UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

OFFICE OF PERSONNEL & EMPLOYEE RELATIONS
SAFETY & RADIATION SAFETY
417 ACADEMY STREET
PHONE: 302-738-8475

June 24, 1981

Mr. John E. Glenn
USNRC
Material Licensing Branch
Division of Fuel Cycle and Material Safety
Washington, D.C. 20555

RE: License No. 07-01579-19
Control No. 07086
Well Logging Amendment

Dear Mr. Glenn:

This is in reference to your letter dated June 2, 1981, requesting additional information regarding the reference amendment.

1. One 48 inch handling tool will be used to manipulate the source. The female end of the tool slips over a square peg on the source and a threaded rod secures the source into tool. The source is then unscrew from the shipping container and screwed onto the logging probe. A drawing of the handling tool is attached.

2. Written instructions to be given to individual authorized to perform well logging operations are attached.

3. Well logging will not be performed to locate potable water.

The users would like to begin field studies in the near future. Your expeditious review of our application will be appreciated.

Sincerely,

Stuart W. Kline

Stuart W. Kline
Assistant Director

SWK/gk

SUPPLEMENT TO ATTACHMENT #12

WELL-LOGGING SECTION

THE UNIVERSITY OF DELAWARE

DELAWARE GEOLOGICAL SURVEY

GEOPHYSICAL LOGGER SUPPLEMENT

USE OF CESIUM-137 GAMMA DENSITY PROBE

RADIATION PROTECTION PROGRAM

The procedures specified in this supplement are intended to ensure compliance with the provisions of 10CFR Part 19, "Notices, Instructions and Reports to Workers; Inspections," and Part 20, "Standards for Protection Against Radiation." These procedures are adequate to provide against potential radiation hazards associated with well logging activities. Contact the Safety Office, 738-8475, if additional information is required.

The Code of Federal Regulations Title 10; Parts 19 and 20, The University of Delaware Nuclear Regulatory Commission License; license conditions or documents incoporated into operating procedures applicable to licensed activities, may be inspected by appointment at the Safety Office, 417 Academy Street (Ext. 8475).

IN CASE OF EMERGENCY CALL: .

Safety Office	738-8475	(Normal Work Hours)
Security Office	738-2222	(Off Hours)
Fire	738-3131	

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

NOTICE TO EMPLOYEES

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

The Nuclear Regulatory Commission (NRC) in its Rules and Regulations: Part 20 has established standards for your protection against radiation hazards from radioactive material under license issued by the NRC; Part 19 has established certain provisions for the options of workers engaged in NRC licensed activities; Parts 30, 40, 50, and other parts containing provisions related to employee protection.

POSTING REQUIREMENTS Copies of this notice must be posted in a sufficient number of places in every establishment where activities licensed by the NRC are conducted, to permit employees to observe a copy on the way to or from their place of employment.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to—

1. Apply these NRC regulations and the conditions of his NRC license to all work under the license.
2. Post or otherwise make available to you a copy of the NRC regulations, licenses, and operating procedures which apply to work you are engaged in, and explain their provisions to you.
3. Post Notices of Violation involving radiological working conditions, proposed imposition of civil penalties and orders.
4. Refrain from discriminatory acts against employees who provide information to NRC.

YOUR RESPONSIBILITY AS A WORKER

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

WHAT IS COVERED BY THESE NRC REGULATIONS

1. Limits on exposure to radiation and radioactive material in restricted and unrestricted areas;
2. Measures to be taken after accidental exposure;
3. Personnel monitoring, surveys and equipment;
4. Caution signs, labels, and safety interlock equipment;
5. Exposure records and reports;
6. Options for workers regarding NRC inspections;
7. Identifies "protected activities" that employees may engage in;
8. Prohibits discrimination against employees who engage in these protected activities;
9. Identifies the Department of Labor as a source of relief in the event of discrimination; and
10. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The NRC regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or in the license. The basic limits for exposure to employees are set forth in Section 20.101, 20.103, and 20.104 of the Part 20 regulations. These Sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air.
2. If you work where personnel monitoring is required pursuant to Section 20.202:
   (a) your employer must give you a written report of your radiation exposures upon the termination of your employment, if you request it, and
   (b) your employer must advise you annually of your exposure to radiation, if you request it.

INSPECTIONS

All activities under the license are subject to inspection by representatives of the NRC. In addition, any worker or representative of workers who believes that there is a violation of the Atomic Energy Act of 1954, the regulations issued thereunder, or the terms of the employer's license with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the appropriate United States Nuclear Regulatory Commission Regional Office (shown on map below). The request must set forth the specific grounds for the notice, and must be signed by the worker or the representative of the workers. During inspections, NRC inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he believes contributed to or caused any violation as described above.

EMPLOYEE PROTECTION

If an employee believes that discrimination has occurred due to engaging in the "protected activities" said employees may, within 30 days of the discriminatory act, file a complaint with the Department of Labor, Employment Standards Administration, Wage and Hour Division. The Department of Labor shall conduct an investigation and shall, where discrimination has occurred, issue an order providing relief to the employee if relief is not provided by other means of settlement.

PROTECTION OF INSPECTORS

The amended Atomic Energy Act, section 235, provides criminal penalties against any individual who kills, forcibly assaults, resists, opposes, impedes, intimidates or interferes with any person who performs any inspections which (1) are related to any activity or facility licensed by the Commission, and (2) are carried out to satisfy requirements under the Atomic Energy Act or under any other Federal law covering the safety of licensed facilities or the safety of radioactive materials. The acts described above are criminal not only if taken against inspection personnel who are engaged in the performance of such inspection duties, but also if taken against inspection personnel on account of such duties.

SABOTAGE OF NUCLEAR FACILITIES OR FUEL

The amended Atomic Energy Act, section 236, provides criminal penalties against any individual who intentionally and willfully destroys or causes physical damage, or attempts to do so, to any production, utilization, or waste storage facility licensed under the act, or any nuclear fuel or spent fuel regardless of location.

UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICE LOCATIONS

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

Regional Offices

REGION	ADDRESS	TELEPHONE
I	U.S. Nuclear Regulatory Commission Region I 631 Park Avenue King of Prussia, PA 19406	215 337 5000
II	U.S. Nuclear Regulatory Commission Region II 101 Marietta St., N.W., Suite 3100 Atlanta, GA 30303	404 221 4503
III	U.S. Nuclear Regulatory Commission Region III 799 Roosevelt Road Glen Ellyn, IL 60137	312 932 2500
IV	U.S. Nuclear Regulatory Commission Region IV 611 Ryan Plaza Drive, Suite 1000 Arlington, TX 76012	817 465 8100
V	U.S. Nuclear Regulatory Commission Region V 1450 Maria Lane, Suite 210 Walnut Creek, CA 94596	415 943 3700

NRC FORM 3
(8-82)

A. GENERAL INFORMATION

1. The well logging source is a 125 millicurie, Cesium-137 sealed source manufactured by 3M Company, model number 3M 4F6B, serial number 1022.

2. Radiation exposure when the source is housed in the shipping container is 10 mr/hr (maximum) at the surface of the container and less than 0.5 mr/hr (average) at 1 meter from the container.

3. Radiation exposure at 1 meter from the unshielded source is 41 mr/hr (maximum).

4. The University of Delaware Radiation Safety Committee has authorized Kenneth Woodruff and/or John Talley, Delaware Geological Survey (DGS) and individuals under their direct supervision to utilize the source.

5. The source is stored in room 18B Penny Hall Annex.

6. Keys to the source are controlled by Kenneth Woodruff and/or John Talley.

7. The University Radiation Safety Officer is Stuart Kline, phone 738-8475.

8. The source shall not be utilized to locate potable water.

B. RECORDS AND MATERIAL MANAGEMENT

1. Copies of the Utilization Logs and records of surveys shall be maintained by the Radiation Safety Officer and DGS.

2. Inventories, personnel exposure records, and leak test results will be maintained by the Radiation Safety Officer.

3. Records and material management will be reviewed on a periodic basis by the RSO and DGS.

C. PERSONNEL MONITORING

1. The individuals on the logging team shall obtain from the Radiation Safety Officer film badges and ring badges prior to the use of the source.

2. Badges shall be worn at all times when the source is transported and/or utilized.

3. Badges shall be stored in a background area when not in use.

4. New badges will be supplied on a monthly basis.

D. LOADING VEHICLE

1. Record date and time of loading on "Utilization Log." Log is maintained in Room 18B Penny Hall Annex near the source.

2. Unlock and unchain source shipping container from retaining bolt.

3. Place source shipping container on handtruck and transfer to logging vehicle.

4. Place source shipping container in designated area in right rear of logging vehicle. Secure source shipping container by placing chain through eye bolts, and lock in place.

5. With GM survey meter, survey radiation levels around vehicle and record results as designated on "Well Logging Survey Form."

6. Advise RSO that the source is being taken off-campus.

7. Drive vehicle to job site.

NOTE: Radiation levels in the passenger compartment should be background (0.02 mr/hr). Shipping container is labeled Radioactive Yellow II; placarding of vehicle is not required. Radiation levels outside the vehicle should not exceed 2 mr/hr (right rear) at contact with vehicle and background (0.02 mr/hr) at 1 meter.

The source shall not be stored in the transport vehicle.

The transport vehicle and well site shall not be left unattended when the source is utilized.

E. WELL SITE PROCEDURES

1. After arriving at well site and before use of the density logging tool, arrange with drilling superintendent to clear the area of additional personnel.

2. Placard "Caution-Radioactive Material" signs at the well site, remove all personnel but logging crew to a distance of 50 feet from logging truck and well head.

3. With GM survey meter, survey and record background radiation at well head on "Well Logging Survey Form."

4. Unlock and unchain source shipping container and orient holder with cap pointed to rear of vehicle.

5. Unlock and remove retaining pin and unscrew cap.

6. Using handling tool, remove source from shipping container (handling tool is turned counter-clockwise), place source in nose of density probe (handling tool is turned clockwise). Make sure source is screwed tightly into tool and all threads are tight.

7. Attach logging cable to density probe.

8. Place probe in well and lower to depth mark (5 feet or 10 feet). Place surface electronics in operation and commence logging (down). Logging may be observed by other personnel while density probe is in the hole so long as the radiation level is at background. Loading procedure should not take more than 10 minutes.

9. At the end of the logging run (up), while probe is at 10 foot depth mark or deeper, again clear area of all personnel but logging crew.

10. Remove probe from hole and unscrew logging cable.

11. Place probe on floor in rear of logging vehicle.

12. Using handling tool, remove source from probe and transfer to shipping container (turn in clockwise direction).

13. Replace retaining pin and lock and replace cap on source holder.

14. Chain and lock source shipping container in the logging vehicle. Unloading procedure should not take more than 10 minutes.

15. With a GM survey meter, survey radiation level at well site and record results an "Well Logging Survey Form."

16. With GM survey meter, survey handling tool and probe for contamination, record result on "Well Logging Survey Form."

17. Leak test the logging tool and handling tool for contamination by rubbing a piece of filter paper along the shaft. Check leak test wipe with GM survey meter for gross contamination, place in envelope and label contents.

18. With GM survey meter, survey radiation levels around vehicle and record results as designated on "Well Logging Survey Form."

19. Report any unusual radiation levels immediately to the RSO, phone: 302-738-8475.

20. Proceed to shop.

F. UNLOADING VEHICLE

1. Unlock source shipping container and place on hand truck.

2. Transfer source shipping container to storage area, 18B Penny Hall Annex.

3. Chain and lock source shipping container in storage area.

4. With GM survey meter, survey radiation levels around vehicle and record results as designated on "Well Logging Survey Form".

5. Record date and time of return on "Utilization Log".

6. Forward a copy of the "Well Logging Survey Form" and the logging tool leak test sample to the RSO.

7. Forward completed copies of the "Utilization Log" to the RSO.

G. EMERGENCIES

In case of emergency (ie. source lost down hole, source rupture, accident, fire or explosion) refer to Geophysical Logger Emergency Procedures.

GEOPHYSICAL LOGGER
EMERGENCY PROCEDURES

Radiation Safety Officer	302-738-8475
University Public Safety	302-738-2222

Vehicle Wreck

In the event of an accident while transporting radioactive materials, the following procedure should be followed:

a. Do not leave the area unattended by qualified personnel.

b. Notify the investigating officer.

c. Notify the Radiation Safety Officer. The RSO will provide special instructions as needed.

d. Monitor the area to determine source integrity.

e. Close off the area if source damage is indicated.

f. The RSO will notify the proper governmental agency.

g. Report all details to the RSO on return.

Fire and Other Emergencies

a. Notify all personnel in the area immediately.

b. Attempt to put out small fires if a radiation hazard is not immediately present.

c. Notify the fire department.

d. Notify the Radiation Safety Officer.

e. The RSO will set up restrictions governing the fire fighting and other emergency activities.

f. Monitor the area to determine source integrity.

g. Close off the area if source damage is indicated.

h. Monitor all persons involved in combating the emergency if source damage is indicated. Advise RSO of results.

i. Prepare a complete history of the accident and report to the Radiation Safety Officer who will in turn report it to the proper State agency.

Leaking Source

a. If a source is leaking, which the logging tool would indicate, shut the operation down.

b. Notify contractor and immediately call Radiation Safety Officer for instructions.

c. Set up control procedures for keeping personnel out of the immediate area until instructions are received from the Radiation Safety Officer.

Procedure For a Lost Source Downhole

a. When a source is lost, notify the well owner that a source is stuck in the well. As soon as possible hand him a drawing of the source and logging tool.

b. Notify the Radiation Safety Officer; he will notify the proper agency involved that a source has been lost and keep them informed of the progress toward recovering the source. The RSO will provide other instructions as needed.

c. Where practical, everyone should leave the area, except the driller and enough personnel to cover the hole.

d. Attempt to fish probe out of the hole.

e. If abandonment of a source appears imminent, the RSO notifies the Nuclear Regulatory Commission and State by telephone. We then attempt to determine which line of action is to the best interest of all concerned and present a packaged proposal to the agencies for final approval or further recommendations.

f. Abandonment of a source in a dry hole is simple. All records, including those of the State agency issuing permits for or controlling the drilling of oil and gas wells, should contain information regarding the depth, date, type and quantity of radioactive materials. The wellhead, if left above the surface, should contain the same information on an engraved durable metal placard.

g. A source left below a producing zone presents little difficulty. In most cases the normal cementing of the production string of casing or tubing will isolate the source (Figure 1). If the well is to be produced from open hole completion, cement should be spotted around and/or above it to prevent the movement of fluids past the capsule and eventual destruction of the capsule through abrasion (Figure 2).

h. In questionable cases the life of the capsule and the solubility of radioactive materials might influence the acceptance of the proposal. (The source capsules have an estimated life of 500 years in undisturbed salt water. The solubility of the radioactive materials is on the order of one part per billion per week.)

i. Production of gas, water or oil past a source should be prohibited unless the capsule is protected from abrasion. Casing or tubing should be adequate. The spotting of cement, if practical and feasible, adds to the protection (Figure 3). Care should be taken in setting casing past the location of the tool to avoid dislodging it. A gamma ray survey run after the casing is below the zone will give assurance that the tool and source will not be encountered and damaged at a lower level.

j. In the event a source is left in a producing zone it should be cemented in place, if possible. Extreme caution should be used in side tracking to avoid reentering the original hole and damaging the source container (Figure 4). Normally, the source is at or near the bottom of the tool. If there were sufficient clearance to place cement around the source the tool would, in most cases, be retrievable. However, the drilling mud would probably harden in a short time to prevent appreciable flow of fluids by the source. In addition, the separation between the new and original hole would reduce the rate of flow at the tool to a very small figure. It is recommended that the new and old holes be separated by at least 15 feet to preclude any possibility of damage to the source by perforating.

Summary

a. All precautions should be taken to avoid rupture of a radioactive source during fishing operation. Although the source has been pressure tested, it is small and will not withstand milling, drilling or pounding fishing operations.

b. A radioactive source which is intact may be safely abandoned in the well. The decision as to whether to abandon a tool with a source would be based on the accepted considerations for abandoning any other type tool. Added guidelines are the safety aspect, the proper placarding of the well and entering the information in the well records.

c. There should be no costly delay in obtaining approval to abandon a radioactive source inasmuch as the University keeps the agencies well advised of the progress of the fishing operations as events develop.

d. It is the responsibility of the University to notify the regulatory agencies and make all reports.

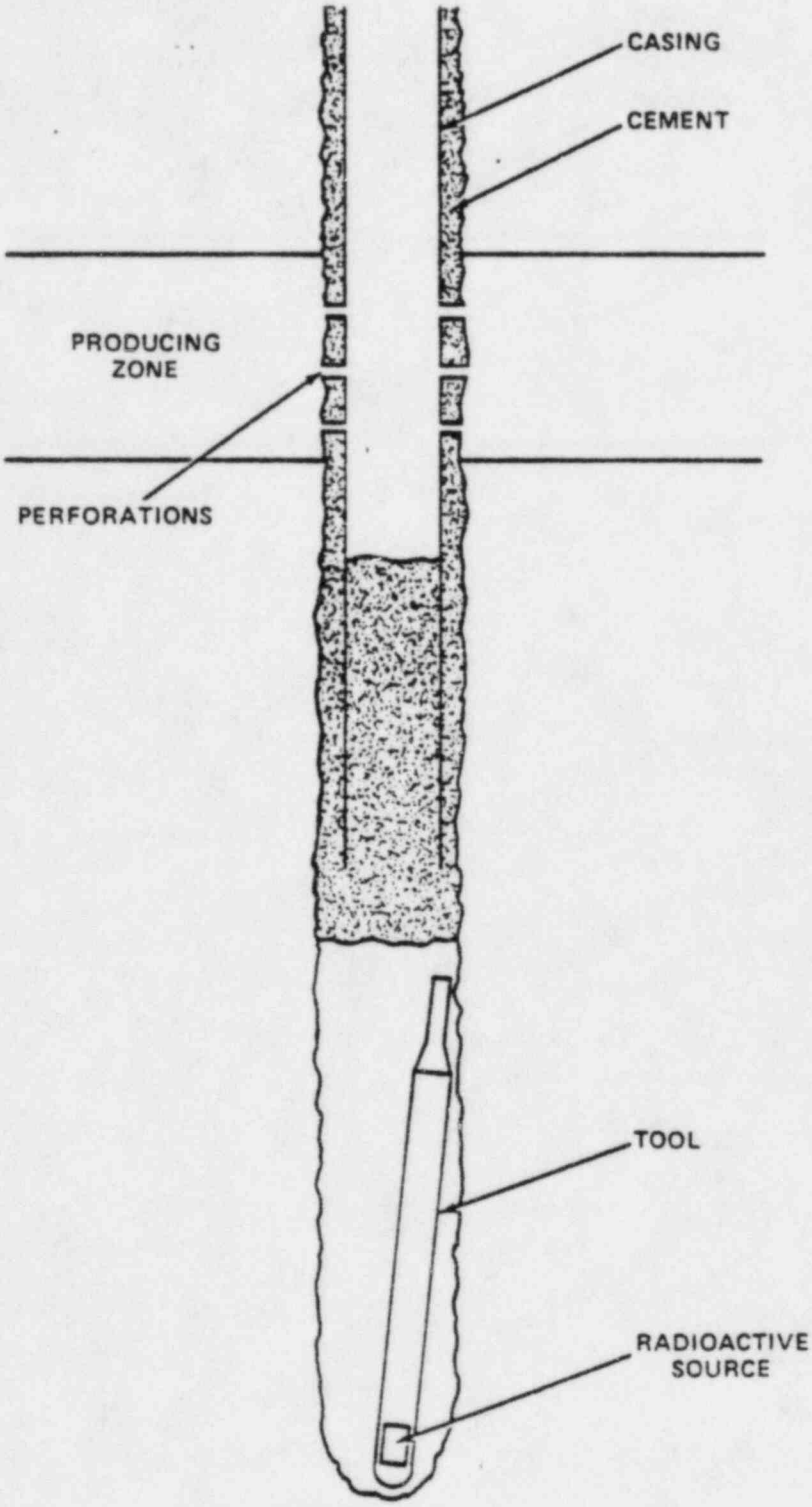

CASING
CEMENT
PRODUCING ZONE
PERFORATIONS
TOOL
RADIOACTIVE SOURCE

FIGURE 1

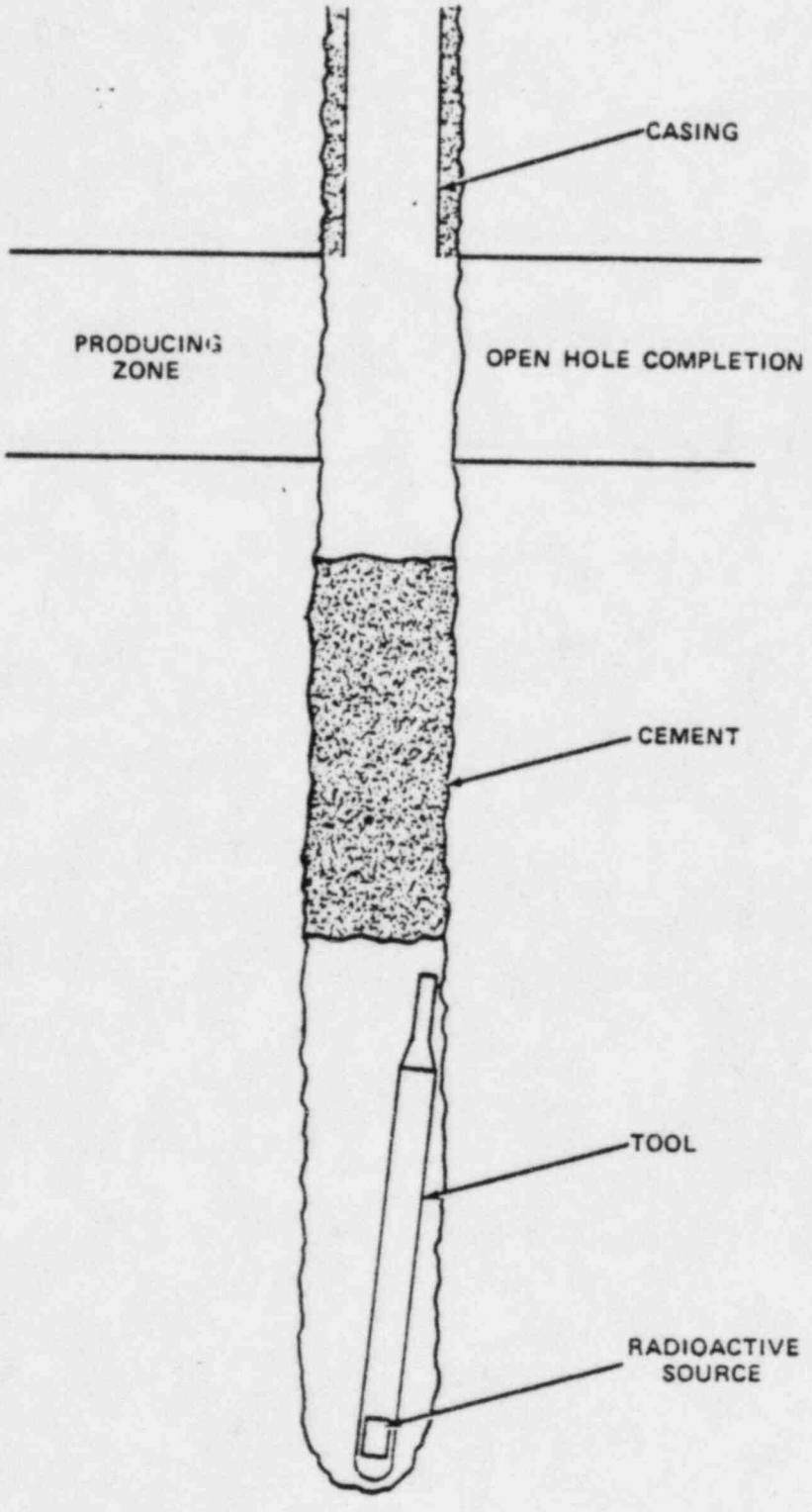

CASING
PRODUCING ZONE
OPEN HOLE COMPLETION
CEMENT
TOOL
RADIOACTIVE SOURCE

FIGURE 2

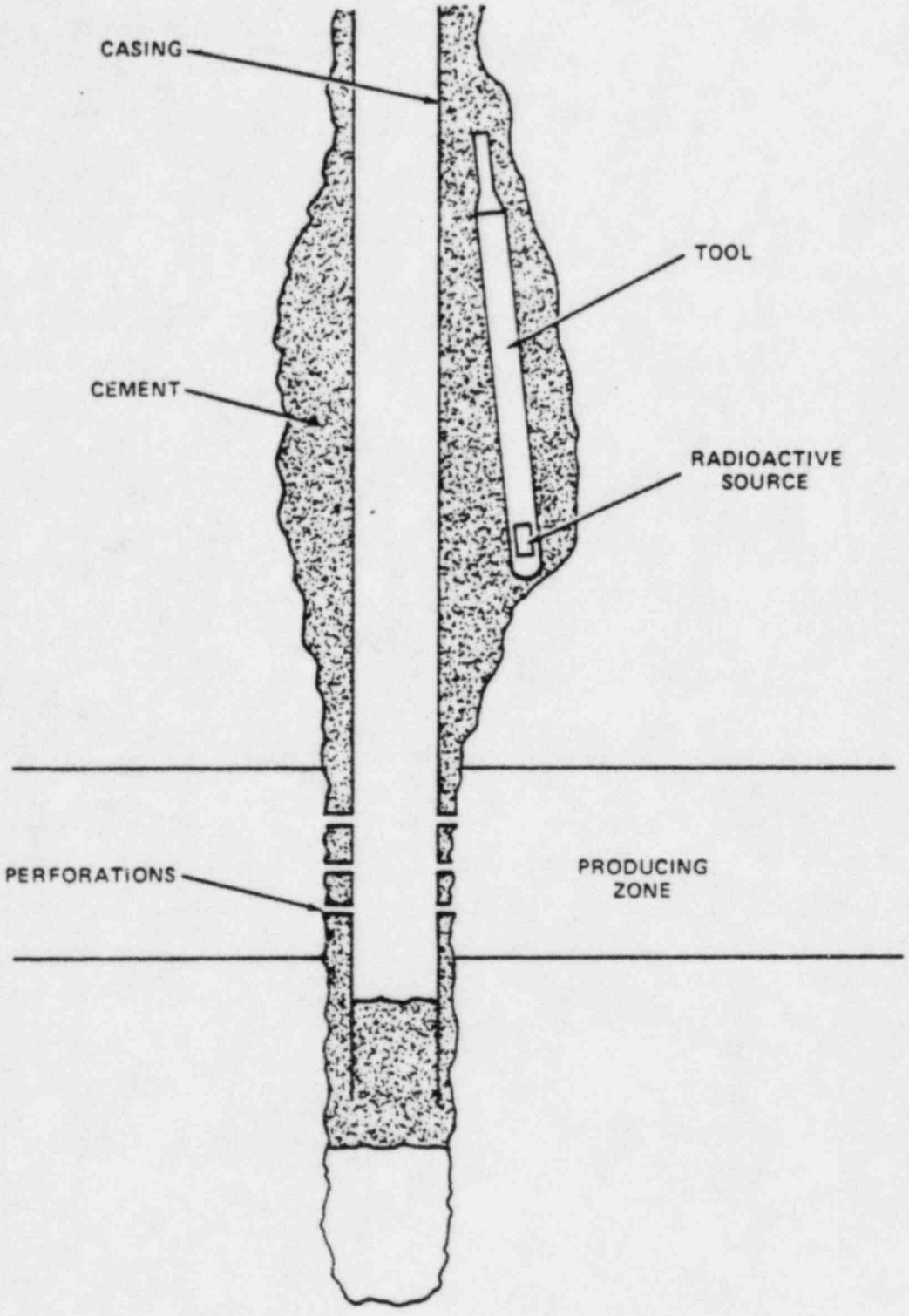

CASING
TOOL
CEMENT
RADIOACTIVE SOURCE
PERFORATIONS
PRODUCING ZONE

FIGURE 3

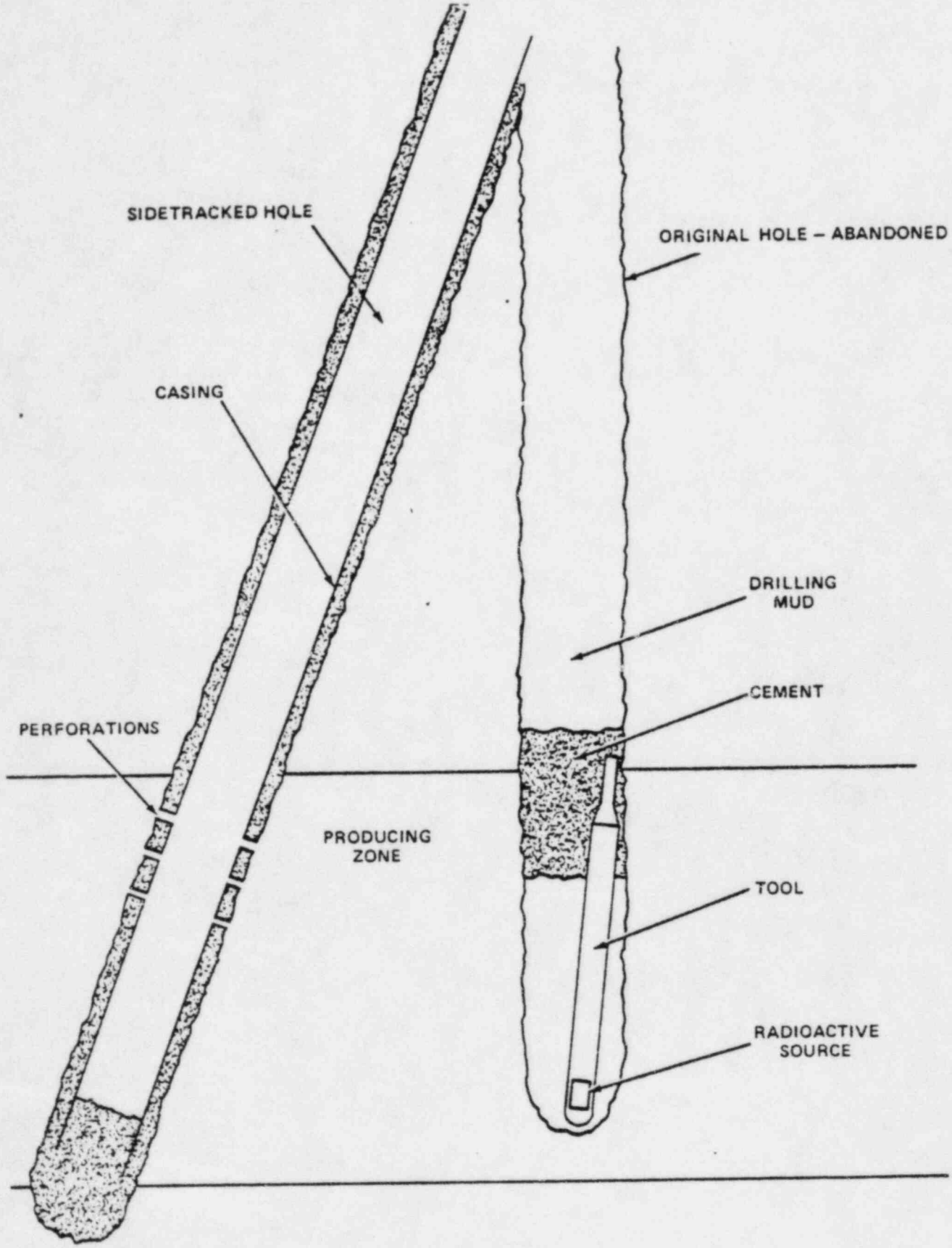
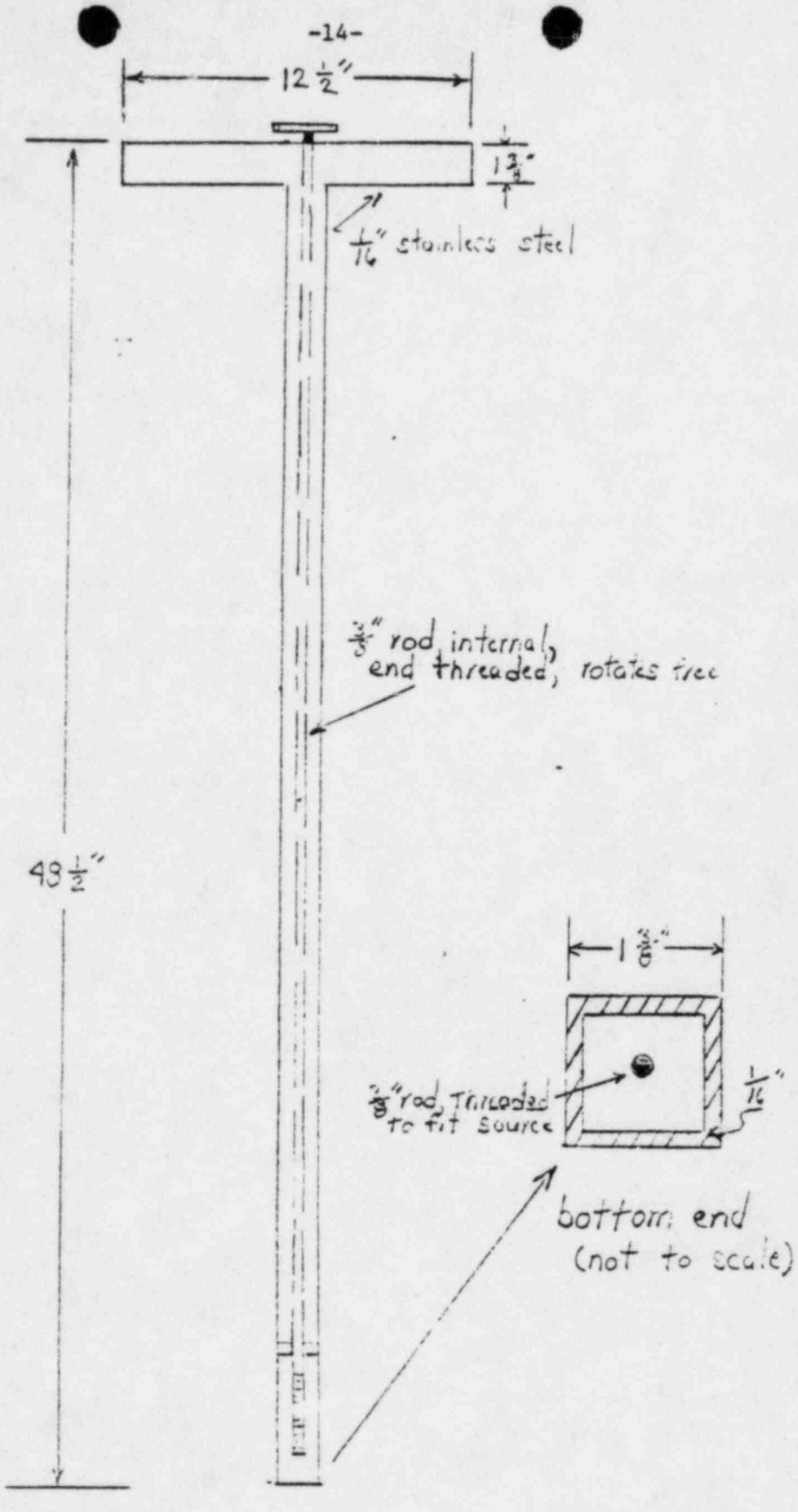


FIGURE 4



SOURCE HANDLING TOOL

ML18

UNIVERSITY OF DELAWARE
DELAWARE GEOLOGICAL SURVEY
CS-137 WELL LOGGING SOURCE
UTILIZATION LOG

Month of _____ 19 ____

SOURCE NO.	DATE AND TIME REMOVED	LOCATION USED	DATE AND TIME RETURNED	TRUCK NO.

Distribution: Original - DGS
Copy - Safety Office

UNIVERSITY OF DELAWARE
WELL LOGGING SURVEY FORM

I. SITE INFORMATION

Company _____ Well No. _____
Field _____ County _____
Drilling Supervisor _____ State _____
Other Information: _____

_____

II. UNIVERSITY OF DELAWARE PERSONNEL

1. Name _____ Film Badge _____ Ring Badge _____
2. Name _____ Film Badge _____ Ring Badge _____
3. Name _____ Film Badge _____ Ring Badge _____
4. Name _____ Film Badge _____ Ring Badge _____

III. SURVEY INSTRUMENT

Manufacture _____ Model No. _____
Serial No. _____ Date Calibrated _____

IV. MONITORING PROCEDURE BEFORE LEAVING SHOP TRUCK-LOADED

Background Rate _____ mr/hr Source No. _____ Isotope _____
mr/hr at 6 inchs from shipping container _____ mr/hr Source Secured _____
Survey Results: Passenger Compartment _____ mr/hr Right Side _____ mr/hr
Left Side _____ mr/hr Front _____ mr/hr Rear _____ mr/hr
RSO notified source is being taken off-campus _____

V. MONITORING PROCEDURES BEFORE OPERATIONS BEGIN

Background Rate _____ mr/hr Well Head _____ mr/hr

VI. MONITORING PROCEDURE AFTER OPERATION COMPLETE

Well Head _____ mr/hr Handling Tool _____ mr/hr Logging Tool _____ mr/hr
Leak Test Taken _____ Exact Location of any Contamination _____
_____
Steps Taken to Remedy _____
_____

VII. TRUCK MONITORING BEFORE LEAVING JOB SITE (LOADED)

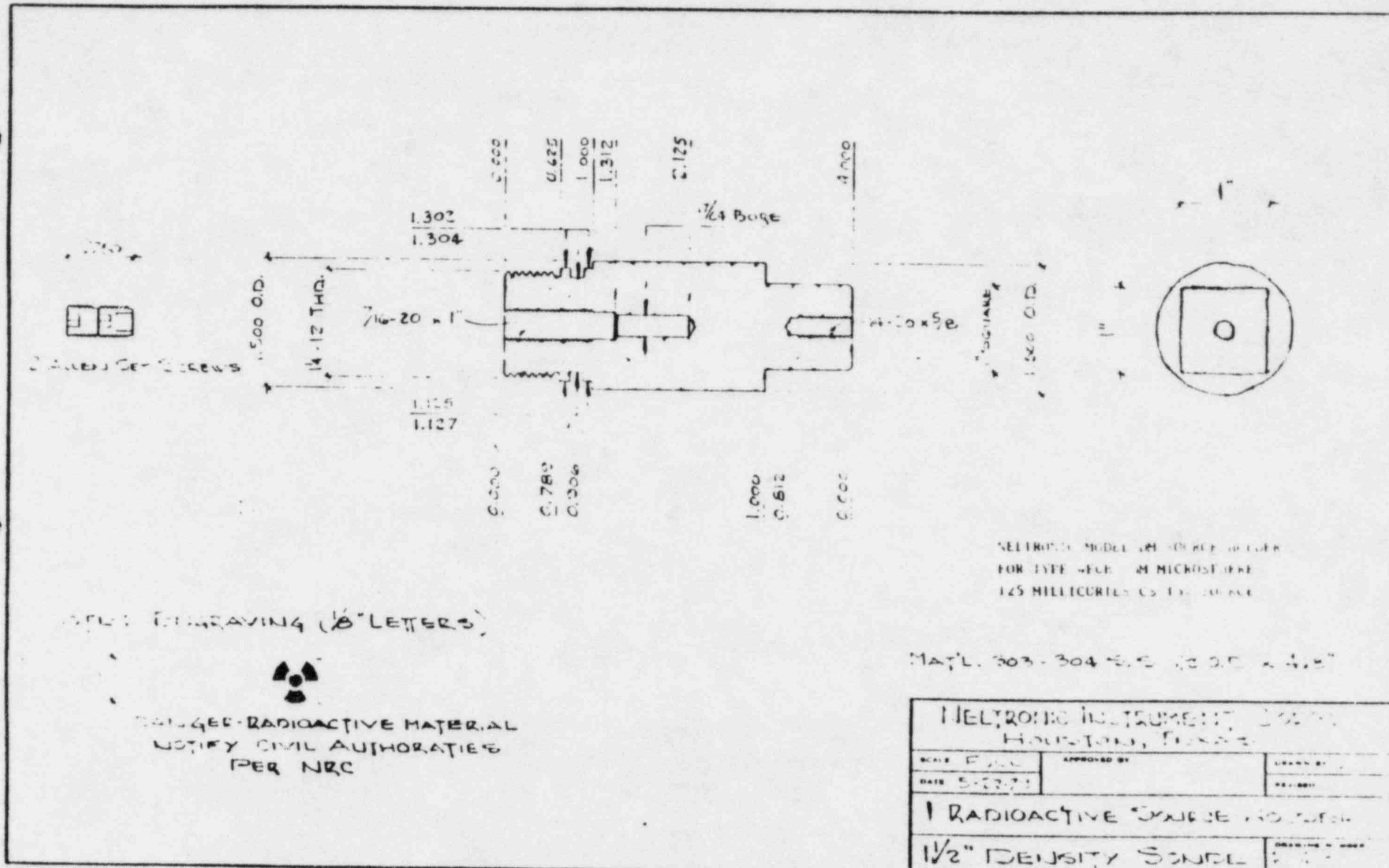
Survey Results: Passenger Compartment _____ mr/hr Right Side _____ mr/hr
Left Side _____ mr/hr Front _____ mr/hr Rear _____ mr/hr

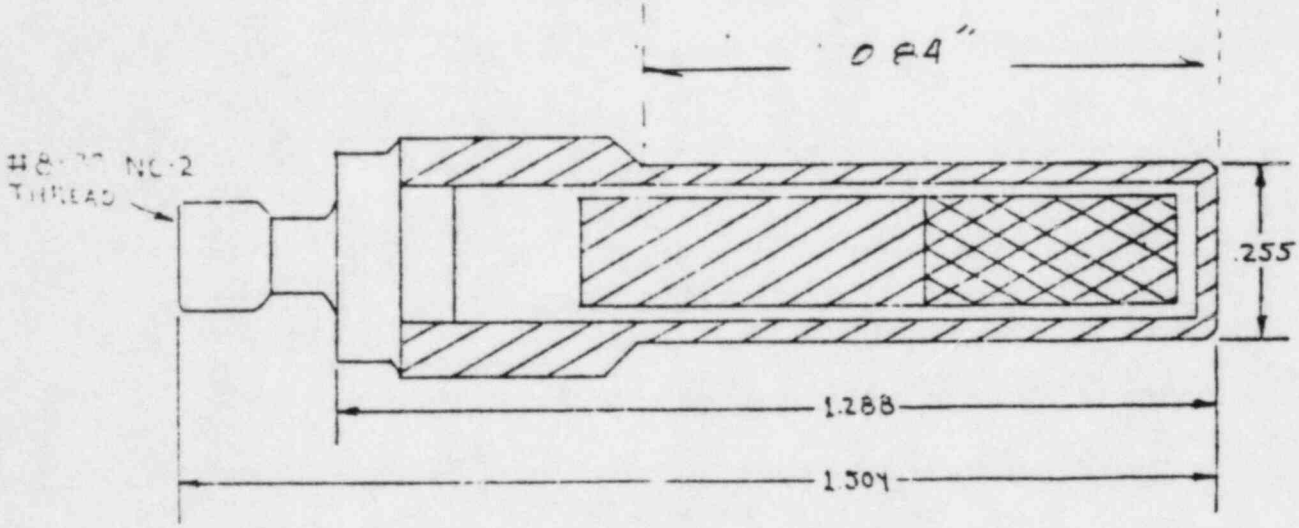
VIII. TRUCK MONITORING AFTER UNLOADING AT SHOP

Survey Results: Passenger Compartment _____ mr/hr Right Side _____ mr/hr
Left Side _____ mr/hr Front _____ mr/hr Rear _____ mr/hr

Operator _____ Date _____

Distribution: Original - DGS
Copy - Safety Office
Wipe Test - Safety Office


1.302
1.304
1.127
7/16-20 x 1"
1/4 Bore
1.000
1.312
0.625
0.125
1.500 O.D.
0.789
0.812
ENGRAVING (1/8" LETTERS)
DANGER-RADIOACTIVE MATERIAL
NOTIFY CIVIL AUTHORATIES
PER NRC
125 MILLICURIES
1 RADIOACTIVE
1½" DENSITY



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ML10

SUPPLEMENT NO. 2 to ATTACHMENT #12

HANDOUTS

APPENDIX TO REGULATORY GUIDE 8.13

INSTRUCTION CONCERNING PRENATAL RADIATION EXPOSURE

Basic Radiation Exposure Limits

As a worker in an activity licensed by the Nuclear Regulatory Commission (NRC), you may be exposed to more radiation than the general public. The amount of radiation an individual receives is called the "dose" and it is measured in "rems."[1] The average individual in the United States accumulates a dose of 1 rem from natural radiation sources[2] every 12 years. The NRC has established a basic radiation exposure limit[3] for all occupationally exposed adults of 1.25 rems per calendar quarter, which is 5 rems per year. If a licensee has records of your previous radiation exposure history and your total radiation exposure does not exceed an average of 5 rems per year, the regulations currently allow a maximum of 3 rems per calendar quarter (a total annual dose of 12 rems per year).[4] Individuals under 18 years of age and members of the general public are permitted to be exposed to only 0.125 rem per calendar quarter or one-tenth of the occupational limits.

It must be remembered, however, that these limits are for adults. Internationally recognized groups of scientists have considered the special situation that exists when an unborn child may be exposed to radiation as a result of occupational exposure of the mother.

[1]Note: a rem is a measure of radiation dose just as the mile is a measure of distance and the pound is a measure of weight.

[2]Exposure to natural or background radiation comes from cosmic rays (from outer space), from radioactive materials that occur naturally in rock or brick structures, and from radioactive elements present naturally in the food and water we eat and drink.

[3]In the Code of Federal Regulations, Title 10, Part 20, "Standards for Protection Against Radiation," Section 20.101, "Radiation Dose Standards for Individuals in Restricted Areas."

[4]Recent guidance from the Environmental Protection Agency recommends a maximum allowed dose of 5 rems per year rather than 12. This recommendation is included in a proposed rule change by the NRC, which was published for public comment in the Federal Register (44 FR 10388, February 20, 1979).

Recommendations of Scientific Organizations

The scientific organization called the National Council on Radiation Protection and Measurements (NCRP) has recommended that because the unborn[5] are more sensitive to radiation than adults, their radiation dose from occupational radiation exposure of the mother should not exceed 0.5 rem (Ref. 1). The International Commission on Radiological Protection (ICRP) recommends that occupational radiation exposure of women of reproductive capacity be received gradually in small increments so that it would be unlikely for an unborn baby to receive more than 0.5 rem in the first 2 months when a woman may not be aware that she is pregnant (Ref. 2). After a woman knows she is pregnant, the ICRP recommends that she not work in areas where the annual exposure would probably exceed 1.5 rems.

NRC Requirements

All Nuclear Regulatory Commission licensees are required[6] to inform all individuals who work in a restricted radiation area of the risks associated with radiation exposure. This instruction should include information on the risks to the unborn. The regulations also require[7] licensees to keep radiation exposures as low as is reasonably achievable. For radiation protection purposes, the NRC assumes that there is some risk associated with any amount of radiation exposure (down to zero). According to the NCRP, vigorous efforts should be made to keep the radiation exposure of the unborn at the very lowest practicable level during the entire pregnancy.

Therefore, it is the responsibility of your employer to take all practicable steps to reduce your radiation exposure and to keep you informed of the exposures you are receiving.

---

[5]Scientifically, from conception to about 15 days an unborn child is referred to as a zygote; from 15 days until 2 months as an embryo; and from 2 months until birth as a fetus. In this appendix, the term unborn is used to include all three stages.

[6]By the Code of Federal Regulations, Title 10, Part 19, "Notices, Instructions and Reports to Workers; Inspections."

[7]In the Code of Federal Regulations, Title 10, Part 20, "Standards for Protection Against Radiation," Section 20.1, "Purpose."

Your Responsibility

It is your responsibility to decide whether the risks to you or to a known or potential unborn child are acceptable. The following facts will help you make your decision:

1. The first 3 months of pregnancy are the most important, so you should make your decision early.

2. In most work situations, the actual dose received by an unborn child would be less than the dose you would receive yourself because some of the dose would be absorbed by your body.

3. The dose to the unborn child can be reduced, where possible, (a) by decreasing the amount of time you spend in an area where you will be exposed to radiation, (b) by increasing the distance between youself and the source of radiation, and (c) by shielding your abdominal area.

4. If you do become pregnant, you could ask your employer to reassign you to areas involving less exposure to radiation.

5. When your occupational exposure is below the 5 rems-per-year limit, the risk to an unborn child may be small in relation to other day-to-day risks to the unborn during pregnancy. Experts disagree on the exact amount.

6. There is no need to be concerned about sterility, that is, loss of your ability to bear children. The radiation dose required to produce this effect is more than 100 times greater than the Nuclear Regulatory Commission's basic dose limits for adults of 5 rems per year, 1.25 rems per calendar quarter.

7. Even if you work in an area where you receive only 0.5 rem per 3-month period, in 9 months you could receive 1.5 rems, and your unborn baby could receive more than 0.5 rem (the full-term limit recommended by the NCRP). Therefore, if you decide to restrict your unborn baby's radiation exposure as recommended by the NCRP, be aware that the 0.5-rem limit to the unborn applies to the full 9-month pregnancy.

Your Additional Rights as a Worker

It is up to you to compare the benefits of your employment against the possible risks involving occupational radiation exposure to a known or potential unborn child. You should know that the Pregnancy Discrimination Act, an amendment

of Title VII of the Civil Rights Act of 1964, states that "...women affected by pregnancy, childbirth, or related medical conditions; shall be treated the same for all employment-related purposes, including receipt of benefits under fringe benefit programs, as other persons not so affected but similar in their ability or inability to work..." (Ref. 3). In addition, the Equal Employment Opportunity Commission (a Federal agency) is responsible for examining cases for compliance with this Act.

Why the Unborn are More Sensitive

The remainder of this appendix contains a brief explanation of prenatal[8] exposure to radiation in relation to other risks to the unborn during pregnancy.

The unborn baby is more sensitive to radiation than the adult because of its rapid rate of development. At certain times during development, those cells forming a specific organ or body function are dividing very rapidly and therefore are most likely to be damaged. In addition, the unborn's organs and systems for fighting infections and harmful substances are not yet developed (Ref. 4).

Four to six percent of the live births show some birth defect. Most often it is not possible to say what caused a particular birth defect. Out of 100 children born with birth defects, 2 to 3 can be attributed to drugs and chemicals. Defects in the genetic material[9] of the parents are thought to cause another 25 out of 100 birth defects (Ref. 5). About 1 out of 3 naturally aborted fetuses show abnormal genetic material (Ref. 6). Other factors in the mother's life (including the exposure of the unborn to naturally occurring radiation) are thought to cause another 6 out of 100 birth defects. However, it is not known what causes the remaining birth defects, that is, about 65 out of 100 (Ref. 5). It is estimated that 70 out of 100 fertilized eggs will not result in the birth of a living infant (Ref. 7).

Prenatal Radiation Risk Compared to Other Risks

Some common activities once considered safe have now been shown to be harmful during pregnancy (see Table 1). Alcohol has been said to be the most

[8]Prenatal means prior to birth, while the unborn child is in the mother's uterus.
[9]Substance involved in reproduction or the passing down of traits from parents to their children.

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TABLE 1

EFFECT AND FREQUENCY OF CERTAIN MATERNAL FACTORS ON PREGNANCY OUTCOME

Maternal Factor	Pregnancy Outcome	Rate of Occurrence
German Measles[a]	Defects of: heart, lens of the eye, skeletal muscles, inner ear, teeth.	2 in 3
Cigarette Smoking[b]	In general, babies weigh 5 to 9 ounces less than average babies.	
Less than 1 pack per day	Infant death	1 in 5
Pack or more per day	Infant death	1 in 3
Alcohol Consumption[c]		
2 drinks per day	Babies weigh 2 to 6 ounces less than average babies	
2 to 4 drinks per day	Signs of fetal alcohol syndrome (growth deficiency, brain dysfunction, characteristic facial signs)	1 in 10
4 or more drinks per day		1 in 5
Chronically alcoholic		1 in 3 to 1 in 2
Maternal Age[d]		
20 years	Down's Syndrome (mental and physical growth retardation)	1 in 2300
35 to 39 years		1 in 64
40 to 44 years		1 in 39
Aspirin[e] (Salicylates)	Clubfoot	1 in 13
High Altitude[f]		
Mean altitude:		
263 feet	Low birth weight (higher risk); babies weigh less than 5½ pounds	1 in 15
5000 feet		1 in 10
10,500 feet		1 in 4

Radiation[g]		
Childhood Cancer:		
1 rem	Childhood leukemia deaths before the age of 12 years	1 in 3333
1 rem	Deaths from other childhood cancers before the age of 10	1 in 3571
Bomb exposure at 4-13 weeks gestation:		
From 15 to greater than 100 rads[h] (Hiroshima) Greater than 150 rads (Nagasaki)	Small head size with severe mental retardation at exposures greater than 25 rads	1 in 4

a. G. Tondury, "The Virus as a Danger to Human Embryos," Teratology Symposium, Como, Italy, October 1967, edited by A. Bertelli, L. Donati, Excerpta Medica Foundation, Amsterdam, 1969.

b. M. B. Meyer and J. A. Tonascia, "Maternal Smoking, Pregnancy Complications, and Perinatal Mortality," American Journal of Obstetrics and Gynecology, Vol. 128, no. 5, pp. 494-502, July 1, 1977.

c. D. W. Smith, "Alcohol Effects on the Fetus," Progress in Clinical and Biological Research, Vol. 36, pp. 73-82, 1980.

d. "Preventability of Perinatal Injury," Progress in Clinical and Biological Research, edited by K. Adamson and H. A. Fox, Alan R. Liss, Inc., New York, 1975.

e. I. D. Richards, "A Retrospective Inquiry into Possible Teratogenic Effects of Drugs in Pregnancy," Advances in Experimental Medical Biology, Vol. 27, p. 441, 1972.

f. D. Grahn and J. Kratchman, "Variation in Neonatal Death Rate and Birth Weight in the United States and Possible Relations to Environmental Radiation, Geology and Altitude," American Journal of Human Genetics, Vol. 15, pp. 329-351, 1963.

g. National Academy of Sciences, Report of the Committee on the Biological Effects of Ionizing Radiation (BEIR-80 Report), "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Washington, D.C., November 1980.

h. Rads and rems are measurements of radiation dose. For some types of radiation, such as those present at the bombings, a given dose of rads might equal a larger dose of rems. The experts are not sure.

common chemical causing infant malformation and mental retardation (Ref.). The full "fetal alcohol syndrome" seen in 30 to 50 out of 100 mothers who were heavy drinkers (8 or more drinks per day) shows growth problems, brain dysfunction, and subtle facial signs. Symptoms of the fetal alcohol syndrome were seen in the children of 11 out of 100 women who drank 2 to 4 drinks a day during their pregnancies, and in the children of 19 out of 100 women who drank 4 or more drinks a day during their pregnancies.

Babies born to women who smoked cigarettes while they were pregnant weighed less than average babies, which contributes to a higher risk of early death. In addition, higher numbers of natural abortions were seen with these mothers and lower school performance and physical well being were seen in their children when tested at age 7 (Ref. 9). Aspirin, antihistamines, cold remedies, barbiturates, and amphetamines are a few drugs suspected of having harmful effects on the developing baby (Ref. 10). The Food and Drug Administration has warned pregnant women to avoid or reduce their intake of caffeine (found in coffee, tea, and cola drinks) because of animal studies showing related birth defects (Ref. 11).

Radiation also can be harmful to an unborn baby at doses that would have little or no effect on adults.[10] Large doses of radiation (greater than 100 rems) to unborn babies can cause growth retardation, severe birth defects, and even death. Which organ is most seriously affected by radiation depends on the stage of growth at the time of the exposure. For growth defects, the period of greatest sensitivity is between weeks 2 and 12 of a woman's pregnancy. During a large part of this time, a woman may not be aware that she is pregnant.

The BEIR-80[11] report (Ref. 12) discusses the effects of radiation on the growing baby. Small head size was seen in studies of Japanese children who were in the womb when their mothers received doses of atomic bomb radiation

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[10]For a general discussion of risks to adults from occupational radiation exposure, see Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure." A list of additional publications on the biological risks of radiation exposure can be found in the bibliography of this appendix.

[11]The Committee on the Biological Effects of Ionizing Radiation (BEIR) was established by the National Academy of Sciences to report on the effects on populations from exposure to low levels of radiation.

over a very short period of time, greater than 10 rads at Hiroshima and greater than 150 rads at Nagasaki.[12] The reason for the different degree of effect at the two cities is not known. At higher doses, greater than 25 rads, mental retardation was associated with the small head size.

The BEIR-80 report also discussed several studies performed to evaluate an increased risk of cancer (especially leukemia) in children whose mothers had received medical x-ray examinations while pregnant. The BEIR committee concluded that if 100,000 unborn babies were each exposed to 1 rem, up to 62 of the children could get leukemia before reaching 10 years of age. Of these, 37 cases would occur normally regardless of radiation exposure. Therefore, the number of cases assumed to be caused by radiation would be 25. An equal number of other cancers could result from this level of radiation. Other scientific studies have shown a much smaller or zero cancer effect from this level of radiation. Hence, it is not certain that the low doses of radiation actually caused the childhood cancers or if the babies that later developed cancer were for some reason more likely to be x-rayed while in the womb.

The National Council on Radiation Protection and Measurements (NCRP Report No. 53, Ref. 13) questions whether a dose of 5 to 10 rems, received at critical stages in the baby's development (2 to 12 weeks), can cause birth defects or an increased risk of childhood cancer. Therefore, the NCRP recommends that a radiation exposure limit of 0.5 rem to the unborn during the entire pregnancy be set to ensure a reasonable safety factor. The International Commission on Radiation Protection (ICRP) in their report No. 26 gives a similar recommendation (Ref. 2).

Some Radioactive Material Can Be Inhaled or Swallowed

Special care should be taken when a potentially pregnant woman is working with radioactive material that can be inhaled or swallowed. If you are pregnant, this type of radioactive material may enter your body and cross into your baby's body.[13] If you are working with such material, you should talk to the

[12] A rad is a measure of radiation dose similar to the rem. The radiation dose in rads may be converted to the dose in rems. For example, 10 rads at Hiroshima may have been more than 10 rems; the experts are not sure, but the matter is under study.

[13] Much of this information was presented by Steven A. Book in "Health Physics Education for the Pregnant Worker" at the 1980 Health Physics Society Meeting in Honolulu, Hawaii, December 1979.

person responsible for radiation protection at your place of work (such as the radiation safety officer or health physicist, if available) about the following questions:

1. Will the radioactive material be retained in my body?
2. Will the radioactive material cross from my body to my baby's body?
3. How can I avoid breathing or swallowing this radioactive material?
4. How can I get rid of this radioactive material if I get it into my body?

Radioiodine, a radioactive medicine widely used in hospitals for diagnostic and therapeutic purposes and in research laboratories, is a good example of the type of radioactive material that can enter your body. Radioiodine is important in this regard because it easily crosses into the unborn baby's body and may affect its thyroid gland, which starts to function at about the tenth week of pregnancy (Ref. 14). By the time of birth, the amount of radioiodine in each ounce of the baby's thyroid would be higher than that in the mother's thyroid (Ref. 14). In addition, the baby's thyroid is more sensitive than the adult thyroid (Ref. 15). Radioiodine as a gas easily mixes with the air and has been reported to be present in nuclear medicine workers in concentrations several times higher than workers who did not usually work directly with radioiodine (Ref. 16).

Summary of Risks

Occupational exposures to radiation are, for most workers in NRC-licensed activities, well below the established limits. However, qualified scientists have recommended that the radiation dose to the unborn as a result of occupational exposure of the expectant mother should not exceed 0.5 rem because of possible effects on development of the unborn child and an increased risk of childhood leukemia and cancer. Since 0.5 rem per 9 months is lower than the dose generally permitted for adult radiation workers, women workers may want to take special actions to avoid receiving exposures higher than 0.5 rem per 9 months. Similarly, women may stop smoking and drinking during pregnancy or may restrict their intake of drugs and caffeinated beverages -- all to reduce risks to their developing babies.

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16. M. Blum and A. Tuizzi, "Thyroidal I-131 Burdens in Medical and Paramedical Personnel," Journal of the American Medical Association, Vol. 200, p. 184, 1967.

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5. International Atomic Energy Agency, Radiation--A Fact of Life, A-1400, Vienna, May 1980.

6. Lapp, R. and Russ, G., Radiation Risks for Nuclear Workers, Public Affairs and Information Program, Atomic Industrial Forum, Inc., June 1980.

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DOSIMETER INFORMATION

1. The Radiation Safety Office issues film badges to individuals who require them. Each individual must fill out a "Request for Personnel Dosimeter" form which is available in the Radiation Safety Office.

2. The badge, when required, must be worn at all times when the individual is occupationally exposed. It should be worn in a fashion where it will indicate whole body exposure (breast pocket, collar or belt).

3. Badges are issued once per month, usually the 5th.

4. The badge is not to be worn when the individual is undergoing diagnostic or therapeutic radiation exposure.

5. When not in use the badge should be stored in a location away from radiation (anything above background radiation), excessive heat or moisture.

6. Badges that are not returned to the Radiation Safety Office by noon of the second working day after the badge change date shall be considered LATE. THE INDIVIDUAL WILL BE CHARGED A LATE FEE OF $2 FOR A LATE BADGE. Badges that are not returned to the Radiation Safety Office within two weeks after the film badge change date will be considered LOST. THE INDIVIDUAL WILL BE CHARGED $4 FOR EACH LOST OR DAMAGED FILM BADGE.

7. Any individual receiving a reported monthly dose exceeding 100 millirem will be notified by the Radiation Safety Office. The individual will be required to fill out a written Radiation Exposure Report and return it to the Radiation Safety Office.

8. The Radiation Safety Office will provide an individual, upon written request, a copy of his permanent occupational exposure history. Records of exposure will be forwarded to new employers upon written request of the individual.

RCS 101A

STATEMENT OF TRAINING AND EXPERIENCE

Permit Supervisor's Name .....

1. Name ..... Soc. Sec. No. ..... Born .....

2. Type of Training (Circle "Yes" or "No" in Columns I and II. If "Yes" is indicated in either column, complete Columns III and IV).

	I		II		III	IV
	Formal Course		On the Job		Where Trained	Duration of Training
	(circle one)		(circle one)			
(a) Principles and Practices of Radiation Protection	yes	no	yes	no		
(b) Radioactivity measurement monitoring techniques, and instruments	yes	no	yes	no		
(c) Mathematics and calculations basic to the use and measurement of radioactivity	yes	no	yes	no		
(d) Biological effects of radiation	yes	no	yes	no		

3. Formal Courses (If you circled "yes" in Column I for any of the items above, complete this item, listing all courses pertaining to the use of radiation or radioactive materials, atomic and nuclear structure, radiochemistry, radiation biology, nuclear engineering, etc.)

Title of Course	Where Trained	Duration	Course Content
(a)			
(b)			
(c)			
(d)			

4. Experience (List actual use of radioactive materials, details of formal laboratory courses, or on-the-job training)

Nuclide	Maximum Amount (mc)	Where Experience Was Gained	Duration	Type of Use

5. Were you ever monitored for radiation exposure by another employer/institution? Yes __ No __.

Date

Signature ML18

UNIVERSITY OF DELAWARE

RADIATION SAFETY OFFICE

REQUEST FOR PERSONNEL DOSIMETER

DATE STARTED _____ (For RSO only)

BADGE NO. _____ (For RSO only)

All of the information requested below is required by the Nuclear Regulatory Commission. If this requisition is not complete, it will be returned. No badge will be issued without a completed requisition. (Please Print.)

1. Name _____ (First Middle) 2. Maiden Name _____

3. Sex _____ Social Security No. _____ 5. Birthday _____ (Month-Day-Year)

6. Un[illegible]tion _____ (Department) _____ (Building)

[illegible]ork _____ Employee _____

7. [illegible]lty, Staff, Grad. Student Undergrad. (Circle one)

7a. If [illegible]r staff, give name of Faculty member or Supervisor _____

8. Will [illegible]e working with _____ x-rays? _____ radioisotopes? _____ other?

8a. If other - circle one: accelerator; reactor; gamma irradiator; neutron source?

8b. Date of this request _____

9. Have you previously been associated through employment or course work with an employer or University, etc. where you were required to wear a dosimeter (film badge, TLD, pocket ionization chamber, etc.) Do not include any diagnostic or therapeutic radiation exposure. List most recent employer first.

	Employer & Address	Started	Terminated
A.	_____	_____	_____
B.	_____	_____	_____
C.	_____	_____	_____
D.	_____	_____	_____

_____ SIGNATURE OF REQUESTOR

_____ SIGNATURE RADIATION SAFETY OFFICER

UNIVERSITY OF DELAWARE
SAFETY DIVISION

RADIOISOTOPE AUTHROIZED USER
SAFE LABORATORY PRACTICES

DON'T - Work with radionuclides if there are open cuts or abrasions on the body.

DON'T - Pipet by mouth any radioactive solution.

DON'T - Dispose of radioactive material via the sanitary sewer system or via regular trash.

DON'T - Eat, drink, smoke, prepare food, store food and/or apply cosmetics in any laboratory where radioactive material is used or stored.

DON'T - Store food and beverages in the same refrigerator or freezer as radioactive material.

DON'T - Place notebooks, pens or pencils, or other such items in the work area. All items placed in the work area are considered contaminated.

UNIVERSITY OF DELAWARE
SAFETY DIVISION

RADIOISOTOPE AUTHORIZED USER
SAFE LABORATORY PRACTICES

DO - Report any unsafe conditions to the permit supervisor and/or Radiation Safety Officer.

DO - Comply with Federal and University rules and regulations regarding radioactive material.

DO - Use radioactive material in approved locations.

DO - Wear protective gloves, lab coats, and respiratory protection (if required).

DO - Label containers indicating nuclide(s), amount(s) and date(s).

DO - Minimize the time, maximize the distance and use shielding when using radioactive material.

DO - Wear personnel dosimeters as instructed.

DO - Cover all work areas with absorbent paper.

DO - Use a hood or glove box if atmospheric distribution is expected.

DO - Conduct trial runs with non-radioactive material. Work out problems in experimental protocol.

DO - Check work areas for contamination daily when radionuclides are used.

DO - Maintain good housekeeping practices.

DO - Know the hazards associated with the radionuclides you are using.

DO - Report all spills, accidents, loss and thefts of radioactive material to the permit supervisor and the Radiation Safety Officer.

DO - Label contaminated equipment and avoid cross contamination.

DO - Use auxiliary containers and trays lined with absorbent paper.

DO - Maintain security of radionuclides in use and storage.

DO - Keep exposures as low as reasonably achievable.

DO - Dispose of radioactive waste in proper containers. Expedite waste removal from the lab.

DO - Survey hands, shoes, body and clothing for radioactivity and remove any contamination before leaving the laboratory.

DO - Submit urine or blood samples, as required, be monitored for thyroid uptake of iodine, as required.

Guidelines for Iodine 125 & 131

The problems of storage, handling and use of radioactive iodine compounds have been discussed recently by the Radiation Safety Committee. Due to this concern the following guidelines are recommended for those permit supervisors and authorized users who are or will be using radioactive iodine. (Especially as NaI for protein iodization)

A. Please note that one requirement stated in our N.R.C. license is that anyone handling and using in an experiment 10 mCi of radioiodine as I-125 or I-131 shall submit a urine sample for bioassay to the Radiation Safety Office 24 hours before such use and a urine sample shall be again submitted 24-48 hours after such use.

1. Physical properties

I-125 - physical half life, approximately 60 days
biological half life, approximately 20 days
soluble maximum concentration in air = 5×10^{-9} uCi/ml
soluble maximum concentration in water = 4×10^{-5} uCi/ml
maximum permissible body burden thyroid approximately 0.3 uCi
major radiations - gamma 0.035 MeV
e^- 0.004, 0.03 MeV

I-131 - physical half life, approximately 8 days
biological half life, approximately 24 days
soluble maximum concentration in air = 9×10^{-9} uCi/ml
soluble maximum concentrations in water = 6×10^{-5} uCi/ml
maximum permissible body burden thyroid = 0.7 uCi
major radiations - gamma 0.364 MeV (82%)
β^- 0.606 MeV maximum average
e^- 0.046, 0.330 MeV

2. Storage

It is recommended due to the increased chemical diffusion properties of iodine when frozen or refrigerated, that iodine compounds not be stored in freezers or refrigerators, but rather at room temperature within the confines of a hood.

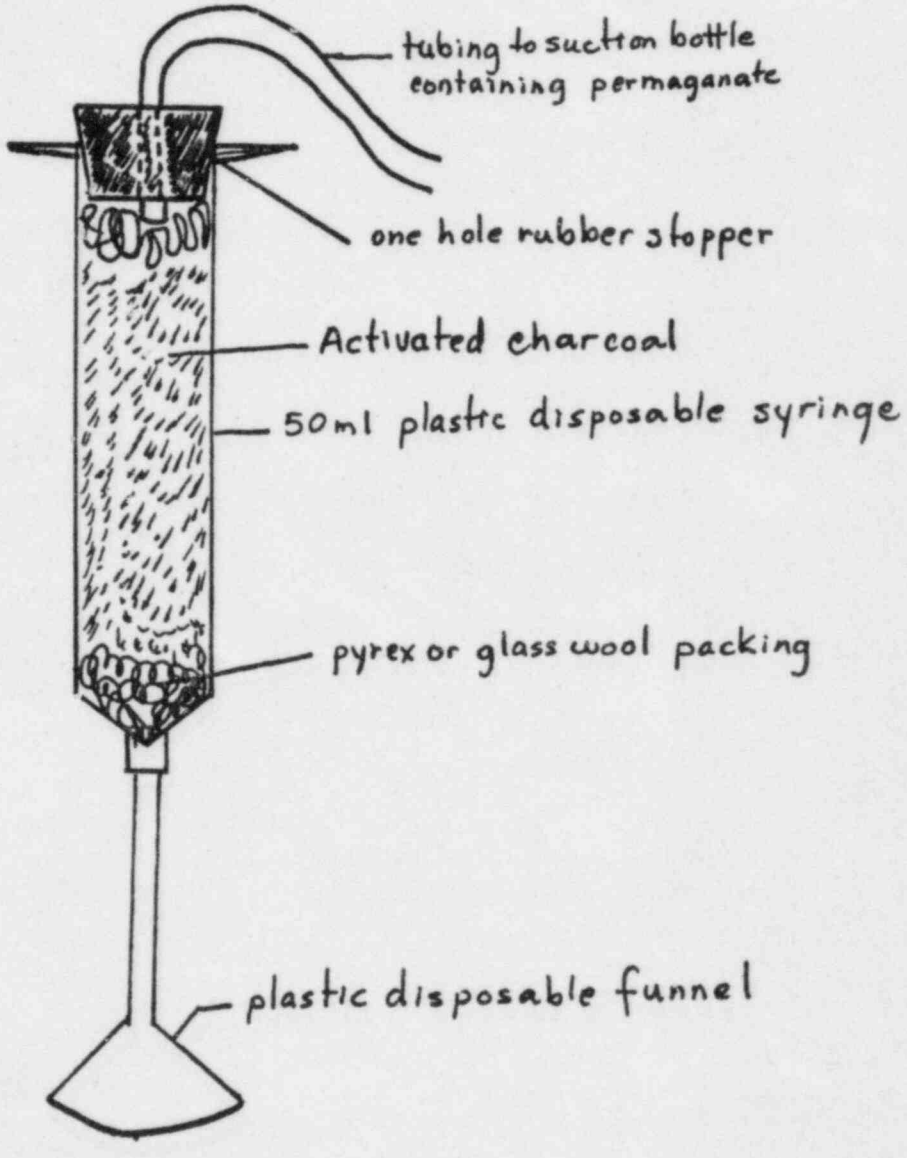
3. Handling and Use

Gloves: Contamination of the fingers has been noted even when wearing 2 pairs of polyvinyl (surgical) gloves. It is recommended that 2 pairs of polyethylene disposable gloves be used due to a greatly reduced permeability of polyethylene. The outer pair should be changed frequently to avoid recontamination.

Hood: It is recommended due to diffusion of free iodine into the air from open vials containing the compound that handling be restricted to hoods having a flow rate of 100 linear feet per minute; that the sash be no higher than 8-12 inches from the fully closed position.

ML10

Should a flow rate not be adequate to remove airborne contamination diffusing from the radioactive iodine vial, a "mini" hood apparatus consisting of a disposable 50 ml plastic syringe, packed with activated charcoal attached to a disposable plastic funnel can be used as an additional safeguard. This mini hood is diagrammed below and can be attached to a suction bottle containing permaganate solution. The mini hood can be constructed for around $2.



Additional Recommendations

1. Lab coats, preferably disposable, should be worn covering arms. These lab coats should be left in the laboratory and monitored for contamination.

2. A lab monitor or portable G-M survey meter should be available at all times when working with mCi amounts of radioactive iodine.

3. Lead shielding (bricks and containers) should be used to reduce exposure to the whole body.

4. Waste associated with the handling and use of radioiodine should be stored in the hood, sealed in a plastic bag until picked up by the Radiation Safety Officer. Should you wish the waste removed sooner than the scheduled waste disposal day for your area, notify the Radiation Safety Officer so such arrangements can be made.

5. Wrist film badges to monitor exposure can be arranged for with the Radiation Safety Officer previous to use of radioactive iodine or when dealing with large amounts of radioactivity. Whole body film badges are required for all gamma emitters.

Adherence to the laboratory safety rules as outlined in the Radiation Safety Manual is required in all restricted areas.

ATTACHMENT #13
REVISION 1
2/83

Item 15.

WASTE DISPOSAL

The University of Delaware utilizes Radiac Research Corporation, 261 Kent Avenue, Brooklyn, New York 11211, which is a commercial waste disposal service.

Radioactive waste is packaged for disposal in accordance with methods prescribed by Radiac, the State of Washington, the State of Nevada, and/or the State of South Carolina. Waste packaging procedures are attached. The Radiation Safety Officer is responsible for the proper packaging of radioactive waste.

In addition, radioactive waste may be disposed of pursuant to 10CFR 20. 303 and 306. The Safety Division is responsible for disposal of waste, the determination of disposed activity and the records necessary pursuant to 10CFR20.303 and 306. The intentional release of bulk activity via the sewer system is not permitted by Permit Supervisors.

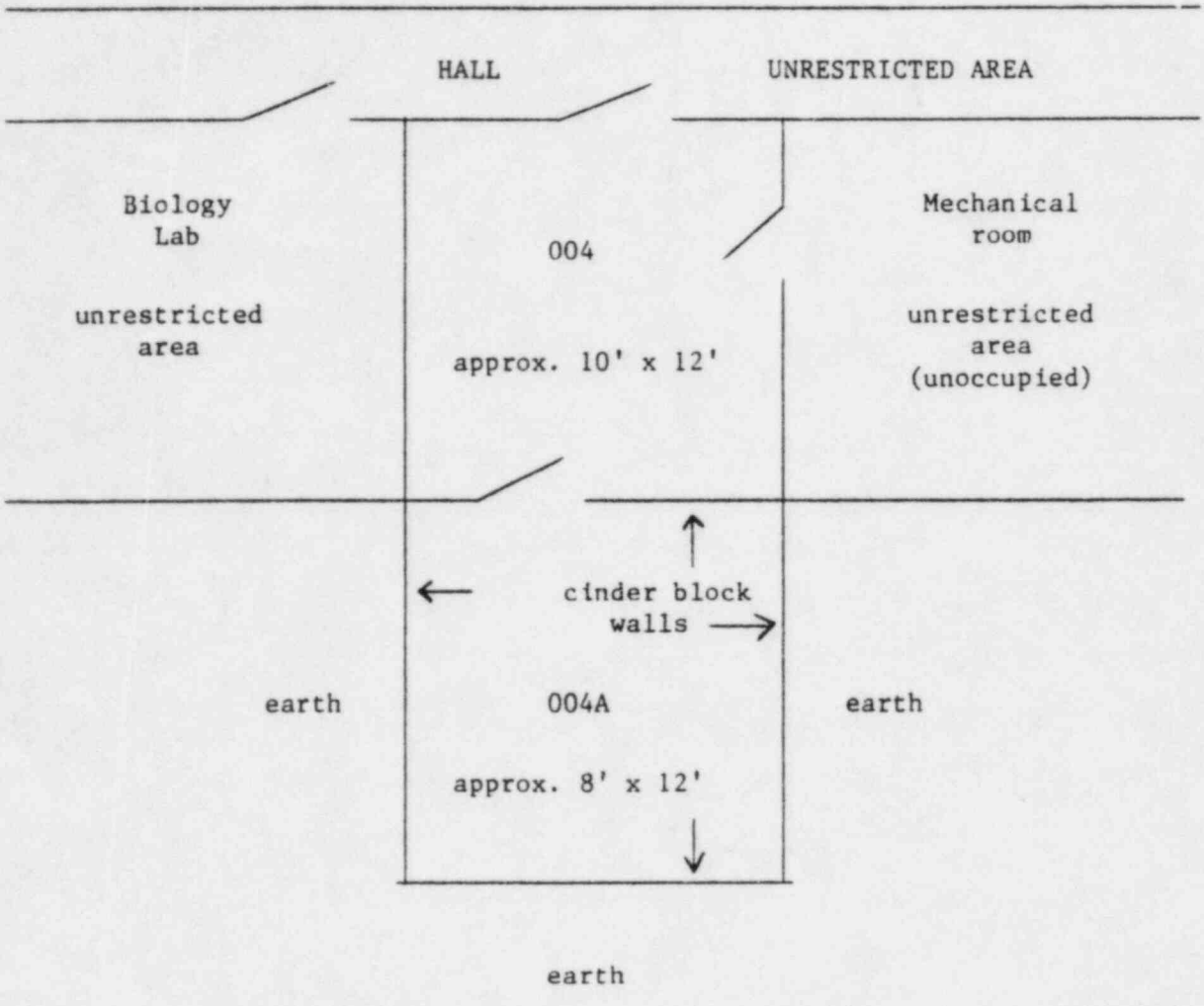
Disposal of radioactive waste pursuant and 10CFR20.305 is not requested at this time.

DISPOSAL VIA DECAY-IN-STORAGE

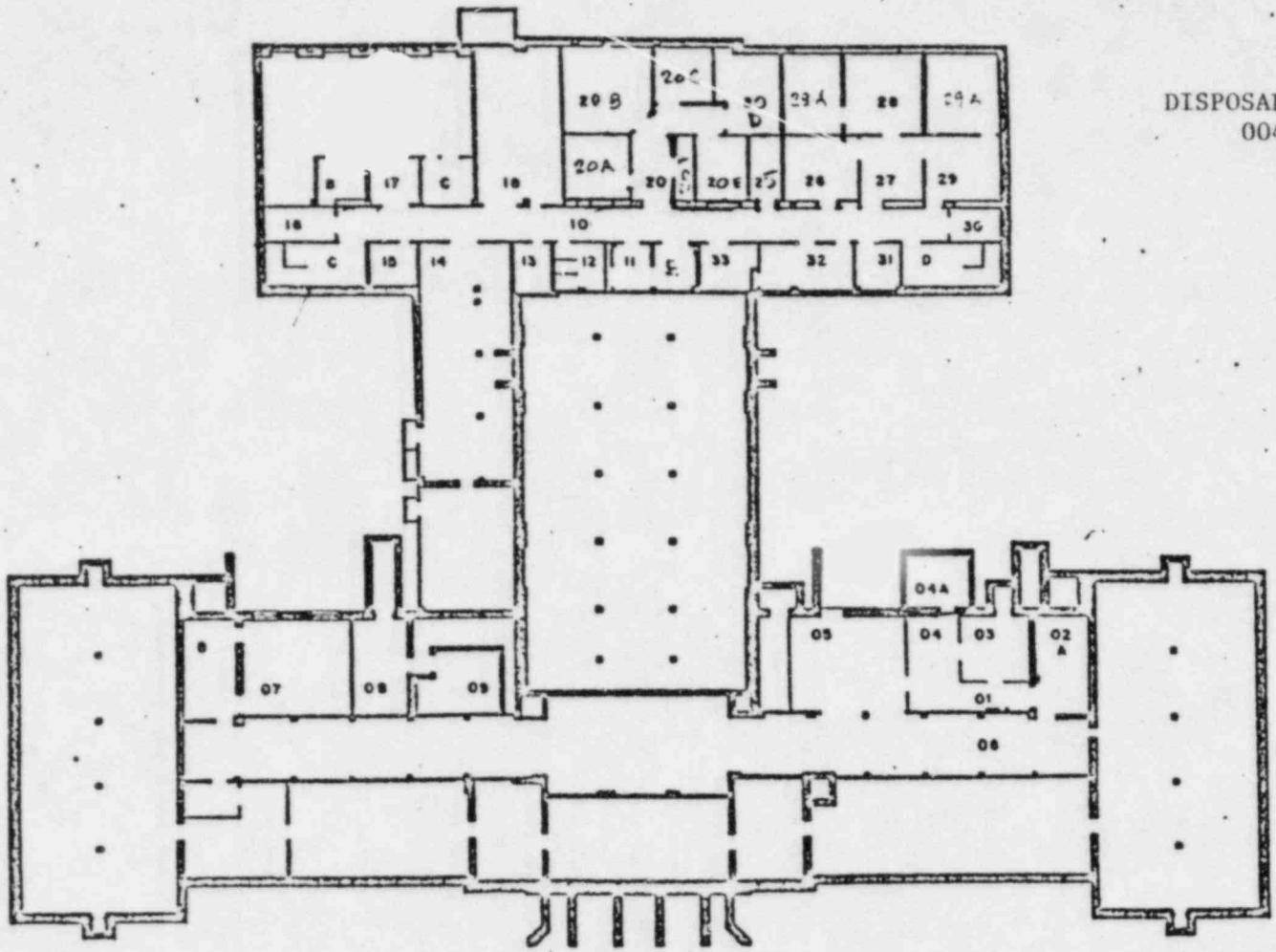
1. Location

   Waste will be prepared and stored in room 004 and 004A Wolf Hall. Room 004 will serve as a preparation area for packaging material into suitable containers. Room 004 will also be used as the low background monitoring area. Room 004A will serve as the storage area. Room 004A has cinder block walls and is surrounded by earth on three (3) sides. Above is a steel trap door and wench for lowering and raising heavy objects. A steel door provides access from room 004 to room 004A.

ATTACHMENT #13
REVISION 1



DISPOSAL VIA DECAY-IN-STORAGE
004-004A WOLF HALL



BASEMENT

0 5 10 20 30 40 50 60
GRAPHIC SCALE

UNIVERSITY OF DELAWARE
WOLF HALL
NEWARK DELAWARE
HOWELL LEWIS SHAY & ASSOCIATES
ARCHITECTS ENGINEERS PLANNERS
PACKARD BLDG PHILA PENNA.
DATE 4 21 66 SCALE 1/16"=1'0"

P 22 11390 11-166

"OFFICIAL RECORD COPY"

ATTACHMENT #13
REVISION 1

Liquid waste and freezers for animal carcass may be located in room 004 due to electrical limitations and the fact that room 004A is not heated (liquid freeze possibility). Material will be removed from room 004 as needed to provide low background conditions for monitoring purposes.

Waste will be stored such that radiation levels in unrestricted areas do not exceed the limit specified in 10CFR20.105. Radiation levels in unrestricted areas are not expected to be above background (0.02 $mrhr^{-1}$). The cinder block walls and the distance from the waste to unrestricted areas is expected to provide adequate protection.

2. Types of Waste

Waste with a half-life less than 100 days is expected to de disposed of by decay-in-storage. Waste will consist of contaminated paper, glass, plastic, shipping containers, equipment, liquids and animal carcasses.

Nominal isotopes and activities are as listed below:

ISOTOPE	NOMINAL EQUILIBRIUM ACTIVITY IN STORAGE
P-32	10 mCi
S-35	10 mCi
Rb-86	5 mCi
I-125	10 mCi
Other isotopes T1/2 < 100 days	10 mCi

3. Security

Rooms 004 and 004A Wolf will be posted with applicable warnings (Caution Radioactive Material or Caution Radiation Area), part 19 notification, NRC-3, and emergency phone numbers. Both rooms will be locked with a restricted key to prevent unauthorized access. The trap door to room 004A will be locked (padlock) when not in use.

4. Surveys and Records

Radiation levels in rooms 004 and 004A Wolf Hall and adjacent unrestricted areas will be monitored with an appropriate survey meter anytime waste is added to or removed from the storage facility. Additional radiation surveys will be conducted at least monthly. Current results will be posted in room 004. Permanent records will be maintained by the Safety Division.

ATTACHMENT #13
REVISION 1

5. Procedures

Waste will be packaged by isotope in appropriate containers (cardboard boxes lined with plastic bags, jugs in buckets or trays, freezers, etc.). Activity and date will be noted for each container.

Waste will be stored for a minimum of ten (10) half-lives.

At the end of ten (10) half-lives, waste will be monitored in a low background area (room 004) with all shielding removed.

A low level GM type survey meter (end window) as appropriate for contamination surveys will be utilized to monitor waste. The most sensitive scale will be utilized (0 - 0.2 $mrhr^{-1}$). A sodium iodide probe may be utilized for gamma emitting isotopes or a liquid scintillation counter may be used for liquid samples as a means to confirm decay to background levels. Surveys will be made at contact with waste.

Waste which has not reached background levels will be stored for an additional ten (10) half-lives or until a background reading is obtained. Surveys will be made at contact with waste.

All radiation labels will be removed or obliterated prior to disposal.

Records of these surveys will be maintained as required under 10CFR20. The Safety Division will maintain such records.

SUPPLEMENT TO ATTACHMENT #13

WASTE PACKAGING PROCEDURES

RADIOACTIVE WASTE PACKAGING CRITERIA

THE FOLLOWING PACKAGING REQUIREMENTS ARE OUTLINED ACCORDING TO THE PHYSICAL CLASSIFICATION OF THE TYPE OF RADIOACTIVE WASTE. IN ADDITION TO THESE SPECIFIC PACKAGING REQUIREMENTS DESCRIBED HEREIN, ALL RADIOACTIVE WASTE MUST BE PACKAGED ACCORDING TO THE FOLLOWING GENERAL REQUIREMENTS.

GENERAL REQUIRMENTS

1.1 ALL RADIOACTIVE WASTE MUST BE PACKAGED IN DEPARTMENT OF TRANSPORTATION APPROVED CONTAINERS.

1.2 ISOTOPE (S), ACTIVITY, CHEMICAL FORM, COMPANY OR INSTITUTE, AND RADIATION LEVEL MUST BE COMPLETED ON THE FRONT SIDE OF THE RADIOACTIVE WASTE DISPOSAL RECORD AFFIXED TO THE TOP OF THE CONTAINER.

NOTE: CHEMICAL FORM

THE TERM "CHEMICAL FORM" MEANS A DESCRIPTION OF THE ATOMIC OR MOLECULAR COMPOSITION OF THE SUBSTANCE CONTAINING THE RADIONUCLIDE. WHEN THE TRUE DETAILED CHEMICAL DESCRIPTION OF THE SUBSTANCE IS BURDENSOME, A GENERAL OR OTHER APPROPRIATE DESCRIPTION MAY BE USED. THE FOLLOWING ARE EXAMPLES OF DESCRIPTIONS WHICH MAY BE USED (THIS LIST IS NOT INTENDED TO BE ALL INCLUSIVE, OTHER SIMILAR DESCRIPTIONS ARE ACCEPTABLE):

PROTEIN	CARBOHYDRATE	STEROID
AMINO ACID	SUGAR	FATTY ACID
ORGANIC SALT	ENZYME	ANIMAL CARCASSES
INORGANIC SALT	SCINTILLATION RESIDUE	

1.3 NO CONTAINER SHALL CONTAIN IN EXCESS OF THOSE ACTIVITIES SPECIFIED FOR "TYPE A" PACKAGING (SEE ATTACHMENT A).

1.4 NO CONTAINER SHALL CONTAIN MATERIALS (RADIOACTIVE OR NOT) WHICH WOULD CREATE A HAZARD BECAUSE OF POTENTIAL EXPLOSIVE OR PYROPHORIC CHARACTERISTICS.

1.5 THE MAXIMUM RADIATION LEVEL ON ANY CONTAINER SURFACE SHALL NOT EXCEED 200 MR/HR. FOR DOSE RATES GREATER THAN 200 MR/HR, CONTACT RADIAC FOR REQUIREMENTS.

1.6 EACH CONTAINER MUST BE WIPE TESTED TO ASSURE THAT THERE IS NO SIGNIFICANT REMOVABLE CONTAMINATION ON THE EXTERIOR SURFACE OF THE CONTAINER. THIS DATA SHALL BE RECORDED ON THE REVERSE SIDE OF THE RADIOACTIVE WASTE DISPOSAL RECORD (SEE ATTACHMENT B).

continued...

1.7 THE APPROPRIATE RADIOACTIVE MATERIALS LABEL: RADIOACTIVE WHITE I, YELLOW II OR YELLOW III MUST BE COMPLETED AND AFFIXED TO TWO (2) SIDES OF THE CONTAINER (SEE ATTACHMENT B).

1.8 THE OUTSIDE OF EACH CONTAINER MUST BE BOLTED AND INCORPORATE A SEAL WHICH IS NOT READILY BREAKABLE AND WHICH, WHILE INTACT, WILL BE EVIDENCE THAT THE PACKAGE HAS NOT BEEN ILLICITLY OPENED.

1.9 AFTER CLOSING, THE TOP OF THE CONTAINER MUST BE LEGIBLY MARKED EITHER "SOLID", "VIALS", "ABSORBED LIQUIDS", "BIOLOGICAL", "IN VITRO", OR "ANIMAL CARCASSES".

LIQUID SCINTILLATION VIALS

1. VIALS MUST BE INTACT WITH TOPS SECURELY IN PLACE.

2. CONTAINER MUST BE LINED WITH A MINIMUM 4 MIL PLASTIC LINER AND LONG ENOUGH SO THAT WHEN THE CONTAINER IS FULL, THE LINER MAY BE TWISTED AND TAPED SECURELY.

3. PLACE 3 INCHES OF APPROVED ABSORBENT AT THE BOTTOM OF THE CONTAINER. VIALS AND ABSORBENT MUST BE PLACED IN THE CONTAINER IN LAYERS NOT EXCEEDING 6 INCHES IN DEPTH. AT LEAST 1 INCH OF ABSORBENT MUST BE PLACED BETWEEN EACH LAYER OF VIALS.

4. THE CONTAINER MUST BE FILLED WITH A 2 TO 1 RATIO OF ABSORBENT TO LIQUID IN THE VIALS.

IN VITRO WASTE

1. RADIOACTIVE MATERIALS IN INDIVIDUAL UNITS OR VIALS, NOT TO EXCEED 50 MILLILITERS, USED FOR IN VITRO CLINICAL OR LABORATORY TESTING, MUST BE PACKAGED IN CONTAINERS LINED WITH A MINIMUM 4 MIL PLASTIC LINER.

2. MATERIALS MUST BE LAYERED IN SUFFICIENT ABSORBENT MATERIAL TO ABSORB TWICE THE TOTAL VOLUME OF THE LIQUID IN THE CONTAINER.

ABSORBED LIQUIDS (LARGE VOLUMES)

1. THE INNER CONTAINER MUST BE LINED WITH A MINIMUM 4 MIL POLYETHYLENE LINER.

2. THE INNER CONTAINER MUST BE FILLED WITH A 2 TO 1 RATIO OF ABSORBENT TO LIQUID, LAYERED IN APPROXIMATELY 1 FOOT LAYERS TO ENSURE EVEN DISPERSION. THERE SHOULD BE NO FREE STANDING LIQUID AT THE TOP OF THE CONTAINER.

3. ABSORBED LIQUIDS SHOULD NOT BE ACIDIC OR ALKALINE.

4. THE INNER CONTAINER MUST BE PLACED UP-RIGHT IN THE OUTER CONTAINER WITH ABSORBENT ON THE BOTTOM AND AROUND THE SIDES OF THE OUTER CONTAINER.

SOLIDIFIED LIQUIDS (SMALL VOLUMES)

1. ACCEPTABLE SOLIDIFICATION MEDIA ARE:
   DOW MEDIA — UREA FORMALDEHYDE
   CEMENT — ASPHALT
   DELAWARE CUSTOM MEDIA

2. FOR SMALL VOLUMES OF LIQUIDS (1 TO 4 GALLONS) SOLIDIFICATION KITS UTILIZING DELAWARE CUSTOM MEDIA ARE AVAILABLE, WITH INSTRUCTIONS, FROM RADIAC.

ML18

BIOLOGICAL, PATHOGENIC OR INFECTIOUS MATERIAL

(EXCLUDING ANIMAL CARCASSES)

THIS PACKAGING PROCEDURE PERTAINS ONLY TO BIOLOGICAL, PATHOGENIC OR INFECTIOUS MATERIAL OR EQUIPMENT THAT IS RADIOACTIVE (e.g. SYRINGES, TEST TUBES, CAPILLARY TUBES).

1. THE INNER CONTAINER MUST BE LINED WITH A MINIMUM 4 MIL POLYETHYLENE LINER WHICH SHALL BE SEALED.

2. THE INNER CONTAINER MUST BE PLACED UP-RIGHT IN THE OUTER CONTAINER WITH ABSORBENT ON THE BOTTOM AND AROUND THE SIDES OF THE OUTER CONTAINER.

ML18

ANIMAL CARCASSES

1. THE INNER CONTAINER MUST BE LINED WITH A MINIMUM 4 MIL POLYETHYLENE LINER.

2. THE ANIMAL CARCASSES MUST BE PACKAGED AND LAYERED WITH ONE PART LIME TO TEN PARTS ABSORBENT. THIS SHOULD BE DONE IMMEDIATELY AFTER THE ANIMAL IS SACRIFICED AND BEFORE IT IS FROZEN.

3. UPON FILLING THE CONTAINER, THE PLASTIC BAG MUST BE TWISTED AND SEALED WITH TAPE.

4. THE INNER CONTAINER SHALL BE CLOSED WITH AN APPROPRIATE TOOL AND PLACED UP-RIGHT IN THE OUTER CONTAINER WITH ABSORBENT ON THE BOTTOM AND AROUND THE SIDES OF THE OUTER CONTAINER.

SPECIAL NOTES

A. TRANSURANIC WASTE: RADIOACTIVE WASTE CONTAINING LESS THAN 10 NANOCURIES TOTAL TRANSURANIC NUCLIDES PER GRAM OF WASTE IS ACCEPTABLE PROVIDED TRANSURANIC NUCLIDES ARE ESSENTIALLY EVENLY DISTRIBUTED WITHIN A HOMOGENEOUS WASTE FORM. THIS CONDITION DOES NOT AUTHORIZE BURIAL OF COMPONENTS OR EQUIPMENT CONTAMINATED WITH TRANSURANIC NUCLIDES.

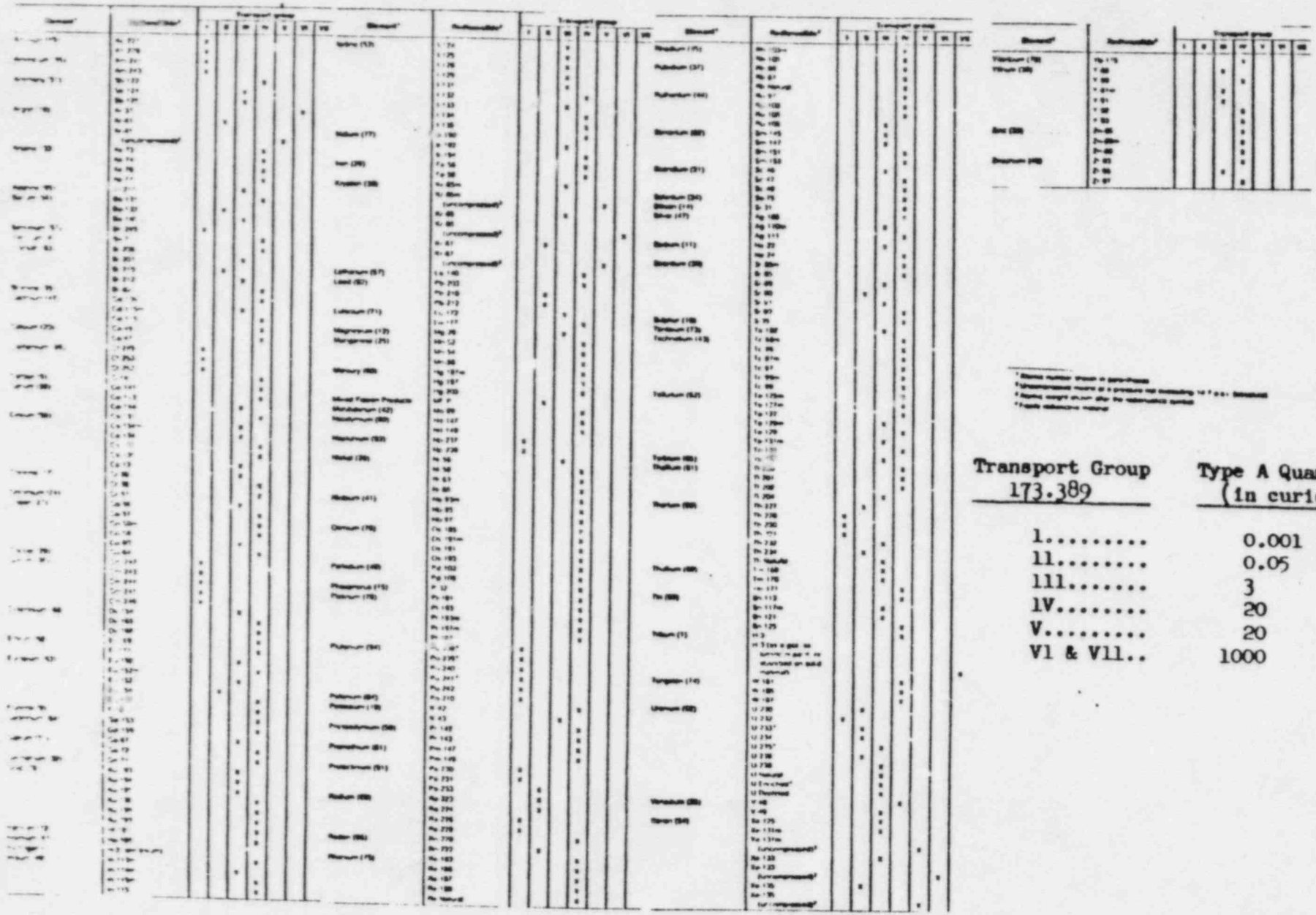
B. SMOKE DETECTORS CONTAINING AMERICIUM 241 FOILS WHICH MAY EXCEED THE TRANSURANIC LIMIT OF 10 NANOCURIES PER GRAM OF MATERIAL MAY BE ACCEPTED FOR DISPOSAL PROVIDED THE ENTIRE DETECTOR IS DISPOSED.

ML10

ATTACHMENT A

TRANSPORT GROUPS OF RADIONUCLIDES

(See 49 CFR 173.390)



Transport Group 173.389	Type A Quantity (in curies)
I.....	0.001
II.....	0.05
III.....	3
IV.....	20
V.....	20
VI & VII..	1000

ATTACHMENT B

Contamination Control - DOT 173.397

Removable (non-fixed) radioactive contamination is considered significant if the level of contamination, when averaged over any area of 300 square centimeters of any part of the package surface, exceeds any of the following:

Contaminant	dpm/100 cm^2
Natural or depleted uranium or thorium:	
Beta - gamma.....	2200
Alpha.....	220
All other beta - gamma emitting radionuclides.....	220
All other alpha emitting radionuclides.....	22

In assessing the surface contamination of a package, a sufficient number of measurements must be taken in the most appropriate locations so as to yield a represntative assessment of the contamination situation. The average amount of removable (non-fixed) radioactive contamination may be determined by wiping the external surface of the package with an absorbent material, using moderate pressure, and then measuring the acivity on the wiping material. If the measured activity per square centimeter does not exceed 10 percent of the levels prescribed above, it may be assumed that those levels have not been exceeded. Other measurement methods of equal or greater efficiency may also be utilized.

Radioactive Materials Labels - 172.403

Radioactive White 1	0.5 mr/hr or less
Radioactive Yellow 11	0.51 mr/hr to 50 mr/hr
Radioactive Yellow 111	greater than 50 mr/hr