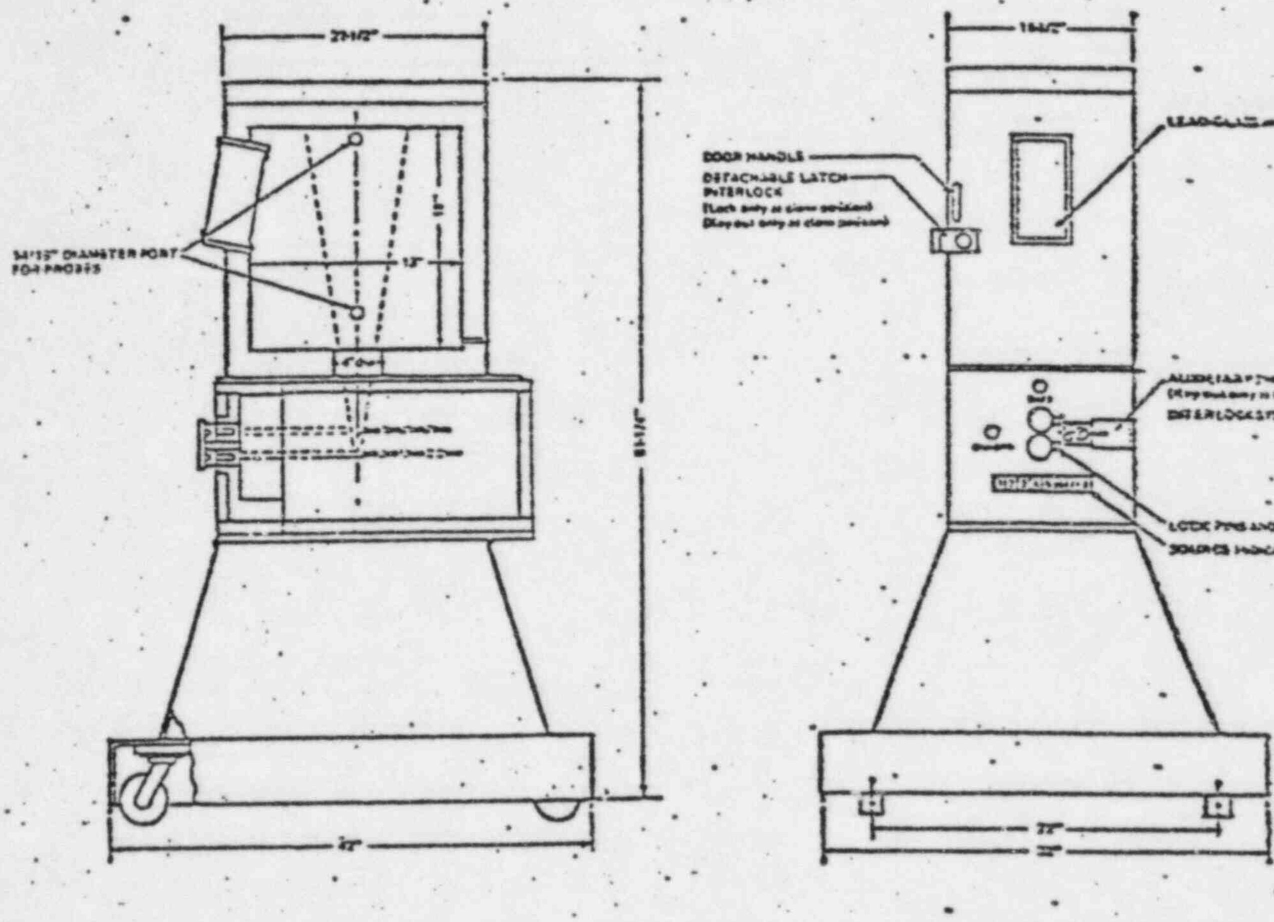
MULTIPLE SOURCE GAMMA CALIBRATOF

MODEL 1000

EBERLINE INSTRUMENTS
DONALD MILLER - 312-697-0123
546 RANDALL ROAD
ELGIN, ILLINOIS 60120

GENERAL

The Model 1000 Multiple Source Gamma Calibrator is designed to provide a beam of ionizing radiation internal to a self-contained source shield for the calibration of radiation detection instruments. The Calibrator is designed for beam utilization vertically upward. The Model 1000 consists basically of two source drawers which move through a cylindrical shield and, an exposure chamber (lead safe) with lead-glass window; all mounted on a castered base. The sources are SAFE with the drawers in the IN position and EXPOSED when OUT: source transfer from the SAFE position is accomplished manually.



1. The Model 1000 is self-contained and meets all DoT-55 shipping requirements for shipment when loaded with Cesium-137.

2. Before shipment, the Instrument Calibrator is loaded with Cesium-137 which is double encapsulated in heliarc-welded stainless steel capsules, IRL Source capsule, Model CS-2.

3. Provision is made for lifting the Instrument Calibrator by forklift.

4. Approximate dimensions are:

   a. Height – 65 inches.

   b. Width – 32 inches (base).

   c. Length – 42 inches (base).

   d. Weight: – 3,000 pounds.

1. Lead shielding is free of voids and pitholes.

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2. All steel encasing the lead is carbon steel on the external surfaces minimum of 3/16" thick (finished as below), and corrosion-resistant steel or other corrosion-resistant materials on the internal portions surrounding the source. The exposure chamber is fabricated of 1/8" thick steel; all closures are effected by welding.

FINISH

All carbon steel is painted with zinc chromate primer enamel finish. Metal is properly prepared prior to painting. Finish color will be desert beige.

DOSE RATE

The total source size may range up to 175 curies. Sources supply an unscattered radiation dose rate from 0.1 mR/hr to 600 R/hr. Source dose rate is 1,000 R/hr at one-half inch above the exposure chamber base.

RADIATION BEAM

The Calibrator is designed to provide a collimated radiation beam. The beam size is a maximum of 18° included angle with a shield exit diameter of 4.0" maximum.

EXTERNAL RADIATION LEVELS

The Calibrator is designed to meet the requirements of 10CFR20 and NBS Handbook 73. The surface radiation level averages 2.0 mR/hr and averages less than 0.1 mR/hr at one meter from the source with no point higher than 1.0 mR/hr per 175 curies Cesium-137.

EQUIPMENT

1. Standard

a. Solid lead beam port plug.

b. Kirk Company one-key interlock system.

c. Indicator for all sources SAFE and indicators for sources EXPOSED. 115 VAC power.

d. High intensity magnetic base lamp for chamber illumination. 115 VAC power.

e. Swivel casters (2 with locks).

f. Instrument fixtures for correct positioning within chamber.

g. Two (2) access ports at chamber side for Eberline "Teletector" Model 6112 and/or cables.

RADIATION SAFETY

1. Model 1000 shall not be operated by unauthorized personnel.

2. Leak test wipes may be taken on the front surface of the Calibrator where the source drawer actuation rods exit the shield. This should be done with the source drawers in the EXPOSED positions.

3. It is not possible to remove the source drawer with normal tools.

4. In the event of damage or malfunctions:

a. Keep chamber door closed and place "Danger High Radiation Field" sign on source drawer actuation rod.

ORIGINAL

6. Notify Radiation Safety Officer.

OPERATION

The source is manually actuated to the EXPOSED position as follows:

1. Plug power cord into 115 VAC outlet. Depress ON-OFF breaker switch; SAFE light should illuminate.

2. Using provided key, open chamber door.

3. Place instrument to be calibrated above beam port using appropriate fixture. Direct light such that instrument me[illegible] scale is properly visible.

4. Close door and remove key.

5. Place key into source drawer lock and actuate; SAFE light should go out.

6. Pull out desired source drawer actuation rod until appropriate source indicator is illuminated.

7. The source is now EXPOSED.

8. Note the instrument reading. Instrument should read per instructions manual calibration procedures.

9. The source is returned to a SAFE position by pushing IN on the actuation rod.

10. The source drawers are locked into a SAFE position by the actuating key. Safe light should illuminate.

11. Remove key, open chamber door as above and adjust instrument per manufacturer's calibration instructions.

12. This cycle may be repeated as necessary or a new instrument placed in chamber.

CERTIFICATION

1. Source calibration information for the Cesium-137 sources at various cavity positions will be provided. Measureme[illegible] are made using the Landsverk Electrometer Model L-64 Roentgen Meter or equal. A Source Leak Test Certificate is a[illegible] provided.

2. Warranty Provisions: Eberline Instrument Corporation warrants the Model 1000 Multiple Source Gamma Calibrat[illegible] including sealed radioactive sources, to be free of defects of material and workmanship, and assumes responsibility f[illegible] servicing or replacing the equipment which, under normal operating conditions, proves to be defective within one year [illegible] delivery. The service or replacement will be F.O.B. IRL, Plainsboro, New Jersey, at no charge. This warranty does n[illegible] cover damage resulting from improper use or improper handling of the equipment and the warranty may be void if rep[illegible] has been attempted by unqualified personnel.

3. Unauthorized tampering or modifying the Calibrator or removal of sources or source drawers from the Calibrator [illegible] prohibited.

INSTALLATION

1. The Model 1000 is shipped complete and ready to use, refer to operation instructions.

2. Two copies of operating instructions are provided with delivery of the Model 1000.

ORIGINAL

APPENDIX II

Procedures For Calibrating Radiation Survey Meters Using The Eberline Multiple Source Gamma Calibrator Model 1000

1. Wear radiation dosimeter when performing calibrations and when interacting with groups in other buildings during meter pick-up and return.

2. An inventory of all meters in the Midland location is located in the meter calibration file drawer. Use the inventory to identify the meters that need calibration during the specified time interval.

3. Select a meter to be calibrated and obtain the original calibration sheets from the meter calibration file drawer. The calibration sheets are filed by manufacturer and model number. Figure I is an example calibration sheet. Pay strict attention to serial numbers of the various models.

4. Get the meter from its identified location. Some meters are in the health physics meter cabinet and some meters are in various buildings, other than 1803 Building, being used by different groups. For those meters not in 1803 Building, take a health physics meter as a temporary replacement until the group's original meter is returned to them, after calibration.

5. Check all batteries in the meter using the battery tester. Replace batteries as needed. Stocked batteries taken from the health physics supply closet should also be replaced if the supply is sufficiently low.

6. The meter should be warmed up for approximately five minutes.

7. If possible, zero the meter. Many meters have a "zero" mode and zero adjustment knob identified on the instrument casing. If the zero adjustment knob is identified but no zero mode is available, turn the meters scale switch to the least sensitive scale and adjust the needle to zero deflection.

8. All meters are calibrated by varying the sources and exposure distances inside the calibrator. A table of exposure rates (mR/hr) for each source versus height in the calibration chamber is attached to the front of the calibration chamber door.

9. An interlock key system on the calibrator provides for employee safety. The key controls both the door of the exposure chamber and the release mechanism for the source control rods. When using the interlock key, the exposure chamber door cannot be opened if a source is exposed and vice versa.

   DO NOT ATTEMPT TO DEFEAT THE INTERLOCK SYSTEM.

10. During calibration, the meter is placed inside the calibration chamber with the center of the meter's detector (eg. ion chamber, gm probe) at the desired height. Meters are moved to various heights within the calibration chamber by placing them on an aluminum sheet which is supported by movable brackets. A measuring scale is attached to the inside of the calibration chamber's walls. A hole has been cut in the aluminum sheet above the area of source exposure to eliminate shielding effects.

11. Move the meter to the various heights, and scale identified on the calibration sheet. Exposure desired source and record data.

12. Each scale of the meters will be checked at two points, approximately 25% and 75% of full scale.

13. If a meter reading is more than ±10% of the full scale deflection compared to the true reading, adjust the calibration pods (potentiometers) to correct to true values.

14. Some meters require specialized exposure configurations. Two holes are located on the side of the calibrator that allow an operator to insert equipment. For example, the Teletetor radiation detector has to be inserted through these holes. And a rod used to punch the "read" button of the Xetex digimasters, is also inserted through these holes. A specially constructed jig is used to hold the Xetex meters. Both holes should be covered with the provided lead plugs and locked in place when not in use.

15. A beta correction factor (BCF) may be calculated for most meters. Many meters have a beta radiation shield. When in place, the beta radiation shield prevents most beta radiation from reaching the detector. When not in place, both gamma and energetic beta radiations penetrate the detector. Using the depleted uranium slab source, calculate the BCF as follows:

    a. Take reading (mR/hr) with beta shield off (beta + gamma).
    b. Take reading (mR/hr) with beta shield on (gamma only).
    c. Subtract b from a (beta only).
    d. BCF = 220 mR/hr/c

16. A sticker indicating the calibration date, battery condition, silica gel condition (if applicable) and the initials of the individual who calibrated the instrument will be attached to the meter casing.

17. Place the calibration sheet in the calibration file and return the meter to its original location.

Malfunctioning meters or ones that cannot be calibrated, should be returned to the manufacturer for repair. If a meter leaves the Dow Midland location, please note this fact on the loan-out sheet and on the original calibration sheet.

It is important to recognize that there are many variables involved in meter calibration. These include the detector geometry, the calculated exposure rates and the human factors. As a "rule of thumb", all meters which cannot be adjusted to measure within ±20% of the full scale deflections should be examined and probably returned to the manufacturer. For meters reading in the range of ±10% to ±20% of the full scale deflection, correction factors may have to be applied. All deviations and correction factors will be noted on the calibration sheet and the meter calibration itself. The results of all meter calibrations and quality control checks are kept on file at the Industrial Hygiene Laboratory.

Instrument ____________________ Dept/Loc ____________________

Model Number ____________________ Man Responsible ____________________

Serial Number ____________________

HEIGHT	SOURCE POSITION	ACTUAL EXPOSURE (MR/HR)	SCALE	OBSERVED EXPOSURE (MR/HR)						
DATE										
BATTERIES										
BETA CORRECTION FACTOR										
INITIALS										

COMMENTS ____

TABLE 1. EBERLINE MODEL 1000 MULTIPLE GAMMA CALIBRATOR CS-137

SOURCE # (mR/HR)

Source Activity:	74.83 uCi	6.97 mCi	273.80 mCi	6.38 Ci	2.97 mCi	141.16 mCi	2.64 Ci	112.25 Ci
Inches	1	2	3	4	5	6	7	8
1	11.00	85.5	1955	44802	15.48	529	9775	391003
2	8.14	63.5	1548	35842	13.04	432	7983	325836
3	6.51	48.9	1303	29325	11.00	358	6762	276961
4	5.29	38.3	1059	24438	9.37	310	5702	236231
5	4.07	31.0	937	20365	8.16	265	4806	195502
6	3.35	26.1	774	17103	6.84	228	4154	171064
7	2.68	22.0	676	14663	5.94	196	3666	147034
8	2.28	17.9	587	13033	5.29	171	3258	130742
9	1.87	15.5	513	11404	4.73	155	2851	114449
10	1.63	13.9	448	10590	4.16	139	2606	105896
11	1.45	12.2	399	9368	3.75	122	2363	93678
12	1.30	11.4	358	8146	3.51	110	2118	85532
13	1.22	10.6	326	7657	3.10	106	1955	79829
14		9.8	293	7087	2.85	98	1792	73313
15		9.0	269	6517	2.69	90	1629	68426
16		8.1	253	6109	2.52	82	1548	63537

09/06/83 G. W. Engdahl

CRI NUMBER

DOW CHEMICAL U.S.A.

RESTRICTED: for use within The Dow Chemical Company only.

LABORATORY REPORT CODE

DATE ISSUED: May 9, 1979

DEPARTMENT: Environmental Sciences Research

LAB. NO.: 1 9 1 | PROBLEM NO.: 3 0 0 0 1 8

TITLE: Liquid Scintillation Counting Method for the Radioassay of Wipe Test Samples

27 PAGES IN FULL REPORT

AUTHOR(S): L. C. Lickly   I. T. Takahashi

AUTHOR(S) SIGNATURE(S): L. C. Lickly, 5-8-79   I. T. Takahashi, 5-2-79

REVIEWER'S SIGNATURE: F A K[illegible], 5-9-79

This report is: ☐ INTERIM ☒ FINAL and mainly: ☒ NEW ☐ REVIEW

DESCRIPTIVE SUMMARY WITH CONCLUSIONS: (Include in this space references to data books, and to earlier related reports, patents and publications.)

A general method has been established and validated for assaying a variety of isotopes on wipe test swabs by immersion counting with currently used liquid scintillation counters. The method can be used to assay wipe test samples originating from leak test surveys of sealed radioactive sources and from laboratory surveys for loose contamination, in compliance with NRC regulations. Validation of the method involved calibration of isotope solutions followed by the determination of the counting efficiency of each isotope on swabs in the channel with maximum counts. It was found, for the instruments used in this lab, that with wide window settings, and gain setting of red channel 2%, green channel 10%, and blue channel 50%, the average counting efficiencies for each channel are 88%, 77%, and 32% respectively. The detection limits for the three channels with gain settings of 2%, 10%, and 50% are 5×10^{-6}, 6×10^{-6}, and 14×10^{-6} microcuries respectively. An attempt was also made to determine the effects of color quenching, as often occurs with dirty swab samples. It was found that for wipe test purposes slight color does not seriously affect the quantitative results.

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