KERR-McGEE CORPORATION
KERR-McGEE CENTER • OKLAHOMA CITY, OKLAHOMA 73125

ENVIRONMENT AND HEALTH MANAGEMENT DIVISION

May 29, 1981

Mr. James Keppler
Region III, USNRC
Office of Inspection and Enforcement
799 Roosevelt Road
Glen Ellyn, IL 60137

Re: License No. SNM-928, Docket No. 70-925

Dear Mr. Keppler:

The Kerr-McGee Nuclear Corporation reports the possible overexposures of two of its employees to soluble airborne uranium enriched to 2.5% with the isotope uranium-235. The exposure estimates are calculated from bioassay data, not air samples. Employee A is estimated to have an exposure of 183 MPC-hrs. resulting from an unrecognized single exposure occurring late in March 1981. Employee B is estimated to have had two separate exposures, one on April 1 and the other around the middle of April, totaling 100 MPC-hrs.

Inadequate air sampling failed to detect these incidents. In addition, delays in delivering urine samples for analysis lengthened the time before the problem was recognized early in May, 1981. These deficiencies have already been corrected as follows:

a. Routine urine samples will be delivered for analysis and processed weekly, regardless of the quantity of samples.

b. Lapel air samplers will be required for the operation in question.

c. Ventilation control at the work location (hood) will be improved.

d. The use of respiratory protective equipment will be required for the operation.

The operation involved the removal of dried uranium carbonate from an oven and transferring these solids from drying trays to a "milk can" type container with a cover. The transfer is done within a ventilated hood which has a high efficiency filter on its air exhaust.

Analysis of special urine samples taken during early and mid-May, 1981, show background levels for uranium. Tests for protine in the urine were negative. Both employees had been placed on work restriction to non-radioactivity work early in May until their urine samples' uranium concentrations returned to normal.

The exposure calculations and employee identification is attached. The affected employees are being furnished a copy of this report in accordance with Part 19 rules.

Sincerely yours,

Gerald J. Linke
Staff Health Physicist

FOR: W. J. Shelley
Vice President
Nuclear Licensing and Regulation

WJS;JS;dc

cc: Director of Inspection & Enforcement
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Pg. 25 of ICRP No. 30 shows the lung model. We will assume the model fits our case for aerosol particle size. For Class D uranium carbonate inhaled, 37% is exhaled, 15% goes to the G.I. tract and 48% is transferred to the body fluids.

On pg. 103 of ICRP 30, it is seen that 44% of the uranium in the body fluids is retained for various half-lives from 6 to 20 days in the bone, kidney and other organs. The remainder (56%) of the body fluid uranium goes directly to excretion; given a half-life of 6 hours (See ICRP 30, pg. 17).

Differentiating the retention equations found on pg. 103 provides the fraction ($-Y_t'$) of the original uptake excreted on the (t)th day after exposure. (Note: Valid 2 days or more after the exposure insult to complete the elimination of the 6 hr. half-life non-uptake uranium.)

$$-Y_t' = \left(0.0069e^{\frac{-0.693t}{20}}\right) + 2\left(0.0139e^{\frac{-0.693t}{6}}\right)$$

This elimination equation applies to 21.13% of the original intake. (48% times 44% = 21.12%). Urine excreting uranium according to this equation shows an elimination half-life of 8 days as calculated or plotted on semi-log paper.

EMPLOYEE A

On 3-23-81, Employee A submitted a urine sample near background levels. Ten days later, on 4-2-81, employee A's urine sample showed 199 dpm/l. By 4/20-81, it was reduced to 65 dpm/l. A semi-log plot of this data shows the half-life to be about 10 days, indicating that no short half-life (6 hr.) non-uptake uranium was being eliminated. Employee A's exposure is calculated as follows:

assume that a single exposure to airborne carbonate occurred to Employee A, ten days to his urine sample dated 4-2-81.

Given: Daily excretions of urine = 1.4liter
40 hour breathing volume = 4.8×10^7 ml
uptake = 0.2112 (intake)
$-Y_t$ = fraction of uptake excreted on the (t)th day.
Weighted MPCa for 2-3% enriched U = 2×10^{-10} uCi/ml.

Solution:

(a) $$\frac{(199 \text{ dpm/l})(1.4 \text{ l/day})}{2.22 \text{ dpm/pCi}} = 125 \text{ pCi/day}$$

(b) $$Y_t = \left(0.0069e^{\frac{-.693(10)}{20}}\right) + 2\left(0.0139e^{\frac{-.693(10)}{6}}\right) = 1.36 \times 10^{-2}$$

(c) $$\frac{125 \text{ pCi}}{(1.36 \times 10^{-2})(10^6 \text{ pCi}/\mu\text{Ci})} = 9.19 \times 10^{-3} \mu\text{Ci uptake}$$

(d) $$\frac{9.19 \times 10^{-3} \mu\text{Ci uptake}}{0.2112} = 0.044 \mu\text{Ci intake}$$

(e) Average 40 hr. concentration =

$$\frac{.044 \mu\text{Ci}}{4.8 \times 10^7 \text{ ml}} = 9.17 \times 10^{-10} \mu\text{Ci/ml}$$

(f) $\frac{9.17 \times 10^{-10} \mu Ci/ml}{2 \times 10^{-10} \mu Ci/ml\text{-MPC}} = 4.59$ MPC

(40 hr. exposure) = 183 MPC - hrs.

EMPLOYEE B

On 4-3-81, Employee B submitted a urine sample with a uranium concentration of 579 dpm/l. On 4-15-81, another urine sample showed 27 dpm/l. A semi-log plot of these two data points shows the apparent half-life to be only 3 days, indicating that a substantial quantity of non-uptake uranium (6 hr. $T_{\frac{1}{2}}$) was excreted on 4-3-81. This places the exposure time at 4-1-81 at the earliest. The 4-3-81 urine concentration cannot be used in the uptake elimination formula; however, the 4-15-81 data can be used for this exposure, as follows:

$$-Y = 0.0069e^{\frac{-.693(14)}{20}} + 2\left(0.0139e^{\frac{-.693(14)}{6}}\right) = .0098$$

$$\frac{(27 \text{ dpm/l})(1.4 \text{ l/day})}{(2.22 \times 10^{6} \text{ dpm/}\mu\text{Ci})(0.0098)(0.2112)} = 8.2 \times 10^{-3} \ \mu\text{Ci intake.}$$

$$\frac{8.2 \times 10^{-3} \ \mu\text{Ci}}{(4.8 \times 10^{7} \text{ ml/40 hrs.})(2 \times 10^{-10} \ \mu\text{Ci/ml-MPC})} = 34.16 \text{ MPC-hrs.}$$

A second exposure occurred to Employee B sometime between 4-15-81 and 4-21-81.

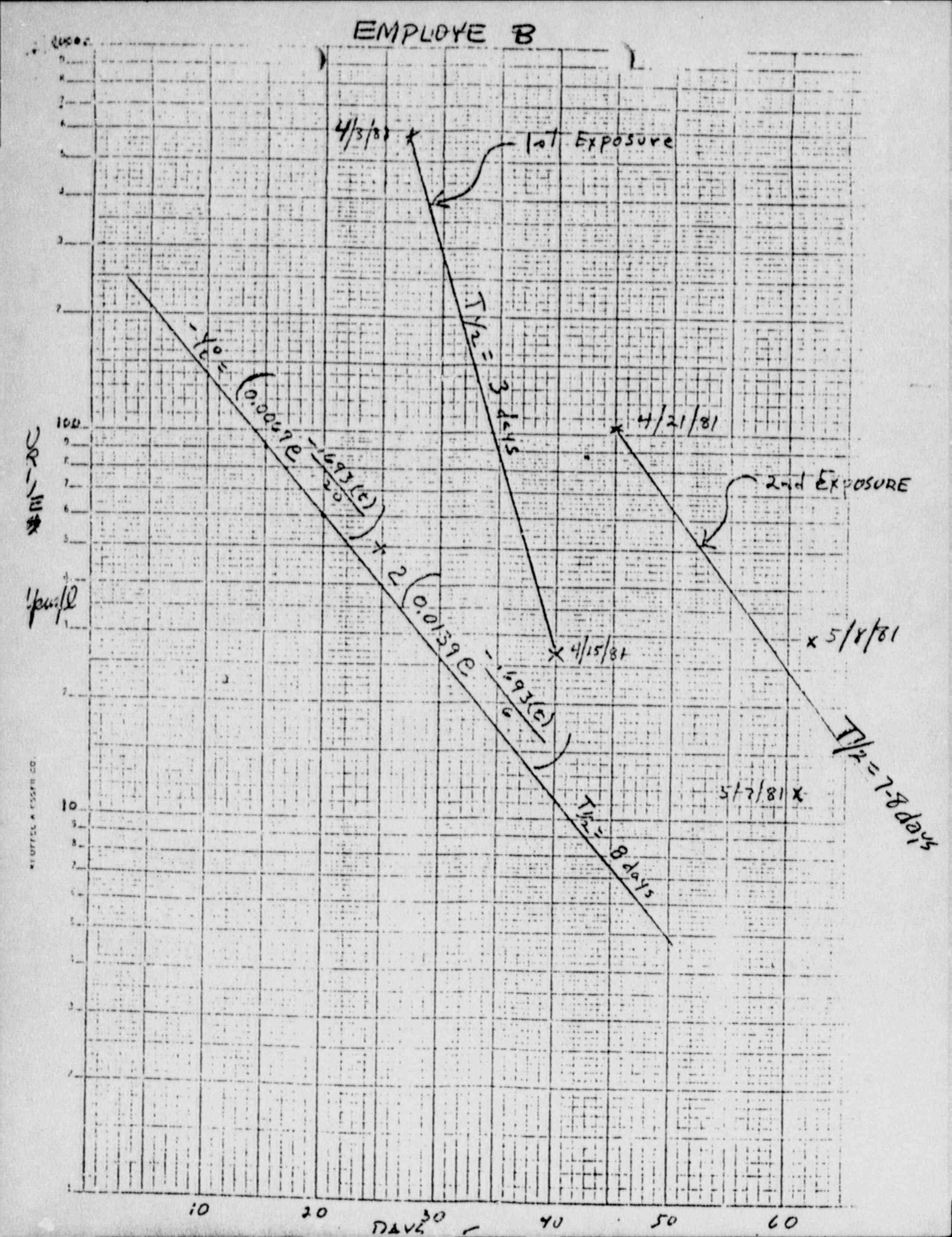
A urine sample dated 4-21-81 showed a concentration of 103 dpm/l. Urine samples for 5/7 and 5/8/81 showed 12 dpm/l and 30 dpm/l. A semi-log plot of this data shows an ~8 day half-life indicating that the uranium in the urine was being released from organ uptake. We will assume the incident occurred 6 days ahead of the 4-21 sample (on 4-15-81). This intake and exposure is calculated as follows:

$$-Y = 0.0069e^{\frac{-.693\ (6)}{20}} + 2\left(0.0139e^{\frac{-.693(6)}{6}}\right) = 0.0195$$

$$\frac{(103 \text{ dpm/l})(1.4 \text{ l/day})}{(2.22 \times 10^{6} \text{ dpm/}\mu\text{Ci})(0.0195)(0.2112)} = 1.58 \times 10^{-2} \ \mu\text{Ci intake.}$$

$$\frac{1.58 \times 10^{-2} \ \mu\text{Ci}}{(4.8 \times 10^{7} \text{ ml/40 hrs})(2 \times 10^{-10} \ \mu\text{Ci/ml-MPC})} = 65.83 \text{ MPC-hrs.}$$

It is concluded that Employee B accumulated an exposure to soluble uranium of 100 MPC-hrs. between the period April 1 and April 21, 1981.


EMPLOYE B
4/3/81
1st Exposure
T1/2 = 3 days
4/21/81
2nd Exposure
4/15/81
5/8/81
T1/2 = 7-8 days
5/7/81
T1/2 = 8 days
-λt
0.0049e
-1.93(t)
20
+ 2 (0.0139e
-1.93(t)
6
10
20
30
40
50
60
DAYS

KERR-McGEE RADIOLOGICAL HEALTH PROGRAM
RARE EARTHS FACILITY
WEST CHICAGO, ILLINOIS

Kerr-McGee Chemical Corporation, upon evaluating various alternatives for the decommissioning or stabilization of radioactive material at its Rare Earths Division located in West Chicago, Illinois, has determined that many tasks are common to all plans being considered.

These tasks are defined as follows:

1. Segregation of all loose organic materials into radioactive and non-radioactive categories.

2. Disposal in local land fill of above non-radioactive material.

3. Packaging of the above radioactive material in preparation for shipment to a licensed low-level radioactive material waste disposal site.

4. Arrange for transportation and disposal of packaged material in accordance with Department of Transportation (DOT) regulations.

5. Industrially clean interiors of buildings by:

   a. Sweeping with industrial sweeping compounds.
   b. Wet scrubbing.
   c. Vacuum cleaning.

6. Surfaces of items to be released for unrestricted use shall meet the criteria listed in Attachment A

7. Secondary structures (components, pipes and non-load bearing walls) will be surveyed for removable radioactive material using the "smear" test technique.

8. Using "smear" test results as a criterion, secondary structures will be decontaminated if practical, to minimize contamination spread during dismantlement.

   In those cases where radioactivity levels cannot be decreased, the affected areas will be painted.

9. Demolition Preparation

   a) Secondary structures within major buildings will be dismantled taking care to segregate contaminated from clean components.

   b) Clean components with the exception of metal, will be transported to a local landfill for burial. Clean metal may be sold as scrap.

   c) Contaminated components will be packaged and stored for ultimate disposal.

10. Thorium Ore Handling System in Building No. 9

    During manufacturing operations, thorium ore was received in Building No. 9. The ore was unloaded and transported to appropriate locations for processing. The transportation scheme was a conveyor and bag filter system located on top of the building. This system will be removed as follows:

a) The bag filter will be disconnected and sealed to preclude dust release.

b) The machinery associated with this system will be dismantled.

c) The bag filter and system components will be lowered from the roof.

d) All system components will be packaged as required by DOT regulations governing radioactive low-specific activity (LSA) materials.

e) Packages will be shipped to a licensed disposal site for burial.

11. Disposal Site

Preparation of the disposal site will be accomplished as follows:

General Clean-Up

a) Loose items and equipment, organic and other, will be surveyed for radioactive contamination.

b) Organic radioactive LSA materials will be packaged and shipped to a licensed radioactive waste disposal site.

c) Other materials which qualify as radioactive LSA materials will be stored for ultimate disposition.

d) All clean materials, with the exception of metals, will be shipped to a local landfill. Clean metal may be sold as scrap.

12. Buildings Nos. 17, 18 and 19 will be prepared for disposal in the following manner:

a) All three buildings will be industrially cleaned on the inside.

b) Roofs and walls will be carefully dismantled down to the concrete foundations.

c) Resultant waste materials will be separated into contaminated and uncontaminated areas.

d) Contaminated organic materials will be packaged and shipped to a licensed disposal site.

In order to minimize the radiological risks to the general public and the required site workers and to reduce industrial risks such as removal of unstable structures and fire hazards, Kerr-McGee has elected to perform the previously defined tasks.

Kerr-McGee Chemical Corporation has contracted with Chem-Nuclear Systems, Inc. (CNSI) to perform the above tasks under Kerr-McGee's source materials license No. STA 583.

Kerr-McGee will have an on-site representative who will report directly to the Kerr-McGee project manager. The Kerr-McGee Radiation Safety Officer or his designee will act as an advisor to the CNSI work force, will approve the radiological work permits, and will audit the operations for compliance with the radiological control program.

CNSI will provide a Project Site Supervisor who will plan and direct the efforts of work during this project. CNSI will provide a Radiological Control Supervisor who will, with his staff, administer the radiological control program, which ensures compliance with 10 CFR 20 (See Attachment B, which lists the project organization and the manning levels).

Most of the work on the site will be of a radiological nature and will be performed under the radiological work permits using CNSI's basic radiological control program. (See Attachment C, Article 213).

All workers who routinely perform radiological work will be trained in accordance with the program defined in Attachment C, Article 106.

A training study guide is prepared for each individual's use.

CNSI will provide a fully-qualified individual (in accordance with Article 107 of Attachment C) for the position of Radiological Control Supervisor. He will have the complete authority to stop any operation because of unresolved industrial or radiological control questions. At least one Radiological Control person on-site will be trained in basic First Aid practices.

The CNSI Radiological Control group on site will be responsible for:

1. Maintaining an adequate supply of disposable anti-contamination clothing and expendable supplies.
2. Source checking radiation detection equipment.
3. Training of personnel.
4. Performing radiological surveys on all equipment, tools, vehicles, packages, and waste which leaves the area.
5. Maintaining daily dosimeter reading records.
6. Issuance of TLD's to all personnel who routinely work on site.
7. Maintaining the respiratory protection equipment.
8. Changing TLD's monthly, or more often if needed, in accordance with CNSI radiation alert system (Attachment C, Article 216).
9. Maintaining logs, records, and reports as required to demonstrate compliance with the radiological controls program (Attachment C, Articles 121 and 122, as applicable).

All material which is released from the site as clean waste, sold as scrap, or disposed of in a local landfill shall be surveyed and determined to meet the criteria in Attachment A. Since this material can be contaminated with naturally occurring isotopes such as Postassium 40, Uranium 238, and Thorium 232, and their daughters, the release limit shall be that for insoluble Natural Thorium, the most limiting isotope.

In most instances, the work will be performed in a manner which does not produce airborne radioactivity. Any airborne activity generated will be long-lived and insoluble. Air samples will be taken to determine the air particulate concentration. This will be confirmed by periodically collecting ten cubic meter air samples and determining the gross alpha activity. Consideration will be given for sampling airborne radioactivity at the perimeter of the site, down-wind from work activity which may create dust releasable to uncontrolled areas. When applicable, this sampling will be made part of the radiation work permit. Samples will be recounted due to the presence of the short-lived daughter products. In order to protect the workers, all personnel working within the buildings when dust may be generated will be required to wear half-face respirators. Personnel who may work in airborne concentrations in excess of 6×10^{-11} μCi/mℓ Natural Thorium will be required to wear full-face respirators and in no instance will personnel be allowed to work in areas which exceed 50 times this control limit. Personnel who perform work in respirators shall have an annual physical examination. All respirator equipment shall be NIOSH approved.

Workers involved in demolition or decontamination work will be required to wear safety shoes, safety glasses, hard hats, and work gloves as a general precaution. Additional clothing and protective equipment may be prescribed on the Radiation Work permit.

Radioactive solid waste which is packaged in accordance with DOT regulations may be released from the site by completing the required Radioactive Shipping Record and short form Bill of Lading. This waste

will be shipped via exclusive-use vehicle to a licensed waste burial site for disposal.

Radioactive liquids will be collected in containers and, prior to being discharged, will be analyzed by gross alpha counting techniques for degassed samples. Only the Kerr-McGee on-site Radiation Safety Officer or his designee can authorize such disposals to the environment. Released of liquid shall be in accordance with 10 CFR 20.

Emergency Conditions

Arrangements will be made with local emergency response organizations such as fire departments, police departments, ambulance teams, etc., to assist on-site personnel if an emergency condition should occur. Arrangements will also be made with a local doctor and hospital for medical assistance if needed.

In the unlikely event of a situation that presents a high potential for personnel internal contamination, a bio-assay plan such as In-vivo counting or fecal analysis, will be considered. However, no routine bio-assay program is planned.

Hygiene

Building No. 12 will be supplied with a change room, showers, eating facility, break room and restroom facilities.

ATTACHMENT A

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[b,c,f]	MAXIMUM[b,d,f]	REMOVABLE[b,e,f]
U-nat, U-236, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228.	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-230, Th-228, Pa-231, Ac-227, I-125, I-129			
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm βγ/100 cm^2	15,000 dpm βγ/100 cm^2	1,000 dpm βγ/100 cm^2

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate director for background, efficienty, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived from each such object.

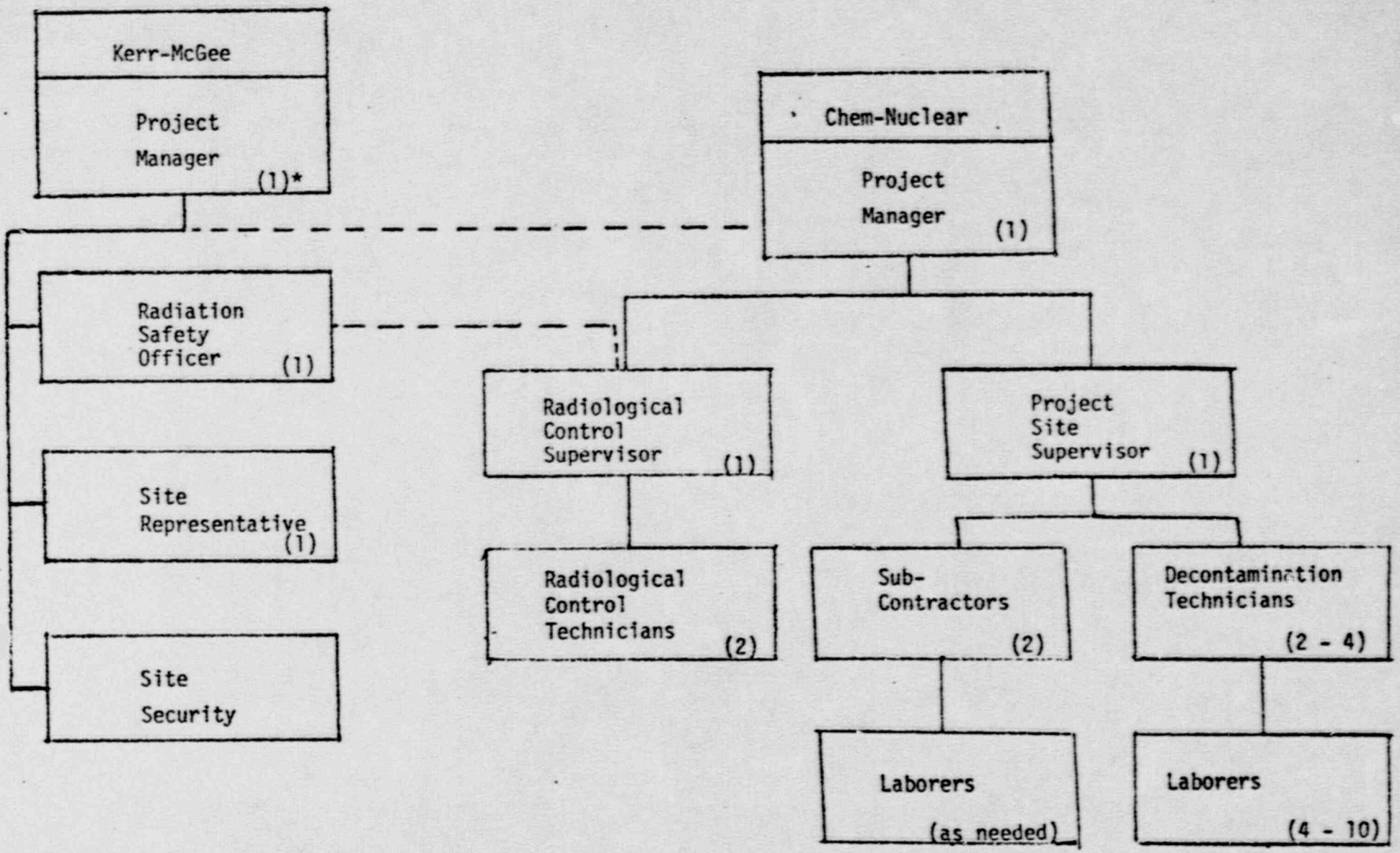
[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

ATTACHMENT B

PROJECT ORGANIZATION



*Estimated number of personnel

ATTACHMENT C

CHEM NUCLEAR
SYSTEMS INC.
DECOMMISSIONING

RAD CON POLICY
AND SAFETY
MANUAL

SECTION I INTRODUCTION

CONTENTS

101. INTRODUCTION AND PURPOSE

DISCUSSION: This manual presents the limits and protection measures applicable to ionizing radiation and radioactivity associated with CNSI operations; it does not cover control of radiation from nuclear weapons, medical uses, or other employment of radiation.

The procedures and limits in this manual are applicable to all CNSI operations.

Radioactive materials in a number of forms are utilized during various operations. These materials must be carefully handled to avoid any inadvertent contact by personnel, including the public. Unnecessary radiation exposure could be caused through mishandling of radioactive materials by personnel who are either unaware of its presence or nature, or are incapable of coping with it.

The radiological safety standards and procedures in this manual have not been developed independently by CNSI but are based on the recommendations and requirements of the Environmental Protection Agency (which has incorporated the functions of the Federal Regulation Council), the National Council on Radiation Protection and Measurements, the International Commission on Radiological Protection, the U. S. Nuclear Regulatory Commission, and on standards which have been reviewed and accepted by the U. S. Public Health Service and the U. S. Department of Labor. Thus, they compare with standards and procedures used throughout the United States and the rest of the world to protect the public. It is important that the standards and procedures in this manual be followed carefully.

The addition of the problems of radiation exposure and radioactive contamination to otherwise normal jobs has required the establishment of numerous radiological controls. The cost and time required to perform a job are increased by the added training, special equipment, difficult working conditions, and added personnel for radiological controls. The major purpose of this manual is to provide procedures to assure that satisfactory control is exercised over personnel radiation exposure and radioactive contamination. However, the objectives of performing the maximum work within prescribed limitations on (1) cost and (2) manpower are also considered throughout this manual.

REQUIREMENTS:

1. Copies of this manual shall be readily available for use by applicable personnel. Distribution of this manual is controlled by Radiation and Safety.

2. The limits and procedures of this manual are applicable to all radioactive material as defined by this manual, and shall be implemented for all operations.

102. RELATED INSTRUCTIONS

DISCUSSION: Specifically, except as referenced herein, this manual establishes the radiological controls requirements associated with CNSI Operations.

103. SUMMARY OF RADIOLOGICAL ASPECTS

DISCUSSION: Radiological controls are required by CNSI in areas where radioactive materials are handled, in areas traversed by potentially contaminated personnel and materials, and in other areas where radioactive work is performed.

Sources of radiation may be both alpha and beta-gamma emitters. Throughout this manual, concentrations of radioactivity are identified as either alpha or beta-gamma radioactivity.

CNSI operations are performed in accordance with operating procedures which contain instructions for handling equipment and materials used. Preparation of these procedures and design of equipment include radiological control considerations; however, implementation of the procedures in this manual is required to ensure adequate radiological control.

The radiological controls requirements of this manual include: (1) control of external radiation exposure to personnel by means of personnel monitoring, area monitoring, installed shielding, and planning and execution of radiological work; (2) control of internal radiation exposure to personnel by monitoring for contamination in air and on surfaces, through use of anticontamination clothing and masks, and through control of contaminated areas; (3) control of radioactive wastes by means of specified procedures and radiochemical analyses; (4) decontamination; and (5) procedures for receiving, transferring, storing, shipping, and accounting for radioactive materials.

The procedures in subsequent articles are those required to assure radiological safety under most situations. In unusual situations, personnel are expected to perform additional measurements and take other additional precautions as deemed necessary to provide adequate protection.

Portions of the articles of this manual have been labeled to specify whether they contain requirements or discussion. Most nonmandatory procedures have been placed in appendices to this manual. Use of practices in these appendices has improved radiological controls.

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104. SUMMARY OF RESPONSIBILITIES

REQUIREMENTS: The following Notice to CNSI Personnel, (figures I-1a and I-1b) shall be conspicuously posted in a sufficient number of places to permit employees working in or frequenting radiation areas or radiologically controlled areas to observe a copy on the way to or from their place of work.

NOTICE TO PERSONNEL

RADIOLOGICAL CONTROL STANDARDS
FOR
CHEM-NUCLEAR SYSTEMS, INC.

STANDARDS

Standards for protection of personnel against radiation associated with CNSI operations are contained in this manual, "Radiological Controls", and shall be utilized for CNSI operations.

These standards are based on recommendations of the Environmental Protection Agency, and are consistent with those of the U. S. Nuclear Regulatory Commission and the U. S. Department of Labor.

YOUR RESPONSIBILITIES

Each individual must constantly remain aware of potential radiological problems. Each of his actions directly affects his exposure, contamination, and the overall radiological problems associated with operations or maintenance. The following rules shall be followed by individuals to minimize radiological control problems:

1. Obey posted, verbal, and written radiological control instructions.
2. Wear TLD and dosimeter where required by signs or by radiological control personnel.
3. Keep track of your own radiation exposure status and avoid exceeding limits.
4. While working, remain in as low a radiation area as practicable.
5. Do not loiter in radiation areas.
6. Do not eat, drink, chew or smoke in areas where radioactive contamination may be present.
7. Obey promptly "stand fast" orders to prevent contamination spread.
8. Obey promptly orders to wear masks. Wear anti-contamination clothing including masks properly whenever required by signs or radiological control personnel.

Figure I-1a

9. Remove anti-contamination clothing and masks properly to minimize spread of contamination.

10. Frisk yourself or be frisked for contamination when leaving a contaminated area.

11. Minimize the possibility of a radioactive spill by carefully following procedures.

12. For a known or possible radioactive spill, minimize its spread and notify radiological control personnel promptly.

13. Do not unnecessarily touch a contaminated surface or allow your clothing, tools, or other equipment to do so.

14. As practical, place all contaminated equipment such as tools and sampling bottles on disposable surfaces (e.g., sheet plastic) when not in use and inside plastic bags when work is finished.

15. Follow good "housekeeping" practices to minimize the amount of material that has to be decontaminated or disposed of as radioactive waste.

16. Report the presence of open wounds to Rad Con personnel prior to work in areas where radioactive contamination exists. If a wound occurs while in such an area, report immediately to radiological control personnel.

YOUR EMPLOYER'S RESPONSIBILITIES

Your employer is required to:

1. Maintain records of your occupational radiation exposure and, upon your written request, advise you of your recorded occupational radiation exposure.

2. Notify you immediately of any radiation exposure which exceeds the quarterly or lifetime cumulative limits.

3. Provide you, after termination of employment, upon your written request and within 30 days after the request, with a written summary of your cumulative recorded occupational radiation exposure received during your period of employment.

4. Notify personnel of the above procedures by posting this Notice conspicuously.

INSPECTIONS

Work involving radiological controls is subject to periodic inspection by the Nuclear Regulatory Commission

INQUIRIES

Inquiries concerning radiological controls should be addressed to your employer. Additional inquiries may be addressed to Chem-Nuclear Systems, Inc., P. O. Box 726, Barnwell, South Carolina 29812.

Figure I-1b

105. RADIOLOGICAL CONTROL TRAINING STANDARDS

DISCUSSION: Periodic radiological control training is necessary to ensure each person understands the general and specific radiological aspects which he might encounter, understands his responsiblity to his employer and the public for safe handling of radioactive materials, and understands his responsibility to minimize his own exposure to radiation.

REQUIREMENTS:

1. Personnel Who Enter Radiological Areas:

CNSI Managers shall select the category of training for each individual which best meets CNSI's needs. Personnel need be trained in only one of the following categories:

a. Personnel authorized to Receive Radiation Exposure in the Course of their Work: (Radiation Worker)

(1) Personnel who require frequent or routine access to or work in high radiation areas, radiation areas, or radiologically controlled areas or personnel who perform work on a radioactive system, shall have, prior to being issued dosimetry equipment, knowledge, understanding, and practical abilities. If it is necessary to issue a person dosimetry equipment prior to completing this qualification, this person must be escorted when in radiological areas.

(2) This training shall be verified by written examination(s) which include questions concerning all areas of required knowledge and questions concerning action required by the individual in event of an unusual radiological control situation (e.g., puncture of a contamination containment area). Knowledge, understanding, and practical abilities shall be verified by signature of a designated individual. Such designated individuals may be supervisory personnel, training personnel, or radiological control personnel.

b. Radiological Control Personnel

(1) Qualified radiological control personnel shall have at least the knowledge, understanding, and practical abilities, and shall be able to apply these abilities to situations they might encounter during normal work and unusual circumstances.

(2) Radiological control supervisors shall have at least the same technical knowledge and abilities as radiological control personnel. However, passing scores on radiological control supervisor examinations shall be higher than required for radiological control personnel or supervisor examinations shall be more difficult than radiological control personnel examinations. Experience shall also be considered in the selection of radiological control supervisors.

(3) Assistant technicians (such as helper or apprentice technicians or chemistry technicians) are permitted to perform radiological control functions such as surveys once trained for these functions. Because assistant technicians are not fully qualified, review by radiological control personnel of survey results obtained by assistant technicians is important to ensure any trends are identified which would be likely to reveal problems. For surveys of areas containing large quantities of radioactivity, surveys shall be reviewed by a fully qualified radiological control technician or supervisor at least daily. For surveys of areas containing small quantities of radioactivity, surveys shall be reviewed by a qualified radiological control technician or supervisor at least weekly. Records of these surveys shall be initialled to show this review was performed.

(4) Practical abilities shall be verified by signature of designated individuals. Upon completion of this verification, final comprehensive written and oral examinations shall be given. Written examinations shall include questions requiring detailed evaluation of all radiological consequences of a postulated incident. Written examination results shall be available prior to administering the oral examination so that weaknesses indicated by the written examination can be further investigated during the oral examination. The final comprehensive oral examination shall include questions involving evaluation of symptoms of unusual radiological control situations. The examinee, during the oral examination, shall be required to evaluate initial symptoms, state immediate corrective action required, state what additional measurements are required, and do a final analysis of the measurements to identify the specific problem.

(5) Group problem solving sessions shall be used in training programs for radiological control personnel and radiological control supervisors and shall include discussion of operational and casualty situations. Problems used in these sessions shall require evaluation of initial symptoms, statement of immediate corrective action, determination of additional measurements needed to identify the problem or to complete the evaluation; and detailed evaluation of the radiological consequences. "Radiological Fundamentals", which includes the information for detailed evaluation of radiological control situations and casualties shall also be used in local training programs.

c. Visitor Personnel

Management, technical, and other similar personnel who require occasional access to radiation areas, high radiation areas, radiologically controlled areas, or areas where radioactive materials are stored and who enter these areas for observation or similar purposes shall have the radiological control training necessary for the radiological conditions expected to be encountered. Where such individuals are not qualified, these personnel shall be escorted when entering such areas by a person qualified. For areas other than high radiation areas or radiologically controlled areas, a continuous escort is not required if the visitor is in continuous view of facility personnel. The presence of personnel normally assigned to these areas fulfills this function.

d. Records

The following records of personnel training and training verification shall be maintained for a three year period or until the person is terminated from CNSI to document satisfactory completion of requirements.

(1) Results, in the form of numerical scores, for each person on all final written examinations and a master copy of each separate examination given.

(2) For radiological control personnel, a summary statement of each person's performance during the final comprehensive oral examination and the areas covered by the examination. This statement shall be signed by the person(s) conducting the examination.

(3) Training records for each individual which indicate the performance of practical abilities. Verification of more than one practical ability with a single signature is acceptable provided the practical abilities were verified by the same person in a single training session. This is permitted provided the verification form used clearly states what group of specific practical abilities the single signature verifies. For example, an individual's practical abilities could be verified with a single signature, if all practical abilities were performed in the same examination session. However, a single verification signature for these practical abilities could not be used if they were performed in several separate examination sessions.

A signature for a practical ability indicates the individual has correctly performed the operation or demonstrated the ability to the person signing. The individual must actually perform the practical ability. Discussion of the practical ability with the person signing does not constitute satisfactory accomplishment of the practical ability.

The training records shall also contain a signed statement certifying that the person has completed all requirements (i.e., passed written and oral examinations and has all the signatures on the record card). For radiological control personnel, this certification shall be by the Radiation and Safety Officer. For other employees, this certification shall be signed only by persons approved by the Radiation and Safety Officer.

(4) A new training record shall be completed for each verification

e. Re-verification of Training

Re-verification of radiological control training of all personnel shall be accomplished at least every two years.

Re-verification of training shall include a comprehensive oral examination and a written re-examination. Personnel shall also demonstrate they retain the practical abilities. Performance of practical abilities during actual work in the six months prior to qualification expiration is considered satisfactory demonstration of such an item if this practical ability was verified by signature of a designated individual at the time the practical ability was performed.

The Radiation and Safety Officer shall review the duties of personnel who fail re-verification comprehensive oral or written examinations and, based on this review, either disqualify these personnel or limit the duties of these personnel until they satisfactorily pass re-verification training. Failure of re-verification examinations is an indication that personnel have not retained the required radiological control knowledge, understanding, and practical abilities.

In order to monitor retention of radiological control knowledge between re-verification periods, personnel shall be periodically selected at random for retention examinations. Based on the results of these examinations, the organization shall determine if more frequent training is necessary. Failure of retention examinations shall be equivalent to failure of a re-verification examination.

2. Other Personnel

To minimize problems caused by the misunderstanding of personnel not directly involved with radiation, each person shall receive sufficient instruction to understand that the radiation environment of personnel outside radiation areas and outside CNSI is not significantly affected by CNSI operations. These person shall also understand (1) the posting of radiation areas and know not to cross radiation barriers, (2) the specific areas they are not authorized to enter, (3) the description and meaning of radiation warning signs and tags and of yellow plastic, and (4) that they are required to comply with instructions of radiological control personnel in event of an incident or accident involving radioactivity.

Each individual shall receive this instruction as soon after reporting to CNSI as practicable. This indoctrination shall be repeated for all personnel at least annually.

3. Implementation

The Radiation and Safety Officer shall specify responsibilities for implementing the requirements of this article. Personnel designated to verify practical abilities, conduct classroom and practical training, and conduct oral examinations shall be designated in writing.

4. Instruction on Radiation Exposure to the Unborn Child

Prior to being issued dosimetry equipment, all personnel authorized to receive radiation exposure, and all females authorized to receive radiation exposure as visitors shall be given specific instruction about prenatal exposure risks to the developing embryo and fetus. This instruction shall include both orally and in writing the applicable information in the appendix to U. S. Nuclear Regulatory Commission Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure".

Instruction concerning prenatal exposure to the unborn child shall be given during initial and re-verification training.

All personnel receiving instruction in accordance with this paragraph shall sign the following statement prior to being issued dosimetry equipment:

> "The recommendations of the National Council on Radiation Protection and Measurements to limit radiation exposure to the unborn child to the very lowest practicable level, not to exceed 0.5 rem during the entire period of pregnancy have been explained to me."
>
> Signature _____
>
> Typed or Printed Name _____
>
> Date _____

The signed statements shall be kept with the training records. Statements signed by visitors shall be retained for three years.

5. Qualified Monitors

Qualified Monitors are individuals assigned by area supervisors and trained and authorized by the Radiation and Safety Officer to perform routine radiological functions related to their work.

a. Functions performed include:

(1) Radiological work in their own area or in another as authorized by area management.

(2) Conduct surveys for radiation and contamination in their own area and provide emergency monitoring assistance when requested by Radiological Control.

(3) Measure radiation levels and monitor daily working time limits for his work group and for other personnel working in the area under an approved Radiological Work Permit.

(4) Monitor and tag radioactive materials as applicable to meet marking and tagging requirements.

(5) Assist in surveying to release areas, equipment, and facilities providing this is done under the surveillance of Radiological Control.

b. Training records shall be retained for three years by first line supervision. Training requirement verifications shall conform to the requirements for the required training topics, but oral examinations are not required. Qualified Monitors shall requalify at least every two years.

c. When functioning as Qualified Monitors, personnel shall not otherwise assist in area operations.

106. RADIOLOGICAL CONTROL TRAINING REQUIREMENTS

REQUIREMENTS:

Personnel authorized to receive radiation exposure in the course of their work shall receive the following training:

1. Radiation Exposure Control

a. State the limits for whole body penetrating radiation. Explain that the rem is a unit of biological dose from radiation.

b. Explain how "stay times" are used.

c. Be aware of the seriousness of violating instructions on radiation warning signs and unauthorized passage through barriers.

d. Discuss procedures and methods for minimizing exposure such as working at a distance from a source, reducing time in a radiation area, and shielding.

e. Discuss potential sources of radiation associated with work performed by individual's trade.

f. State where dosimetry equipment should be placed on an individual's body.

g. Demonstrate ability to read all types of self-indicating dosimeters in use.

h. Discuss importance of the individual keeping track of his own exposure.

i. Be aware of the significance of personnel radiation exposure. The National Council on Radiation Protection and Measurements has stated[1] that while exposures of workers and the general population should be kept to the lowest practicable level at all times, the presently permitted exposures represent a level of risk small compared with other hazards of life. The Nuclear Regulatory Commission has stated[2], "Control of exposure to radiation is based on the assumption that any exposure, no matter how small, involves some risk. The occupational exposure limits are set so low, however, that medical evidence gathered over the past 50 years indicates no clinically observable injuries to individuals due to radiation exposures when the established radiation limits are not exceeded."

j. Discuss the action to be taken when an individual discovers his pocket dosimeter is off-scale.

2. Contamination Control

a. Discuss how contamination is controlled during radioactive work (e.g., containment in plastic bags and use of Contamination Containment Areas).

b. Discuss procedures for preventing contamination of personnel and how contamination is detected on personnel.

c. Discuss how contamination is removed from contaminated objects and personnel.

d. Discuss potential sources of contamination associated with work performed by individual's trade.

[1] NRCP Report No. 39, issued January 15, 1971
[2] Appendix to NRC Regulatory Guide 8.13, 1975

e. State the beta-gamma surface contamination limit. Discuss the meaning of the units of the limit.

f. Demonstrate proper procedure for donning and removing a full set of anti-contamination clothing.

g. Demonstrate proper procedures for entering and leaving a contaminated area including proper procedures for self-monitoring.

h. Explain what radioactive contamination is. Explain the difference between radiation and radioactive contamination.

i. For personnel required to work in containment areas (e.g., glove bags or tents) demonstrate proper procedure for working in these areas. (This ability may be demonstrated on a mock-up.)

j. For personnel who are likely to encounter airborne radioactivity, demonstrate proper procedure for donning and removing the type of respiratory equipment the individual will be required to wear.

For personnel who are required to wear respiratory equipment with anti-contamination clothing, this demonstration shall be performed when donning and removing anti-contamination clothing. The demonstration shall include any leak checks required to be made to test for proper operation of respiratory equipment.

k. For personnel who are likely to encounter airborne radioactivity, state the conditions which require wearing masks, air supplied respirators, or air supplied hoods.

3. Radiological Incidents

a. Discuss the need for consulting radiological control personnel when questions or incidents occur.

b. Discuss procedures to be followed after a spill of material (liquid or solid) which is or might be radioactive.

c. Discuss procedure to be followed when notified that airborne radioactivity is above the limit.

d. Demonstrate action to be taken by an individual in event of a spill of radioactive liquid.

4. Responsibilities of Individuals

Discuss actions required in order to fulfill the responsibilities of individuals. Include the responsibility of the individual to inform his employer of previous or concurrent occupational radiation exposure received outside CNSI.

107. RADIOLOGICAL CONTROL PERSONNEL TRAINING STANDARD

DISCUSSION: This standard sets forth the minimum theoretical and practical abilities requirements for personnel requiring training.

REQUIREMENTS:

1. Units of Radiation and Radioactivity

   a. Define the rem and explain how it differs from the rad and the roentgen.

   b. Explain the meaning of "quality factor" and give the approximate quality factor for each type of radiation.

   c. Define the curie and explain that the curie is a unit of radioactivity.

   d. Explain the difference between dose and radiation level.

2. Types of Radiation and Shielding

   a. Indicate understanding of the four types of radiation (alpha, beta, gamma, neutron) by discussing:

      (1) charge and relative mass of each,

      (2) relative penetrating power of each in air and tissue.

   b. Explain how radiation levels decrease from a point source, line source, and plane source.

   c. Solve radiation level problems using the inverse square law and tenth-value thicknesses.

   d. Explain the relationship between time in a radiation field and total dose; solve problems involving this relationship.

   e. Solve radiation level problems involving line and plane sources.

   f. Know the basic shielding materials and why each type of material is used.

   g. Know the tenth thicknesses of iron, polyethylene, and lead for gamma radiation and of polyethylene and water for neutron radiation. Know how to use these tenth thicknesses to predict radiation attenuation.

   h. Describe how personnel exposure is controlled by the use of temporary shielding. Be able to determine the amount, type, location, etc., of temporary shielding required for various maintenance problems.

3. Radiation Detection

a. Explain the general principles of operation of gas ionization counters.

b. Explain the general principles of operation of scintillation counters.

c. Explain the general principles of operation of dosimetry equipment.

d. Explain how neutrons, which have no charge, are detected with an instrument which depends on ionization.

e. Give an example of each type of radiac instrument used: (beta-gamma low range survey meter, e.g., E-120; beta-gamma low range survey meter, e.g., RD-2; neutron survey meter, e.g., SNOOPY; frisker, e.g., RM-3 with HP-210 probe; alpha survey meter, e.g., PAC-4G).

f. Explain the type of detection employed in each type of instrument used.

g. Demonstrate an ability to convert meter reading to appropriate units.

h. Know the minimum sensitivity of each instrument and explain how this limits the use of the meter.

i. Describe the effect of other types of radiation on indication of a specific radiac instrument.

j. Explain how the type of detector used affects the technique of operation (e.g., directional probe vs. non-directional probe).

k. Explain the devices used for personnel monitoring and the way in which radiation is detected by each device. What is the range of each device?

l. Explain the term "drift" as applied to a pocket dosimeter. How often should a pocket dosimeter be read? Recharged?

m. Explain why personnel are sometimes monitored by two types of dosimetric devices (e.g., TLD's and pocket dosimeters) and at other times only by one type of dosimetric device.

n. Explain why dry swipes are used.

o. Explain why 100 cm^2 is the area swiped when possible.

p. What correction (if other than a Cesium 137 standard is used for determining counting efficiencies) is used for converting swipe activity to a ^{137}Cs basis? Why is this correction used?

q. Describe how friskers and beta-gamma survey meters are used to measure surface contamination. State the minimum sensitivity of each instrument and explain how this sensitivity changes with background radiation levels.

r. Under what conditions should headsets be used with survey instruments?

4. Biological Effects of Radiation and Radioactivity

a. Explain the general effects of various levels of short-term exposures; for example, 100 mrem, 10 rem, 100 rem, 1000 rem.

b. Explain why there is a difference between the effects of short-term and long-term exposures to radiation.

c. Give the basic limit to which external exposures of whole body penetrating radiation is controlled and explain the basis for this limit.

d. Discuss the factors on which the effect of internal radioactivity on the body depends. Explain "body burden" and "critical organ".

e. Explain why the limit for internal exposure is set at 1/10 the normal limit for radiation workers. State the concentrations of ^{137}Cs in water and in air which, for normal working-week exposure, will give the equivalent of 0.5 rem/year whole body external radiation.

f. Give the approximate dose to the lower large intestine from swallowing 1 microcurie (uCi) of insoluble ^{232}Th. What would be the biological effects of swallowing this quantity of ^{232}Th, of swallowing 1 millicurie (mCi) of ^{232}Th?

g. Give the dose to the lungs which results over a few years from breathing air with a given ^{137}Cs concentration for a given number of minutes.

h. Be aware of the significance of personnel radiation exposure. The National Council on Radiation Protection and Measurements has stated[1] that while exposures of workers and the general population should be kept to the lowest practicable level at all times, the presently permitted exposures represent a level of risk small compared with other hazards of life. The Nuclear Regulatory Commission has stated[2], "Control of exposure to radiation is based on the assumption that any exposure, no matter how small, involves some risk. The occupational exposure limits are set so low, however, that medical evidence gathered over the past 50 years indicates no clinically observable injuries to individuals due to radiation exposures when the established radiation limits are not exceeded."

5. Sources of Radiation and Radioactivity

a. Discuss the order of magnitude of the average radiation levels in various areas at CNSI (e.g., inside Hot Cells, in Alpha Facility glove boxes, etc.) and the major sources of these radiation levels.

b. Discuss the order of magnitude of the number of curies of activity at specified locations at CNSI. State the approximate (order of magnitude) radiation level caused by this radioactivity.

c. Name the more significant hot spots at specified locations at CNSI.

d. Discuss the operations for which beta radiation is a concern.

e. Know the nuclides responsible for most of the gamma radiation penetrating the shielding at specified locations at CNSI.

f. Discuss the possible sources of airborne particulate and gaseous activity.

g. State and explain the basis for the airborne particulate limit, state the isotope(s) of major concern, explain why this isotope is limiting, and state how the problem would first be detected.

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[1] NCRP Report No. 39, issued January 15, 1971
[2] Appendix to NRC Regulatory Guide 8.13, Revision 1, November 1975

6. Counting Statistics

   a. Discuss the basic physical principles underlying the use of counting statistics.

   b. Define minimum detectable activity.

   c. Discuss how varying radiation background can affect accuracy of results.

   d. Discuss and explain the basis for various means for increasing the accuracy of a given measurement.

7. Radiation Surveys

   a. Demonstrate an ability to use and care for all radiac instruments (i.e., field check, etc.).

   b. Conduct routine surveys in radiation areas for alpha, beta, gamma, and neutron, and properly log the results. These need not be surveys of an entire area. Pre-determine locations where the ability is to be demonstrated so that time in the area can be reduced.

   c. Conduct a radiation survey using high- and low-range gamma survey meters and a gamma survey meter with a directional probe and properly log the results. These need not be surveys of an entire area. Pre-determine locations where the ability is to be demonstrated so that time in the area can be reduced.

   d. State the required frequency for all radiation surveys.

   e. Discuss in detail the specific procedures for performing each of the radiation surveys and the reason for each of the steps and techniques.

   f. Explain how to review and interpret the results of radiation surveys. Know what normal levels are expected and what action must be taken if actual readings exceed the expected readings or the limits.

   g. Describe how beta radiation is detected by beta-gamma survey instruments and discuss the relationships between the meter reading and actual beta field. Explain why this difference exists.

   h. Explain how to check radiac equipment for proper response to radiation.

   i. Explain what information is obtained using the battery-check position on the instruments. State how often the instruments must be calibrated.

8. Airborne Radioactivity Surveys

   a. Conduct an airborne particulate activity measurement with a portable air particle sampler and properly log the results.

   b. State the required frequency for airborne surveys.

   c. Discuss in detail the specific procedures for performing each of the measurements and the reasons for each of the steps and techniques.

   d. Explain how to review and interpret results of an airborne survey. Know what levels are normally expected and what action must be taken if actual readings exceed the expected readings or the limits.

   e. Estimate the airborne activity levels which will result from various casualties or incidents.

   f. Explain how internal contamination of personnel is controlled.

9. Contamination Surveys

   a. Conduct routine contamination surveys and properly log the results.

   b. State the required frequency for all contamination surveys.

   c. Discuss in detail the specific procedures for performing each of the contamination surveys and the reasons for each of the steps and techniques.

   d. Explain how to review and interpret the results of contamination surveys.

   e. Explain how counting statistics affect the determination of swipe activity.

10. Anti-contamination (Anti-C) Clothing

   a. Demonstrate proper procedure for donning and removing a full set of anti-C clothing.

   b. Demonstrate the proper method of wearing and removing dosimetry equipment with anti-C clothing.

   c. Discuss in detail the specific procedures for performing each of the above items and the reasons for each of the steps and techniques.

d. Explain what anti-C clothing should be worn under various circumstances.

e. State and explain the requirements for donning respiratory protection.

f. Demonstrate the proper procedure for putting on and removing masks, air supplied respirators, and air supplied hoods, including leak checks for masks and air supplied respirators. For personnel who are required to wear respiratory equipment with anti-contamination clothing, this demonstration shall be performed when donning and removing anti-contamination clothing as required.

g. State the conditions which require wearing masks, air supplied respirators, or air supplied hoods. Discuss the need for controlling radioactive work so that respiratory equipment need not be worn.

11. Contamination Control

a. Establish requirements for entry into a radiologically controlled area.

b. Survey personnel with an alpha and beta-gamma low-range survey meter and with a frisker.

c. Isolate and post a radiologically controlled area.

d. Establish the necessary radiological controls for removing a contaminated filter from a ventilation system.

e. Discuss in detail the specific procedures for performing each of the above items and the reasons for each of the steps and techniques.

f. Describe the construction and proper use of the several different types of containment areas. Certify proper setup of a containment area.

g. Describe the proper method for removing contaminated piping or ductwork.

h. Describe the proper method for venting radioactive systems.

i. Describe "controlled surface contamination area".

j. Explain the difference between fixed and loose contamination and explain that fixed contamination is controlled on the basis of radiation levels.

k. State and explain the basis for the limits for loose beta-gamma and for loose alpha surface contamination.

l. Explain why a swipe technique is not normally used for surveying personnel for contamination.

m. Explain the radiological control requirements for making an actual entry into a high radiation and controlled surface contamination area.

12. Decontamination

a. Discuss the different techniques of decontaminating an area, tool, or component, and properly handling the waste.

b. Explain the technique used when decontaminating areas where large variations exist in contamination levels.

c. Demonstrate understanding of the principles to be considered in decontamination by listing and explaining such items as provision for proper disposal of the removed radioactivity, isolation of area, steps to limit spread of surface contamination, adequate ventilation, use of high efficiency filtered vacuum cleaners, and use of respiratory protection.

d. Describe the procedures for decontaminating personnel and the reasons for each of the steps and techniques.

13. Transfer and Receipt of Radioactive Material

a. Discuss the procedures performed and records maintained for shipment of radioactive material.

b. Establish and monitor the necessary radiological controls for operation of solid waste packing.

c. Discuss in detail the procedures for performing the items listed above.

d. Define radioactive material.

e. Explain why the transfer of radioactive material is controlled.

f. Estimate the amount of activity in various items for transfer.

14. Exposure Control

a. State the two limits for whole body penetrating radiation. Know where to find the limits established for skin, forearms, and extremity doses and when to use them.

b. Explain why limits for doses to the skin, forearms, and extremities are set at higher levels than external whole body exposure limits.

c. Explain what types of radiation result in whole body or skin doses.

d. Discuss the guidelines which should be used for radiation exposures during emergency situations.

e. Explain the significance of "stay time" and how it is determined. Consider situations involving limiting radiation levels to extremities as well as situations involving only whole body radiation levels.

f. Define the term "High Radiation Area", describe how these areas are marked, and list and explain the precautions required.

g. Define the term "Radiation Area", describe how these areas are marked, and list and explain the precautions required.

h. Describe the personnel exposure "alert" system procedure and explain how and why it is used.

i. Discuss the action which should be taken if an individual exceeds exposure limits for external or internal radiation.

j. Be able to discuss the procedures for exposure control in various practical situations similar to the following:

(1) General area radiation levels of 150 mrem/hour near the radioactive waste processing system.

(2) Maintenance is required in a high radiation area with general area radiation level of one rem/hour and hot spots near the work site measuring 100 rem/hour on contact.

k. Explain who established legal limits on radiation exposure.

l. Explain who establishes the CNSI radiation exposure control levels and the approvals which must be obtained before exceeding the levels.

m. Discuss procedures and methods for minimizing the radiation exposure of all persons associated with radioactive work.

n. Discuss proper procedures and methods for handling and storage of radioactive components so as to minimize personnel radiation exposure.

o. Explain what action is required when an individual discovers that his pocket dosimeter is "off-scale".

15. Responsibility of the Individual

Know that it is the individual's responsibility to inform his employer of any previous or concurrent occupational radiation exposure received outside CNSI.

108. RADIOLOGICAL ACCIDENTS

Radiological Accident

a. A loss of control of radioactive material which presents a hazard to life, health, or property or which may result in any member of the general population exceeding limits for ionizing radiation.

b. Any accident involving radioactive materials or radiation exposure which prudence dictates to be of such consequence to warrant the information interest of the person. Included in this category are those events having domestic or international implications and those which are likely to give rise to inquiries by the public or press.

REQUIREMENTS:

1. CNSI shall prepare local plans consistent with DOE Manual Instructions. These plans shall use the standard radiation exposure and contamination criteria. CNSI accident plans shall be compatible with those of the State of Illinois.

2. These plans shall require treatment and care of injured personnel who are involved in a high radiation exposure or a casualty associated with radioactivity in accordance with the DOE Manual and consistent with the requirements of NRC Regulatory Guide 3.42 and BUMED Instruction 6470.10.

109. RADIOLOGICAL INCIDENT REPORTS

DISCUSSION: The following are considered radiological incidents and require reporting in incident reports. This is only a summary list of incident report requirements which are fully stated in the referenced articles.

1. External radiation exposure in excess of limits.

2. Internally deposited radioactivity greater than one-tenth of applicable limits associated with CNSI operations.

3. Skin contamination.

4. Personnel exposed to airborne radioactivity above limits without proper respiratory equipment.

5. Lost radioactive material associated with CNSI operations.

6. Any spread of contamination above the limits which results in loose surface contamination outside radiologically controlled areas or which stops work more than four hours.

7. Instances in which personnel who are required to wear dosimetry equipment receive greater than 1 millirem while not wearing the required dosimetry.

8. Improper control of high radiation areas or exclusion areas (e.g., locking personnel in a high radiation area or failure to lock or guard a high radiation area).

9. Unauthorized disposal of solid radioactive waste.

REQUIREMENTS: Since the seriousness of the incident might not be evident until all of the facts are compiled and evaluated, and since the formal report of the incident might be useful in prevention or critique of the incident must begin immediately and the resultant incident report must be issued promptly. The initial publication of the report shall not be delayed if further evaluation is required. Radiological control problems other than those listed above need not be reported as incidents unless they would be likely to have significant training benefit to other organizations.

PART 2 - SUMMARY OF RADIATION CONTROL LIMITS AND PROCEDURES

110. INTRODUCTION

The specific radiological limits and controls detailed and explained in the manual are summarized below. It is emphasized that these are only brief summaries of requirements which are fully stated in the referenced articles, and therefore, should not be used or referenced as requirements. Personnel are cautioned to read and understand the detailed requirements in the other sections of this manual before acting on information summarized here.

111. EXTERNAL RADIATION EXPOSURE LIMITS FOR PERSONNEL*

Limits for doses to the whole body from penetrating radiation are 5 rem per year and 3 rem per quarter year.

Limit for dose to the skin of the whole body is 3-3/4 rem per calendar quarter.

Limit for dose to the extremities (hand and wrist; foot and ankle) is 18-3/4 rem per calendar quarter.

Limit for dose to the forearm is 7-1/2 rem per calendar quarter.

Visitors are limited to 100 mrem per week unless written record of previous exposures shows higher exposures allowable.

112. RADIOLOGICAL SURVEYS*

Radiological surveys are performed by CNSI as applicable to support work programs. The surveys are performed to determine levels of radiation, airborne radioactivity, and surface contamination.

Examples of radiological surveys performed are as follows:

1. Gamma radiation measurements are taken: weekly in radiation and high radiation areas; monthly on potentially contaminated ducts and piping; and during initial entry to a critical facility.

2. Alpha, beta, gamma, and neutron measurements are taken as necessary to control personnel radiation exposure.

3. Airborne radioactivity is monitored frequently during radiological work.

4. Surface contamination surveys are performed weekly in occupied areas where radioactive materials are routinely handled and more frequently in occupied areas surrounding controlled surface contamination areas.

* These are only brief summaries of requirements which are fully stated in the referenced articles.

113. CONTROLLING RADIATION AREAS*

Accessible areas where a major portion of the body could receive a dose greater than 1 mrem in one hour are posted as radiation areas and no loitering is allowed. Areas where a major part of the body could receive a dose of 100 mrem in one hour are posted as high radiation areas, and only authorized personnel allowed entry; no loitering is allowed in these spaces.

Potentially contaminated ventilation exhaust ducts and radioactive liquid waste disposal piping outside radiation areas and access openings to areas containing such piping are permanently marked as required.

114. PERSONNEL MONITORING*

Personnel likely to receive a dose in excess of 125 mrem in a calendar quarter are monitored by a dosimetry badge. All personnel entering a high radiation area or remain in an area where 5 mrem can be received in one hour wear both a dosimetry badge and pocket dosimeter.

Dosimetry badges are normally processed at least quarterly. An Alert System is established for personnel likely to exceed 1.25 rem in a calendar quarter year.

Radiation exposures to personnel are recorded. Pocket dosimeter readings are recorded; 0-200 mrem dosimeters are recharged before their readings exceed 150 mrem. Personnel are frequently informed of their accumulated radiation exposures and upon request.

Personnel are monitored for internal radioactivity via whole body count.

115. SAFETY PRECAUTIONS FOR RADIATION SHIELDING*

Permanent shielding is not to be removed without a formal written procedure approved by the Radiation and Safety Officer. Changes to the permanent shielding and changes in the use of spaces which could affect specific shield design criteria are not made without approval by the Radiation and Safety Officer. If shielding effectiveness is lost, personnel should be kept away from high radiation areas. The adequacy of replaced shielding is verified by radiation survey.

116. CALIBRATION, MAINTENANCE, AND SAFETY PREACAUTIONS FOR PORTABLE RADIAC EQUIPMENT*

Survey instruments are calibrated at least every 6 months. Batteries are checked at least monthly. Survey instruments are checked with radiation sources periodically when instruments are in use. Radioactive test sources are accounted for.

*These are only brief summaries of requirements which are fully stated in the referenced articles.

117. WASTE DISPOSAL*

Highly radioactive liquids are solidified and disposed of as solid waste

Solid radioactive wastes are shipped for land burial disposal in drums and other containers meeting Department of Transportation requirements

118. AIRBORNE RADIOACTIVITY*

Masks are worn in areas where airborne radioactivity exceeds or is likely to exceed the limits of Article 402. Personnel wearing filter-type masks should not unnecessarily remain in areas where airborne radioactivity exceeds 100 times these limits; if access is required to such areas, air or oxygen supply breathing apparatus is used. When personnel may be exposed to airborne radioactivity, appropriate ventilation should be provided.

Continuous air particle detector alarms are set as near the limits . as practicable. Airborne radioactivity is frequently measured with portable air samples and recorded while radioactive materials are being handled The procedures of Article 404 are followed when high airborne radioactivity conditions exist.

Potential sources of airborne alpha radioactivity are discussed in Article 401.

High efficiency filters are checked before and after installation and are replaced when the pressure drop or radiation level is excessive or when a filter is damaged.

119. SURFACE CONTAMINATION*

Areas are posted as controlled surface contamination areas where loose surface beta-gamma contamination exceeds 450 pCi/100 cm^2 as determined by the methods of Articles 511 and 512 or where alpha contamination exceeds 50 pCi/100 cm^2. Only personnel in appropriate anti-contamination clothing (Article 524) are allowed to enter controlled surface contamination areas. No eating, drinking, smoking, or chewing is permitted in controlled surface contamination areas. Levels and extent of loose surface contamination inside controlled surface contamination areas are limited to control possible airborne radioactivity, to facilitate limiting the spread of contamination, and to simplify subsequent decontamination.

Radioactive spills should be controlled.

Loose surface contamination on components and parts to be returned to stock should be limited.

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* These are only brief summaries of requirements which are fully stated in the referenced articles.

120. HANDLING RADIOACTIVE MATERIALS*

Materials are handled as radioactive if their radiation level is greater than 0.1 mrem/hour beta-gamma above background or if their loose surface contamination exceeds 450 pCi/100 cm^2 beta-gamma radioactivity or 50 pCi/100 cm^2 alpha radioactivity.

Contamination Containment Areas are used when working with materials containing loose contamination.

Radioactive material is tranferred only to activities authorized or licensed to receive these materials.

Radioactive materials are marked with tags bearing the standards symbol and the dose rate.

Radioactive materials are accounted for to assist in assuring that radioactive material is not lost, improperly transferred, or stored or used in unsatisfactory locations. The accountability system is evaluated at least once every six months to ensure accountability of all radioactive material.

Radioactive materials are not carried through food preparation and eating spaces; carrying through office spaces is avoided if practicable.

Shipments of radioactive material received are inspected; a receipt is sent to the shipper.

Shipments of radioactive materials comply with regulations of the Department of Transportation.

Yellow plastic film materials are used for packaging and containing radioactive materials having or suspected of having loose surface contamination and are prohibited from use for any other purpose.

121. RECORDS REQUIRED

This article summarizes the records required throughout this manual. These records are listed by subject.

1. Airborne Radioactivity

   a. Portable air samples

   b. Air Particle Detector measurements

   c. Ventilation exhaust monitoring

2. Radiation Exposure

   a. Measurements of dosimetry badges worn on extremities.

   b. Alert list.

   c. Results of posted dosimetry badges.

   d. Pocket dosimeter readings.

   e. Radiation exposure records stated in the DOE Manual.

   f. Visitor exposure.

   g. Internal exposure exceeding one-tenth of applicable limits.

   h. Monitoring results of internally contaminated personnel.

3. Evaluation Records

   a. Periodic evaluations of radiological controls practices and familiarity of personnel with radiological controls procedures.

4. Radioactive Material

   a. Radioactive material shipping records.

5. Shielding

   a. Verification of proper replacement of shielding.

   b. Initial or final shield survey.

6. Surface Contamination

   a. Surveys.

   b. Skin contamination incidents.

   c. Contamination in uncontrolled areas.

   d. Contamination in radiological facilities resulting in loss of half a shift of work time.

   e. Painted-over contamination.

* These are only brief summaries of requirements which are fully stated in the referenced articles.

7. Training

a. Final written examination grades for each trained individual.

b. Master copy of each final examination given.

c. Summary statement of radiological controls personnel individual performance during final examinations and a summary of examination areas covered.

d. Training of radiological control personnel per underlined topics of Article 107 (Article 105).

e. Training of personnel per underlined topics of Article 106 (Article 105).

f. Re-verification of training (Article 105).

8. Radioactive Waste

a. Solid radioactive waste.

9. Radiation Surveys

In addition to the above records, the following records are also required.

10. Radiological Control Facilities Released for Unrestricted Use

11. Radioactive Waste

Radioactive liquid waste and related data

122. REPORTS REQUIRED*

This article summarizes the reports, messages, dispatches, and notifications required throughout this manual under the single classification of report. These reports are organized below according to the time frequency they are required. Unless otherwise indicated below, the reports should be to NRC.

1. Routine Reports

a. Annual Report

(1) Personnel exposure to ionizing radiation (to NRC) Article 238).

(2) Personnel radiation exposure summary

* These are only brief summaries of requirements which are fully stated in the referenced articles.

2. Non-routine Reports

a. Personnel Radiation Exposure or Skin Contamination

(1) Personnel radiation exposure exceeding the limits of this manual.

(2) Personnel radiation exposures exceeding the limits of DOE Manual.

(3) Visitor radiation exposure (to Parent Organization).

(4) Personnel internal exposure (to individual and to PNR).

(5) Incident of high airborne radioactivity where personnel are not wearing masks.

(6) Incident of personnel skin contamination.

b. Other Non-routine Reports

(1) Incident of surface contamination in radiological areas resulting in loss of half a shift of working time.

(2) Radioactive shipment inconsistency between contents and shipping papers or shipment which do not meet applicable transportation regulations (to Shipper and NRC).

(3) Incident of loss of radioactive material.

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* These are only brief summaries of requirements which are fully stated in the referenced articles.

SECTION II EXTERNAL RADIATION

CONTENTS

PART I - EXTERNAL RADIATION EXPOSURE LIMITS

201. GENERAL

DISCUSSION: The radiation exposure limits of Articles 202 through 204 are used for controlling personnel external occupational radiation exposure (excluding medical and dental exposures). The limits and controls in this part are for radiation exposure associated with CNSI operations and are not used in place of controls for other types of radiation exposure. These limits are based on the radiation protection guides of the Environmental Protection Agency (now incorporating the functions of the Federal Radiation Council), requirements of the Code of Federal Regulations, Title 10, Part 20, "Standards for Protection Against Radiation" (10CFR20), and recommendations of the National Council on Radiation Protection and Measurements (NCRP). These limits are such that no detectable biological effects are expected, even if exposures extend for a lifetime at these levels. Nevertheless, these radiation protection guides stress maintaining personnel exposures as low as practicable, even below these limits. The various procedures and controls used to meet these limits are described in succeeding parts of this section which discuss shielding, area monitoring with radiac equipment, personnel monitoring, procedures to minimize exposure, and radiological control agreements.

REQUIREMENTS: As used in this part, calendar year refers to the twelve month period from January to December. As used in this part, quarter year refers to specific periods of about 3 months: January through March, April through June, July through September, and October through December. It is permissible to define a quarter year and start monthly issue of dosimetry equipment on other days than the first of the month. However, annual exposures and annual reports shall be on a calendar year basis using dosimetry equipment processed within ± 15 days of the end of the year.

202. OCCUPATIONAL EXPOSURE OF WHOLE BODY AND CRITICAL ORGANS TO PENETRATING RADIATION

DISCUSSION: The limits listed below for occupational whole body exposure apply to general exposures of penetrating radiation to major portions of the body and also to exposures of certain organs*. Other limits which apply to radiation of low penetrating po-er are discussed in Article 203.

REQUIREMENTS:

1. Yearly Limit: Doses of penetrating radiation to the whole body or certain organs* shall not exceed 5 rem per calendar year, organs not specified shall be limited to 15 rem per year. However, in emergency situations, Article 205 applies.

* Examples of these certain organs are the head and trunk, gonads, lens of the eyes, and active bloodforming organs (primarily the bone marrow).

NRC can approve in unusual circumstances a cumulative radiation exposure limit of 5 rem for each year of a person's life over age 18 (that is 5(N-18) rem, where N is the person's age in years) provided the quarterly limit of paragraph 2 below is not exceeded. Persons less than 18 years of age shall not receive in excess of 0.5 rem per year.

2. Quarterly Limit: Doses of penetrating radiation to the whole body or certain organs* shall not exceed 3 rem per quarter year. This quarterly limit is allowed provided the limit in 1 above is not exceeded.

3. Local Control Levels: Individual radiation exposures have consistently been far below the above limits. Thus, a more effective means is needed to further minimize personnel radiation exposure. CNSI radiation exposure control levels below the preceding limits are used as one means to maintain personnel radiation exposures as low as practicable. CNSI shall use the following as radiation exposure levels:

   a. Except as approved in paragraph c, below, doses of penetrating radiation to the whole body or certain organs* of personnel who are authorized to receive radiation exposure in the course of their routine work or who routinely enter high radiation areas shall not exceed 1.25 rem per quarter year and 3 rem per calendar year.

   b. Except as approved in paragraph c, below, doses of penetrating radiation to the whole body or certain organs* of all other personnel shall not exceed 0.5 rem per calendar year. Similarly, doses to the skin of the whole body and extremities shall not exceed one-tenth of the limits of Articles 203 and 204, respectively.

   c. Prior to any individual exceeding the above control levels, written approval shall be obtained from the Radiation and Safety Officer.

4. Radiation Exposure Limits for the Unborn Child: The National Council on Radiation Protection and Measurements (NCRP) recommends:

"During the entire gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother should not exceed 0.5 rem."

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* Examples of these certain organs are the head and trunk, gonads, lens of the eyes, and active bloodforming organs (primarily the bone marrow).

In Report 39, "Basic Radiation Protection Criteria", the NCRP "recommends vigorous efforts to keep radiation exposure of an embryo or fetus to the very lowest practicable level." The NCRP also states: "The need to control exposure to the embryo and fetus is paramount. It becomes the controlling factor in the occupational exposure of fertile women."

The Nuclear Regulatory Commission took the position that its licensees and contractors "should make particular efforts to keep the radiation exposure of an embryo or fetus to the very lowest practicable level during the entire gestation period as recommended by the National Council on Radiation Protection and Measurements."

CNSI policy is that particular efforts shall be made to keep to the very lowest practicable level exposure to the unborn child from radiation associated with CNSI operations.

Personnel shall be trained on the biological risks to the embryo and fetus from radiation in accordance with Article 106.

203. OCCUPATIONAL EXPOSURE TO THE SKIN OF THE WHOLE BODY

REQUIREMENTS: Doses of radiation to the skin of the whole body shall not exceed 3-3/4 rem per quarter year.* The increased allowance of this limit over those of Article 202 is permitted to account for radiation of low penetrating power such as betas and low level energy gammas, which affect only the skin.

For example, a quarterly combined whole body dose of 3 rem of high energy gammas and 3/4 rem of betas would meet the whole body quarterly limit for penetrating radiation; and since it produces a total exposure of 3-3/4 rem to the skin, it would also meet the quarterly limit of this article.

204. OCCUPATIONAL EXPOSURE TO THE FOREARMS AND EXTREMITIES

REQUIREMENTS: Doses of radiation to the forearms shall not exceed 7-1/2 rem per quarter year**. Doses to an extremity (hand and wrist; foot and ankle) shall not exceed 18-3/4 rem per quarter year. This higher allowance for each of the forearms and extremities is applicable to betas, gammas, and neutrons of any energy.

For example, a quarterly combined whole body dose of 3 rem and a subsequent dose to a hand of 15-3/4 rem would meet the whole body quarterly limit; and since it produces a total exposure of 18-3/4 rem to the hand, it would also meet the quarterly limit of this article.

* Although the Nuclear Regulatory Commission allows an exposure of 7-1/2 rem per quarter year, a lower limit is adopted here to be consistent with the 1971 recommendation of the National Council on Radiation Protection and Measurements.

**Allowable exposure of 18-3/4 rem per quarter year to the forearms.

205. OCCUPATIONAL EXPOSURE EXCEEDING LIMITS

REQUIREMENTS: During normal work, no person or organization has the authority to approve exceeding quarterly or yearly exposure limits of Articles 202.1, 202.2, 203, or 204.

1. In case an individual has exceeded any of these limits, except the local control levels, he shall immediately be removed from duties involving occupational exposure to ionizing radiation until the end of the exposure period (quarter or calendar year, as applicable).

2. In case an individual has received an accumulated dose of ionizing radiation in excess of 5(N-18) rem, he shall immediately be removed from duties involving occupational exposure to ionizing radiation until his exposure record has been evaluated and subsequent exposure limits are established as necessary. This evaluation will be performed by Radiation and Safety Officer.

206. OCCUPATIONAL EXPOSURE AT ORGANIZATIONS OUTSIDE CNSI

REQUIREMENTS:

1. For personnel who receive occupational radiation exposure at another organization outside CNSI (e.g., during part-time work or while on leave of absence), controls shall be established to ensure the quarterly or yearly exposure limits of Articles 202.1, 202.2, 203, or 204 are not exceeded. Unless adequate controls can be established, personnel who receive occupational radiation exposure at organizations outside CNSI shall not be assigned duties involving occupational radiation exposure within CNSI.

2. Exchange of occupational radiation exposure information with other organizations is permissible. Upon receiving a written request from the individual, a report of a person's total radiation exposure received while working for CNSI shall be supplied. This report shall contain the person's total lifetime exposure with at least the current calendar year broken down by quarter year. The person's internal exposure shall be reported as described in Article 406. This information shall not be provided unless the requesting organization or person proves identifying data including, at a minimum, the person's name and social security number and signature of the person authorizing his own exposure to be released.

PART 2 - PERMANENT RADIATION SHIELDING

207. RADIOLOGICAL PRECAUTIONS FOR PERMANENT SHIELDING

REQUIREMENTS: Permanent shielding shall be installed in facilities and modifications to existing facilities where routine operations, materials or equipment produce or involve high radiation levels or where a credible accident could result in such levels.

1. Changes in use or operation of facilities which could affect radiation levels outside the shielding in excess of the specific design levels and changes in the use of areas surrounding shielding must have prior approval of the Radiation and Safety Officer.

2. Removal of permanent shielding shall not be performed unless the source of radiation is removed or shutdown and approval is obtained from the Radiation and Safety Officer.

3. Radiation surveys shall be performed and documented by Radiological Control personnel in accordance with paragraph 225 in the following cases:

   a. After shielding has been initially installed or reinstalled to verify that design radiation levels are not exceeded.

   b. During removal of shielding so that personnel are not unexpectedly exposed to radiation.

   c. After changes in use or operation of the shielded facility.

   d. After modification to the shield or changes in shield materials.

4. Records of the approved shielding design detailing the calculations, the design basis accident, material specifications, shield configurations, construction, and initial radiation surveys verifying design conformance shall be maintained up-to-date and readily available for reference. This record requirement also applies to shield modifications and to changes in the use or operation of the facility as in paragraph 2 above. This information need not be documented for shielding installed prior to May 30, 1978 for which operational and survey data show meeting the requirements.

5. Design of permanent shielding shall be based on a maximum radiation level of 1 mrem per hour at one inch from the shield. This will ensure that exposures will not exceed the non-occupational limit of 0.125 rem per quarter assuming an occupancy factor of 25% during a normal 40-hour work week. Alternate criteria may be approved by the Radiation and Safety Officer provided exposure limits are not exceeded by personnel having access to the area outside the shield.

208. PROCEDURES IN THE EVENT OF HIGH RADIATION LEVELS

DISCUSSION: The loss of solid shielding can result in high levels of radiation in areas outside the shield. The loss of water from a tank used to shield a gamma or neutron source could produce significant changes to radiation levels. The inadvertent slight movement or damage to solid shielding can result in high level radiation beams.

REQUIREMENTS: The following procedures shall be followed in the event of a loss of shielding which could result in abnormal radiation level increases in an area.

1. Immediate Action:

   a. Leave the area affected by the shielding loss and warn other personnel in the area and nearby affected areas as soon as possible.

   b. Notify Radiological Control and the area manager.

   c. Isolate the affected areas.

2. Supplementary Action:

   a. Determine radiological control precautions for re-entry.

   b. Restore shielding.

   c. Evaluate and establish conditions to prevent recurrence of the event.

Personnel working in areas where shielding loss is possible (e.g., where liquid shielding is utilized) shall be instructed in the specific actions to be taken in the event of a loss of shielding.

PART 3 - RADIATION SURVEY REQUIREMENTS

209. CALIBRATION AND MAINTENANCE OF SURVEY INSTRUMENTS

REQUIREMENTS: This article provides the minimum calibration and maintenance requirements for radiation survey instruments. Only instruments with a current calibration label shall be used for conducting surveys. Instruments suspected of providing incorrect measurements shall be removed from service pending a satsifactory response check.

1. Calibration Frequency: Survey instruments in use shall be calibrated at least every six months and after instrument repairs or as required by applicable instructions. If some types of survey instruments are frequently out of calibration at the end of this period or frequently fail in use, initiate action to correct the problem. The current calibration label showing the date the instrument is due for calibration shall be attached to the instrument.

2. Battery Checks: Battery checks for portable monitoring equipment shall be performed to ensure the battery voltage is high enough to permit correct measurements; batteries shall be replaced as necessary.

   a. For instruments with a battery check switch position, the battery check shall be performed prior to use.

   b. For instruments without a battery check switch position, the batteries shall be checked at least monthly. Monthly battery check information shall be kept with the instrument. Since this information is used only to verify that the batteries have been satisfactorily checked during the current month, this information need only be retained until the subsequent monthly check.

3. Response Source Checks: Radiation survey instruments shall be response checked with known sources to verify that the instruments respond properly to radiation. Such checks have proven necessary because instrument failures can occur which would allow proper battery check but improper radiation response. The meter shall be checked to respond to a known dose rate rather than merely verifying that radiation causes the indicator to move. The meter shall be exposed to the source for the indicator to move. The meter shall be exposed to the source for sufficient time to permit the meter response to stabilize. Results of this check shall be kept with the instrument; they need only be retained until the subsequent check has been made.

a. Friskers and alpha survey meters shall be response source checked such that any measurements taken with these meters are accomplished within 1 day after a satisfactory response source check. When these instruments are in continuous use, response source checks once each day satisfy this requirement.

b. For continuous air montiors (e.g., air particle detectors), response source checks shall be performed when the instrument is placed in operation or, when in operation, within one week after being response source checked. When the instrument is temporarily removed from operation, response source checks are not necessary before operation unless more than one week has elapsed since the last response source check.

c. All other instruments not included in paragraphs a and b above shall be response source checked such that any measurements taken with these instruments are accomplished within one week after a satisfactory response source check. When these instruments are in continuous use, this requirement results in weekly response source checks.

210. SAFETY PRECAUTIONS FOR USING SURVEY METERS

REQUIREMENTS: The following safety precautions shall be observed by personnel using radiac equipment:

1. Only personnel trained in the use of portable radiation monitoring equipment shall be allowed to use this equipment. As a minimum, training shall consist of a lecture on the use of the instrument and the meaning of its measurements, a demonstration of its proper handling, and a period of supervised use.

2. Damage to or loss of a radioactive source can result in spreading, inhaling, or ingesting contamination. Therefore, radioactive sources require careful handling and accountability control, to minimize the possibility of inadvertent mishandling or loss of small radiac calibration or response check sources. If a source is lost, immediate steps shall be taken to recover the source and minimize radiation exposure to or contamination of personnel as a result of the lost source.

   In order to prevent sources from being inadvertently lost, all sources shall be held under signature custody. These procedures are in addition to and do not supersede the accountability requirements for sources controlled under Nuclear Regulatory Commission or Agreement State Licenses.

Except for sources which are permanently attached to radiac instruments (e.g., check sources), radiac check sources which are not in use shall be kept in a locked cabinet. The number of keys to the cabinet and the number of personnel having access to the keys shall be kept at a minimum. Combination locks are permitted and, when used, the number of personnel having the combination shall be kept at a minimum.

211. RADIATION SURVEYS

REQUIREMENTS: Radiation surveys are performed as necessary to ensure personnel do not exceed radiation exposure limits and to meet requirements for posting radiation areas. These surveys are performed to determine whether abnormal radiation levels exist and to determine the extent and magnitude of radiation levels. The surveys in this article shall be the minimum performed.

1. Facilities Containing Radioactive Material

a. Radiation surveys shall be performed to control radiation exposure whenever operations are performed that might be expected to change existing radiation levels. Examples of such operations include, movement or removal of temporary shielding, radioactive waste processing, and relocation of highly radioactive materials.

b. Temporary boundaries (e.g., rope boundaries) of radiation areas shall be surveyed daily to ensure radiation areas do not extend beyond posted boundaries.

c. (1) Gamma surveys shall be performed at least weekly in occupied posted radiation areas, and high radiation areas, and in radioactive material short-term storage areas. Long-term storage areas shall be surveyed at least monthly.

d. When highly radioactive equipment (e.g., contact radiation level greater than 200 mrem/hr) is moved, gamma surveys shall be performed in spaces surrounding work areas (including the spaces above and below them if applicable) where personnel are likely to be exposed to a radiation or high radiation area.

e. Potentially contaminated ducts, piping, and hoses outside radiologically controlled areas shall be surveyed at least monthly for gamma radiation when in use or at least annually when not in use (e.g., deactivated systems).

f. Beta-gamma surveys of ventilation filters shall be performed whenever work is performed on these filters.

g. Other surveys shall be performed as necessary to control personnel exposure to gamma, beta, and alpha radiation. Such surveys shall include: (1) a gamma survey during initial entry into a tank containing potentially radioactive piping; (2) gamma surveys in spaces where significant radiation levels might exist from an adjacent operating facility; (3) beta as well as gamma (use of open-window G-M detectors is acceptable) measurements when personnel might come in contact with surfaces exposed to beta-emitting contamination.

h. Surveys shall be conducted when performing operations which could result in personnel being exposed to small intense beams of radiation. These operations include working with spent fuel handling containers, when removing shielding, or when opening shipping/storage containers of radioactive equipment. When surveying areas or equipment where intense small beams of radiation could be present, the instrument shall be used with an audible response (e.g., earphones). An audible response is necessary since the visible meter response is usually considerably slower. The probe shall be moved slowly enough so that the instrument has a chance to give an audible increase for a large radiation level increase. If an audible increase in noted, the probe shall be moved to the location producing maximum response and the meter read. If general dose rates are high such that a change in audible response is not detectable, slower surveys must be performed so that beams will be detectable by observing the meter. The speed of moving the probe is determined by considering the size of the probe, the instrument response time, the possible intensity of the beam, and the general dose rates in the area. Particular attention shall be given to thoroughly scanning suspected areas such as portable shield sections and areas which are or are likely to be occupied. For equipment with complex shield design, surveyors shall be briefed on the equipment design so that areas most likely to have small beams can be given special attention.

i. Gamma radiation surveys shall be performed monthly on a revolving basis in the areas of the work site where radioactive materials are not stored or handled. These surveys shall be scheduled so that all spaces are surveyed at least annually. The survey shall consist of a scan of accessible areas and lockers with either a HP-210 frisker or a portable gamma scintillation survey meter (if available) and shall require the expenditure of approximately 1 man-day per quarter to perform the survey. The usefulness of such surveys has been demonstrated by organizations which have found radioactive materials in non-radioactive work and storage areas.

2. Records of radiation surveys shall be retained for three years. These records shall be reviewed periodically so that trends toward increasing radiation levels will be detected as early as possible. The survey information shall be recorded on a standard form or on locally prepared forms which contain at least the following information:

   a. Date and time of survey.

   b. Reason for survey and type of radiation measured (e.g., weekly gamma).

   c. Type and identifying number of instruments used (e.g., E500B No. _____).

   d. Location (shall be shown on a survey map or listed in a table).

   e. Radiation level measured.

   f. Remarks.

   g. Signature of surveyor.

   h. Signature of persons reviewing results.

212. CONTROL OF RADIATION AREAS

REQUIREMENTS: Specified below are requirements for the posting of radiation areas. It is permissible to cover (but not remove) permanently posted signs if the area referred to by the sign is not a radiation area. When such signs are temporarily covered, positive control must be established to ensure the signs are uncovered prior to subsequent operations that require the area to be posted.

1. High Radiation Areas: Accessible areas where a major portion of the body could receive a dose in excess of 100 mrem in one hour shall be designated as high radiation areas. Major portions of the body include any portion of the head and trunk. Such areas shall be posted and locked or guarded. The requirement to lock or guard a posted high radiation area does not apply to tanks or voids posted as high radiation areas if entry requires the removal of complex closures. Positive controls shall be established for each individual entry into a high radiation area and shall be established in such a way that no individual is prevented from leaving the high radiation area. Prior to locking an unoccupied high radiation area, the area shall be inspected to ensure that no personnel remain inside. No loitering or entry by unauthorized

personnel shall be allowed in these spaces. Signs similar to that shown in Figure II-1 shall be used to identify these areas. Signs shall contain the conventional magenta three-bladed symbol on yellow background and the words "CAUTION HIGH RADIATION AREA". Signs similar to that shown in Figure II-3, "PERSONNEL DOSIMETRY REQUIRED" shall also be posted. Instances in which high radiation areas are not controlled in accordance with the requirements of this paragraph (e.g., locking personnel in a high radiation area or failure to lock or guard a high radiation area) shall be reported to NRC as an incident report.

2. Radiation Area: Accessible areas where a major portion of the body could receive a dose from 1 mrem to 100 mrem in one hour shall be posted as radiation areas*. Major portions of the body includes any portion of the head and trunk. To mark such areas, signs shall be conspicuously posted; signs shall contain the conventional magenta three-bladed symbol on yellow background and the words "CAUTION RADIATION AREA"; signs are permitted to state the general area radiation level. No loitering is allowed in these spaces. Signs similar to that shown in Figure II-2 shall be used to identify these areas.

3. Radioactive Materials Area: Entrances to areas where radioactive materials are handled or stored shall be posted with signs having the conventional magenta three-bladed symbol on yellow background and the words "CAUTION RADIOACTIVE MATERIAL". This posting is in addition to posting required for control of radiation areas, high radiation areas, and radiologically controlled areas.

* A radiation area is defined in 10CFR20 as an area in which personnel could receive a dose in any one hour of 5 mrem or in any 5 consecutive days a dose in excess of 100 mrem. The 1 mrem in one hour is derived from using the more restrictive 100 mrem in 5 consecutive days (i.e., 100 mrem/120 hrs., which is approximately 1 mrem in one hour).

4. Exclusion Areas: Areas where access would result in personnel exceeding the radiation exposure limits of Article 202 in a very short time shall be designated Exclusion Areas and personnel access prohibited. All requirements for control of high radiation areas shall be applied to exclusion areas except signs shall state "EXCLUSION AREA" instead of "High Radiation Areas" and no personnel shall be permitted to enter exclusion areas. Areas where radiation levels (on contact with any surface or item) exceed 3 rem/hour shall (1) be posted as exclusion areas, or (2) be operated using a written procedure, approved by Radiation and Safety Officer, which provides positive control of personnel entries to the area and controls radiation exposures to personnel working in the area. Prior to permitting personnel to enter an area which has been designated as an exclusion area, a person designated by the area supervisor shall determine that the area no longer meets the criteria for an exclusion area and the exclusion area shall be disestablished. Under no conditions shall personnel be allowed to enter an exclusion area.

5. Entrance to Radiation Areas: Entrances to Radiation Areas shall be conspicuously posted with "PERSONNEL DOSIMETRY REQUIRED" signs, shown in Figure II-3.

6. Potentially Contaminated Ventilation Exhaust Ducts and Waste Disposal System Piping: Piping and ducts are marked so that personnel can readily identify the system to which the piping or ducts belong and trace the systems through successive spaces. In conjunction with this marking, for potentially radioactive piping and ducts outside controlled areas the designation "MONITORED" shall also be permanently marked so that it can be easily recognized by monitoring and maintenance personnel. These systems shall not be permanently marked as "RADIOACTIVE" since they are not expected to be contaminated.

7. Fixed Contamination in areas other than 8 below shall be marked with a warning sign such as the following: "CAUTION - FIXED RADIOACTIVE CONTAMINATION - RADIOLOGICAL CONTROLS REQUIRED". Examples of such areas include contaminated paint.

8. Access Openings to Tanks and Voids which contain potentially radioactive piping shall be marked with the name of the system to which the pipe belongs and a warning such as the following: "CAUTION-CONTAINS POTENTIALLY RADIOACTIVE PIPING - RADIOLOGICAL CONTROLS REQUIRED FOR ENTRY".

9. Instrument Test Source Closures which provide access for the source shall be locked. A sign stating "CAUTION - CONTAINS RADIOACTIVE SOURCE - RADIOLOGICAL CONTROLS REQUIRED FOR OPENING" shall be permanently affixed to the access closure.

10. Potentially contaminated ducts, hoses, and piping shall be marked so that personnel can readily identify the system to which the piping or ducts belong and trace them through successive areas. In addition, the following requirements apply:

    a. Internally contaminated or potentially internally contaminated piping, hose and ducts shall be marked to indicate radiological controls are required for work on the systems. A posted sign can serve for such piping in a single space without marking each individual pipe.

    b. Outside radiologically controlled facilities, piping, hose, and ducts which normally are not contaminated but are monitored periodically to verify they are not contaminated shall be permanently marked in black or white letters with words such as "NOTIFY RADIOLOGICAL CONTROLS BEFORE WORK ON THIS SYSTEM". An example of such a system is ventilation ducts downstream of high efficiency particulate air filters. Such systems shall not be marked as radioactive since they are not normally radioactive and since marking as radioactive might be misleading to a public observer.

213. RADIOLOGICAL WORK PERMIT

DISCUSSION: The Radiological Work Permit (RWP) is used to delineate conditions and protective measures to prevent inadvertent exposure of personnel to radiation or radioactive contamination. A procedure approved by the Radiation and Safety Officer that includes necessary radiological controls may be substituted for the RWP ~~(Article 241)~~. The radiological conditions associated with the work to be performed shall be recorded in the procedure or on the RWP; also specified are the protective measures required by personnel entering the designated area. The following requirements are established to assist in the proper use of the Radiological Work Permit.

REQUIREMENTS:

1. The RWP is necessary for work operations not specifically covered by a procedure approved by the Radiation and Safety Officer, that are performed in an area (by personnel other than those normally assigned to the area) where any of the following conditions exist or could be produced:

   a. Airborne contamination in excess of those concentrations listed in current concentration guides.

   b. Surface contamination in excess of the amount specified for clean areas.

   c. External radiation levels in excess of 5 mrem/hr.

   d. Whenever the need for an RWP is in question, such as when soil is to be excavated adjacent to a radiologically controlled facility, Radiological Control should be contacted to determine if potential radiological problems may be encountered. Radiological Control will then determine if an RWP is required.

2. Signs indicating the need for the RWP will be conspicuously posted at the entrances to areas where the RWP is required. The area supervisor is responsible for insuring that such signs are posted.

3. RWP forms are available from appropriate area supervisors, or Radiological Control. Personnel who require or initiate the RWP will complete that portion which includes the location and details of the job. Radiological Control will complete the sections on radiological hazards and controls. Prior to beginning the work specified on the RWP, the form must be signed by the worker, Radiological Control, and the applicable area supervisor.

4. Before scheduling any work, the personnel planning the job should have assurance from Radiological Control that the work can be performed with a specified degree of radiological coverage. Possible delays in performing the work may result if this action is not taken.

5. Radiological Control will determine the degree of monitoring required for a specific operation. This determination will be based on the potential for radiological problems and the experience of the personnel conducting the operation. If non-routine coverage is required, it will be so noted on the RWP.

6. When an operating department is notified in advance that work requiring an RWP is scheduled for a particular time, the department may initiate the RWP a day before the planned job, indicating the job location and details of the work to be performed. The RWP is then forwarded to Radiological Control for completion during the workday prior to the beginning of the job. The RWP can then be picked up by the worker who is to do the job.

7. Each RWP shall name the workers to whom it is issued. It is permissible for a crew of workers to use a single RWP, but when more than one crew works on a single job (e.g., on consecutive shifts), each crew shall be issued a separate RWP.

8. Each RWP shall be signed by Radiological Control and by the appropriate area supervisor at the initiation of each work shift for which the RWP is used. These signatures indicate that the area working conditions and the necessary protective measures are correctly stated on the RWP.

9. An RWP shall terminate following its use for five work shifts, or at 11:59 p.m. on the Sunday following its initiation. If the work is to be continued, a new RWP must be initiated.

10. While an RWP is in effect, copies 1 and 2 shall be retained by the user, copy 3 is retained by Radiological Control, and copy 4 is retained by the area supervisor. When the RWP is terminated, copy 1 must be returned to Radiological Control and copy 2 is delivered to the area supervisor. Radiological Control shall monitor that all RWPs are terminated within the time allotted by paragraph 9 above, and shall maintain copies of all terminated RWPs for three years.

Employees assigned to any particular area who perform routine duties and Radiological Control personnel specifically trained and approved for work in the area are exempt from using the RWP. Area supervision may, with the concurrence of the Manager, Radiological Control, exempt other employees from the use of the RWP by issuing these employees a special permit; however, the supervisor issuing the special permit is responsible for ensuring and documenting that the employee is trained, in the radiological conditions and control procedures in that area.

Individuals or groups such as interviewees, inspection committees, and tour visitors who are escorted full time by the area supervisor or his representative are not required to obtain an RWP. The use of an RWP is not necessary when emergency conditions exist in an area.

214. CONTINUOUS COVERAGE BY RADIOLOGICAL CONTROL PERSONNEL

REQUIREMENTS: Radiological control personnel are required immediately during unusual situations such as a fire involving radioactivity, leaking radioactive piping systems, or for radiological accidents. Therefore, at least one person qualified as a Radiological Control Technician shall be available and designated to respond in such situations on the job site at all times. When operations of a critical nature are being performed, at least one experienced radiological control supervisor shall be available to handle any unusual situation.

PART 4 - PERSONNEL MONITORING FOR RADIATION EXPOSURE

215. DOSIMETRY PROCESSING

DISCUSSION: Dosimetry used by CNSI consists primarily of thermoluminescent dosimeters (TLDs).

REQUIREMENTS: CNSI personnel shall use dosimetric devices as described in this article and in Article 234. Dosimetry procedures shall be approved by NRC.

1. Self-evaluation of dosimetry processing shall be conducted semiannually by the Radiation and Safety Officer.

2. Thermoluminescent dosimeter (TLD) badges shall be processed at least quarterly. Monthly processing is required for persons likely to receive radiation exposures approaching the control levels. As individuals approach these control levels, an increased processing frequency if implemented.

3. CNSI shall establish a training and qualification program for all personnel authorized to read TLDs.

216. PERSONNEL MONITORING PROCEDURES

REQUIREMENTS: Personnel monitoring for radiation associated with CNSI operations is required as follows:

1. Requirements for wearing TLDs: All personnel who are likely to receive a dose in excess of 125 mrem in a quarter year shall be monitored by thermoluminescent dosimeters (TLDs). Personnel shall be monitored for radiation exposure as follows:

   a. The following personnel shall be monitored with TLDs:

      (1) Personnel entering an area posted as a radiation area or high radiation area.

      (2) Personnel who routinely remain in areas immediately adjacent to radiation areas. An example of this situation is an office or other frequently occupied areas adjacent to hot cells. Even though the general area radiation levels in the area are less than one mrem per hour, personnel shall be monitored.

(3) Personnel who directly handle or touch radioactive material, or personnel in a controlled surface contamination area, even though they do not enter a radiation area. However, it is permissible for personnel to handle radiac instruments containing check sources without being monitored with TLDs.

b. The following procedures shall be used for personnel touring areas which are actual radiation areas.

(1) Prior to the visit, all weekly radiation surveys required shall be conducted to verify radiation levels are normal.

(2) Guides provided for each tour group shall be issued a TLD for each group. This TLD shall be worn by the guide in addition to his own TLD.

(3) Group TLDs shall be returned for reading at the end of the tour.

(4) Results of reading group TLDs shall be recorded along with the names of personnel in each group on an exposure record card.

(5) Any measurement greater than 10 mrem for any group shall be forwarded to NRC for evaluation. Personnel exposure record form entries for exposures less than 10 mrem are not required.

c. TLDs shall be worn on the area of the body expected to receive the highest radiation dose; under most circumstances this will be on the frontal area of the chest or waist. When the location of the body which will receive the maximum dose is not certain, for instance, trunk of the body or head, additional TLDs shall be worn; radiological control personnel shall specify the location of these additional TLDs. When exposure to extremities (hands and wrists; feet and ankles) or forearms is expected to exceed 25 percent of the limits of Article 204, additional TLDs and pocket dosimeters shall be worn on the exposed extremity or forearm. When additional TLDs are worn, results of TLD processing for all TLDs shall be included in individual personnel exposure records. Care shall be taken to ensure separate recording of exposures for extremities or forearms and for the whole body radiation exposure

d. Since beta radiation is not normally present until shielded systems are opened or is insignificant compared to the gamma radiation personnel beta exposures are not normally limiting. In situations where beta radiation is measurable using the HP-210 or equivalent, personnel shall be shielded from the beta radiation using ma[illegible] and/or anti-contamination clothing. If the beta radiation cannot be shielded, methods for controlling beta radiation exposure shall be evaluated and implemented to control exposures to established limits for skin exposures.

e. Certain radioactive isotopes given to personnel for medical diagnostic purposes can result in measurable radiation levels for some period after receiving the treatment. If such a situation becomes apparent, the person shall be restricted from wearing TLDs until the medical isotope is eliminated from the body to the extent that it will not affect TLD measurements. The only purpose of restricting this individual from wearing a TLD is to avoid including radiation exposure from the medical isotope to that received from CNSI operations. Such personnel shall also be restricted from entering areas requiring monitoring for contamination until the medical isotope is eliminated from the body to the extent that it will not affect personnel frisking.

2. Requirements for Wearing Pocket Dosimeters: Self-indicating pocket dosimeters shall be worn in high radiation areas and in radiation areas when an exposure of 5 mrem can be received in one hour to control radiation exposure accumulated between TLD measurements. The following personnel shall be monitored with a self-indicating pocket dosimeter:

a. All personnel entering a high radiation area or in radiation areas where they could receive a dose in excess of 5 mrem in one hour shall be monitored by a self-indicating pocket dosimeter worn at the same location on the body as the TLD. The above does not preclude use of pocket dosimeters for other exposure monitoring. Personnel who have been placed on the alert list shall wear a pocket dosimeter in addition to their TLD badge.

b. The following alert system shall be initiated by Health Physics and by Radiological Control to control exposures of personnel who are approaching the 1.25 rem per quarter year and 3.0 rem per year local control levels of Article 202. Prior to receiving exposures exceeding

1000 mrem per quarter year or 2750 mrem per year, an alert dose shall be calculated by the following formulae:

Quarterly Control Alert Dose (mrem) =

$$\frac{1250 - \text{previous TLD exposure for quarter}}{2}$$

Annual Control Alert Dose (mrem) =

$$\frac{3000 - \text{previous TLD exposure for year}}{2}$$

The person's TLD shall be processed prior to pocket dosimeter measurements exceeding the lesser of the calculated alert doses. Additional exposure shall not be allowed when TLD measurements total 1200 mrem for the quarter year or 2950 mrem for the year unless approved as discussed in Article 202.3.a.

c. Personnel who have received approval to exceed the local control levels of Article 202.3.a as required by Article 202.3.c, shall have their name added to the alert system identified in (b) above. Alert doses for these persons shall be calculated by the following formulae:

Quarterly Limit Alert Dose (mrem) =

$$\frac{3000 - \text{previous TLD exposure for quarter}}{2}$$

Annual Limit Alert Dose (mrem) =

$$\frac{5000 - \text{previous TLD exposure for quarter}}{2}$$

The person's TLD shall be processed prior to pocket dosimeter measurements exceeding the lesser of the calculated alert doses. Additional exposure shall not be allowed when TLD measurements total 2700 mrem for the quarter year or 4700 mrem for the year.

d. The names of personnel who are allowed less than 1250 mrem in the current quarter because they have exceeded previous quarterly limits (Article 202.1) shall also be placed on the Alert list. Special processing frequencies shall be established for these individuals starting when their exposure reaches 250 mrem less than their adjusted current quarterly limit.

When an individual is placed on the Alert List, his pocket dosimeter and dosimetry badge shall be distinctively marked (e.g., with colored tape or a self-adhesive label) in order to aid in identification of the individual's Alert List status.

Exposure Record Cards. In addition to the requirements of the Alert System of paragraph b above, Radiological Control maintains a log of all pocket dosimeter resets between routine badge processings. Before the pocket dosimeter is rezeroed, the measured radiation exposure is recorded and the individual's quarterly and yearly exposure totals are determined. The individual is thereby prevented from inadvertently exceeding the control levels.

e. Additional pocket dosimeters are required if the location of the maximum dose on the body is not certain. This is discussed in paragraph 1.d above for TLDs.

3. TLD measurements shall be made available to personnel so as to enable them to keep track of their own exposure.

4. Lost Dosimetry Devices. When a dosimetry badge or pocket dosimeter is lost, misplaced, or damaged, Radiological Control shall be immediately notified. The person's exposure will be estimated based on pocket dosimeter results (if available), exposure times and radiation levels, or exposures of other personnel performing similar work.

217. READING DOSIMETERS

REQUIREMENTS:

1. Pocket dosimeters, whether low or high range types, shall be read by the wearer prior to entering radiation or high radiation areas and periodically thereafter to control his own radiation exposure while in these areas.

   a. To prevent off-scale reading, low range dosimeters shall be recharged before the reading exceeds 150 mrem. When dosimeters are recharged, doses shall be recorded by Radiological Control. Recorded doses need not be retained after TLDs exposures for the period have been recorded.

   b. To prevent an off-scale reading, higher range dosimeters shall also be read, recharged and doses recorded whenever the reading exceeds three-fourths of full scale. Recorded doses need not be retained after the TLD for the same period is read.

c. When a pocket dosimeter reading is off-scale or a dosimeter is lost under conditions such that a high exposure is possible, the person's TLD shall be processed immediately and the person removed from Radiological areas until his exposure has been determined.

2. Pocket dosimeters in use shall be tested at least every six months to ensure accuracy and drift standards. If dosimeters frequently do not meet standards or frequently fail in use, Health Physics and the Rad Con Officer shall initiate action to correct the problem.

218. EXPOSURE RECORDS

REQUIREMENTS: CNSI shall retain radiation exposure records permanently as required by DOE Manual or NRC Regulations.

219. EXPOSURE REPORTS

REQUIREMENTS:

1. This report shall include exposures of other visitors, vendor's representatives. The annual summary exposure report shall contain the following information about exposures:

a. Occupationally exposed personnel

(1) Number of personnel monitored.

(2) Number of personnel receiving annual exposures in each of the following ranges:

0, 0-0.5, 0.5-1, 1-2, 2-3, 3-4, 4-5, and over 5 rem

(3) The sum of the rem received by all occupationally exposed personnel.

(4) The number and reference to incident reports of personnel who received internally deposited radioactivity.

(5) The number and reference to incident reports of skin contamination recorded.

b. The number of personnel who exceeded local control levels.

2. Exposure in Excess of Limits. Reports of personnel exceeding the radiation exposure limits of Article 202.1, 202.2, 203, or 204 shall include results of a detailed evaluation of the incident and the incident report forwarded to PNR. This evaluation shall include action taken to verify the magnitude of the exposure, description of the radiological environment including radiation and contamination levels, events leading to the incident, titles of management personnel performing the evaluation, and action taken to prevent recurrence of similar incidents.

3. Exposure Greater than 25 Rem. Report of an incident shall be submitted immediately to PNR whenever an individual is believed to have received a single exposure greater than 25 rem from work associated with CNSI operations.

4. Reports to Personnel. Each person who has been monitored shall be informed of his radiation exposure when he so requests.

5. Reports to Personnel Who Have Exceeded Exposure Limits. Each person who has exceeded the limit of Article 202.1, 202.2, 203, or 204 shall be informed of the nature and extent of exposure in writing. The notice to the individual shall include the statement, "You should preserve this report for future reference". Copies of these reports shall be permanently retained in the individual's exposure record.

6. Reports to Former Personnel of Past Exposure. At the request of a former employee, the employee shall be furnished a written report of his radiation exposure while employed at CNSI. Such a report shall be furnished within 30 days from the time the request is made; it shall include total lifetime exposure with at least the current calendar year broken down by calendar quarter, and shall include the name of the organization providing the report. The report shall also include internal exposure recorded in accordance with Article 406. The report shall contain the following statement: "You should preserve this report for future reference". The former employee's request shall include appropriate identifying data, such as social security number and dates and locations of employment.

7. Termination Reports. Termination reports of personnel exposure to ionizing radiations are required to be submitted to PNR in accordance with the DOE Manual.

8. Annual Reports. CNSI is required to submit annual reports of personnel exposure to ionizing radiations in accordance with the DOE Manual.

220. MEDICAL EXAMINATIONS

REQUIREMENTS: Medical examinations required in conjunction with exposures of personnel to radiation are prescribed by the DOE Manual. These medical examinations consist of three types: (1) preplacement, (2) periodic examination, and (3) employment termination examinations. Retention periods for records of medical examination and bioassays shall be in accordance with DOE Manual.

221. VISITORS

REQUIREMENTS:

1. Visitors shall not receive radiation doses which when added to previous doses will cause limits of Article 202 to be exceeded. Before receiving exposure, a visitor shall be questioned to determine his known or estimated dose for the current calendar quarter and year; unless a written record of his previous cumulative dose and the dose for the current calendar quarter and year is obtained, he shall not be allowed to exceed either (1) a dose of 100 mrem per week (or 100 mrem per visit if the visit is shorter than one week) or (2) limits allowed by Article 202 if this requires less than 100 mrem per week. Visitors shall also be questioned to provide some assurance that visitors with medical disqualifications (such as personnel undergoing extensive radiation treatments) do not receive significant radiation exposure. In view of the above, visitors shall be requested to fill in and sign the following statement before issue of dosimetric equipment.

   "My known or estimated occupational radiation exposure is _____ mrem for the current calendar quarter and _____ mrem for the calendar year. I know of no medical disqualification which should prevent my receiving a radiation dose within prescribed Federal Standards".

2. The radiation standards of Articles 202 and 240 shall be shown or explained to the visitor.

3. When the exposure received by a visitor is greater than zero, a report of the exposure shall be sent to this parent organization promptly. Reports of zero exposures shall be provided upon request. All records of visitor exposures shall be retained as specified.

4. Visitors shall be monitored with only one TLD.

PART 5

CONTROLLING RADIATION EXPOSURE DURING OPERATION, MAINTENANCE AND REPAIR

222. MINIMIZING RADIATION EXPOSURE

REQUIREMENTS: CNSI activities shall maintain personnel radiation exposure as low as practicable. A continuing effort is required to meet this goal by developing and implementing improvements to work procedures and work performance. The following are to assist in meeting this goal.

1. Methods which have proven effective in minimizing personnel radiation exposure during radioactive work are contained in Appendix F. These methods shall be considered by the area operating personnel in preparation of work procedures. Individual work procedures shall specify applicable actions (e.g., mockup training or removal of equipment from high radiation areas) to be used to minimize radiation exposure while working.

2. Supervisory personnel and radiological control personnel shall ensure that personnel are not waiting unnecessarily in radiation areas. Provisions shall also be made to call inspection and radiological control personnel in advance so that other personnel working in radiation areas are not inactive while waiting for inspection.

3. Detailed written work procedures shall be used for major work accomplished in high radiation areas. Prior to entering a high radiation area, a worker shall receive specific job training and pre-shift briefings which are considered necessary to enable him to perform his work at minimum radiation exposure. Examples include mockup training in shops for specific jobs or periodic briefings by supervisory personnel for routine work.

4. Radiation levels in high radiation areas shall be identified by the use of signs which clearly show the areas with the high and low radiation levels.

5. CNSI shall maintain records of the cumulative radiation exposure involved in performing work as necessary to improve methods to minimize personnel radiation exposure in future work.

6. A detailed work procedure is required for work which could result in spread of radioactive contamination, airborne radioactivity, or significantly increased radiation levels, or which, if improperly performed, could result in a radiological incident (Article 110). A work procedure is therefore required for all work performed within a radiologically controlled area which involves direct contact with actually or potentially contaminated items or areas (observations, inspections, and similar operations do not require procedures if there is no contact with such items or areas). Work

procedures are also required for work in other areas when the conditions listed above could result from normal operations, improperly performed work, or credible accident conditions. A work procedure is distinguished from the Radiological Work Permit (RWP) in that an RWP is required when existing radiological conditions meet the criteria of Article 213, whereas a work procedure is required when radiological conditions could be increased as a result of the work being performed.

Normal area operations and frequently performed non-routine operations (e.g., maintenance operations) which meet the critiera listed above may be controlled by area operating procedures. For other work meeting these criteria, individual work procedures will be required for each job. Each work procedure shall be approved by the Radiation and Safety Officer prior to initiation of radiological work.

223. INSPECTION REQUIREMENTS FOR RADIOLOGICAL CONTROLS

REQUIREMENTS: Radiological control inspections shall be required in work procedures in which omission or incorrect accomplishment of a procedural step could result in any one of the following:

1. Personnel whole body radiation exposure greater than 1.25 rem/quarter or momentarily to levels greater than 10 rem/hr For example, incorrect removal of shielding from a radiation hot spot might cause work area dose rates of 10 rem/hr which in 10 minutes could cause exposures greater than 1.25 rem.

2. Release, to the environment, of airborne radioactivity greater than the concentration limits of Article 402. For example, this could be caused by incorrect installation of high efficiency filters.

3. Release to the environment of radioactive liquids. This might result from failure to comply with Article 304 for inspection of liquid waste transfer equipment.

4. Surface contamination greater than 1×10^6 pCi/100 cm^2 (beta-gamma) or 1,000 pCi/100 cm^2 (alpha)within a radiologically controlled area (not including contamination containment area might permit radioactivity to leak to the surrounding work area.

5. Limits of Article 502 being exceeded in an uncontrolled area. This might result from transferring improperly bagged contaminated material through an uncontrolled area.

Steps requiring inspection or action by radiological control personnel shall be designated (e.g., by the symbol R in the margin) to call attention to this inspection or action requirement. Such steps shall be signed off by qualified radiological control personnel prior to proceeding to the next step in the procedure. Signatures indicating that the inspection or action was performed are permitted to be made on the work procedure, the check list for the procedure, or an applicable tag.

224. TEMPORARY SHIELDING

REQUIREMENTS: Since incorrect installation, unauthorized movement, or removal of temporary shielding can result in large changes in work area radiation levels, control of temporary shielding is essential.

1. Temporary shielding installation and removal shall be controlled by written procedures. These procedures shall specify locations and amounts of temporary shielding. These procedures shall require the approval of appropriate technical and radiological control personnel.

2. After installation, temporary shielding shall be inspected to ensure it is properly located.

3. Periodic radiation surveys conducted in accordance with Article 212 shall be reviewed to ensure that shielding maintains its effectiveness in reducing radiation exposure. In reviewing these surveys, particular attention shall be paid to components which had radiation levels greater than 1 rem/hr prior to shielding, since personnel could receive high radiation exposure in a short time if the shielding has lost its effectiveness.

4. Formal written approval for changing location or amount of temporary shielding shall be established. This written approval shall specify the location and amount of shielding changed. Instructions implementing this requirement shall designate persons authorized to approve such changes.

5. Lead shot may be used for temporary shielding.

225. RADIOLOGICAL CONTROL AGREEMENT

DISCUSSION: Subcontractors authorized by Nuclear Regulatory Commission License to handle radioactive equipment and materials are responsible for maintaining effective radiological controls for all work being performed with CNSI by the subcontractor. However, this does not mean that requirements in CNSI's radiological control manuals need be duplicated by both CNSI and subcontractors engaged in the same work. Only one organization need complete the requirement even though radiological control manuals for both organizations

require completion of the requirement. To clarify responsibility for completion of radiological control requirements, radiological control agreements shall specify which organization is responsible for completing requirements duplicated in both organizations' radiological control manuals.

During radioactive work performed by a licensed subcontractor with CNSI radiological control normally is maintained by the subcontractor in accordance with the subcontractor's approved procedures. CNSI performs only surveillance and checks of subcontractor radiological control practices to assure that adequate control is being maintained.

REQUIREMENTS: Prior to initiating work, the subcontractor and CNSI shall have written agreement on specific radiological control working arrangements to be used during the work period. The primary purpose of these agreements is to define areas of responsibility rather than to allow CNSI to specify radiological control procedures to be used by the subcontractor. Agreements shall be available for review by CNSI and subcontractor personnel.

SECTION III - WASTE PROCESSING AND ENVIRONMENTAL MONITORING

CONTENTS

PART 1 - RADIOACTIVE LIQUID PROCESSING AND DISPOSAL PROCEDURES

301. GENERAL

DISCUSSION: The policy of CNSI is to minimize the amounts of radioactivity discharged to the environment. The procedures in this section implement this policy. These procedures are consistent with applicable recommendations of the Federal Radiation Council, U. S. Department of Energy, U. S. Environmental Protection Agency, U. S. Nuclear Regulatory Commission, National Council on Radiation Protection and Measurements, and International Commission on Radiological Protection.

Criteria for disposal of radioactive liquids, when such disposal is required, are based on minimizing radiation exposure to the public and the potential for buildup of radioactivity in the environment.

302. REQUIREMENTS FOR CONTROL OF RADIOACTIVE LIQUIDS

REQUIREMENTS: Radioactive liquids or potentially contaminated liquids shall not be discharged.

1. Concentration Limits. The concentration of gross unidentified beta-gamma activity or alpha activity in liquid waste shall not exceed 3×10^{-7} uCi/ml. Limits for identified radionuclides shall not exceed those of DOE Manual Chapter 0524.

303. SOLIDIFICATION OF RADIOACTIVE LIQUIDS AND PROCESSING MEDIA

REQUIREMENTS: Local procedures shall include criteria and requirements for solidification of radioactive liquids, such as those containing high concentrations of radioactivity, oil or grease, or chemicals which are difficult to process (e.g., APAC decontamination solutions), as well as processing media (e.g., resin). All radioactive liquids and processing media that are to be shipped for disposal shall be solidified into a free standing mass. At a minimum the solidification requirements in local procedures shall include the following:

1. Consideration shall be given in selecting the location where solidification is performed to minimize transport of liquids to be solidified.

2. Soldification shall be performed in containers which meet applicable Department of Transportation regulations. Steel drums, when used, shall be new (not reconditioned after previous use), visually inspected for soundness, and leak tested before use. Plastic containers which are used for solidification shall be shipped in a closed vehicle such that the contents are not visible except that a complete

enclosure of canvas only shall not be considered as being a closed container for this application. Canvas is acceptable as the sole closure for only the top of the vehicle.

3. Drums and other containers of solidified radioactive liquids shall be disposed of as solid radioactive waste.

PART 2 - DISPOSAL OF SOLID RADIOACTIVE WASTES

304. GENERAL

DISCUSSION: The following articles specify requirements for packaging and disposition of solid radioactive waste.

305. SOLID WASTE SHIPMENT AND DISPOSAL

REQUIREMENTS:

1. Solid radioactive wastes from CNSI shall be disposed of only in land disposal sites operated by the Department of Energy (DOE) or by an organization which is licensed by the Nuclear Regulatory Commission (NRC) or by an Agreement State.

2. CNSI shall minimize the volume of radioactive solid waste generated by minimizing the amounts of material which becomes contaminaed during operations and by compaction of compressible solid radioactive wastes.

3. Shipments of solid radioactive waste for disposal shall be minimized. Consistent with this requirement, the length of time for which such waste is stored shall be minimized. Shipments of solid radioactive waste shall meet the requirements of this manual, which include requirements for packaging, labeling, accountability, records, receipts, shipping, and procedures to be implemented in case of loss of radioactive material. Legal custody of the solid radioactive waste in each shipment shall be transferred to the organization responsible for disposal prior to the departure of the shipment from operation site.

306. SOLID WASTE PACKAGING

REQUIREMENT: Solid radioactive waste shall be packaged to meet applicable requirements summarized in Article 707. Local written procedures for packaging solid radioactive waste shall include at least the following requirements:

1. Visually inspect containers (fifty-five gallon drums meeting DOT specifications or other DOT approved containers) inside and out for soundness, leaks, and fit of gasketed closures.

2. Locate containers in radiologically controlled areas during filling with radioactive wastes.

3. Load bags containing solid waste into containers and seal the containers as soon as practicable to avoid accumulation of radioactive combustible waste and the accompanying fire hazard.

4. Use a waste compressing machine to package compressible solid waste. Separate non-compressible waste prior to compaction to avoid damage to the compressor. Check that the filtered ventilation exhausts for the compressing area are operating properly before commencing compressing operation.

5. Monitor airborne particulate radioactivity levels during solid waste packaging operations and measure radiation and surface contamination levels as necessary to ensure applicable shipping regulations and the radiological control requirements of this manual are complied with.

6. Seal containers with gaskets as required by DOT regulations.

7. Estimate the number of curies inside each container

8. Complete records for each container as required by Article 702.

9. If temporary storage prior to shipment is required, place containers in a radioactive material storage area.

307. SOLID WASTE RECORDS AND REPORTS

REQUIREMENTS:

1. Records shall be maintained for each shipment of solid radioactive waste, of the radiation level, estimated number of microcuries (see Appendix B for method of estimating) and description and volume of material for each container, date and time shipment was made, and name of organization receiving waste.

2. An incident report shall be submitted promptly to NRC concerning any unauthorized disposal of solid radioactive wastes.

SECTION IV - AIRBORNE RADIOACTIVITY

CONTENTS

PART 1

LIMITS AND PROCEDURES FOR CONTROLLING AIRBORNE RADIOACTIVITY

401. GENERAL

DISCUSSION: The basic criterion used for control of airborne radioactivity is that internal radiation exposure resulting from inhalation of airborne radioactivity should be small and not require personnel monitoring. Therefore, the limits used in the Code of Federal Regulat ons, Title 10, Part 20 for personnel outside controlled areas are used as the basis for limits on airborne radioactivity in this manual.

Radioactivity in the form of radioactive particles, gases, or both can become airborne through sources such as (1) radioactive system leaks, (2) grinding or welding a contaminated component, (3) decontamination operations, (4) disturbing surface contamination in a work area, (5) improper use of containment enclosures, (6) inadequate vacuum cleaner and ventilation system control, (7) inadequate application of procedures for venting and draining radioactive systems or components, (8) damage or defect in radioactive instrumentation calibration and check sources, and (9) radon from radium sources and from trace amounts of natural radium impurities in construction materials.

Line management of operating facilities is responsible for maintaining airborne radioactivity concentrations below the established CNSI limits. Radiological Control will provide the continuous or periodic sampling required to detect and evaluate the levels of airborne radioactivity in work areas and exhaust air systems.

It should be noted that these procedures are primarily concerned with the control of particulate airborne activity. Most operations and materials handled by CNSI do not result in the discharge of gaseous airborne activity. In many cases where radioactive gases may be released, charcoal filter beds are utilized to minimize these releases.

This section contains procedures for controlling airborne radioactivity.

402. LIMITS FOR AIRBORNE RADIOACTIVITY

REQUIREMENTS: The CNSI limits for airborne radioactivity are based on concentration guides. Concentration guides for typical radionuclides of interest at CNSI are listed in Table 4-1.

TABLE 4-1

CNSI CONCENTRATION GUIDES FOR
TYPICAL RADIOACTIVE MATERIALS IN AIR

RADIONUCLIDE	CONCENTRATION GUIDE (uCi/ml)
Cesium-134	4×10^{-10}
Cesium-137	5×10^{-10}
Cobalt-60	3×10^{-10}
Iodine-129	2×10^{-11}
Iodine-131	1×10^{-10}
Lead 212 (Rn-220 daughter)	6×10^{-10}
Plutonium-239	6×10^{-14}
Strontium-90	3×10^{-11}
Thorium-232	1×10^{-12}
Unidentified alpha emitters	1×10^{-12}
Unidentified beta emitters	3×10^{-11}
Uranium-233	4×10^{-12}
Uranium-235	4×10^{-12}
Uranium-238	3×10^{-12}
Natural Uranium	5×10^{-12}
Natural Thorium	1×10^{-12}

Concentrations guides for other nuclides are derived from the DOE Manual as described in Appendix A.

1. Limit for Occupied Areas. Airborne radioactivity in occupied areas resulting from CNSI operations shall be controlled so that personnel are not exposed to radioactivity levels greater than the concentration guide for the nuclide present.

2. Investigation Levels. Any measurement of airborne radioactivity (e.g., continuous air monitor, or portable air monitor sample) which indicates the airborne radioactivity concentration to be in excess of 50% of the appropriate CNSI concentration guide shall be investigated to determine the cause of the airborne radioactivity levels and appropriate controls shall be implemented to maintain the airborne radioactivity levels "as low as practicable".

403. PROCEDURES FOR CONTROLLING PERSONNEL EXPOSURE TO AIRBORNE RADIOACTIVITY

DISCUSSION: Personnel exposure to airborne radioactivity is controlled using contamination containments and respiratory equipment as required below. In addition many organizations have required use of respiratory equipment for work in areas with high levels of surface contamination (e.g., 25,000 pCi/100 cm^2) because of the likelihood that this surface contamination could become airborne. In some circumstances, respiratory equipment might be necessary for work in areas where surface contamination exists at lower levels.

REQUIREMENTS:

1. Contamination containments shall be used to the maximum extent practicable to prevent personnel from being exposed to airborne radioactivity above the limits of Article 402. These containments are required during radioactive work which has been known to cause or is expected to cause airborne radioactivity.

2. Personnel shall wear respiratory equipment in accordance with Article 407 in areas where airborne radioactivity exceeds the applicable limit of Article 402.

3. Signs shall be posted at entrances to areas where respiratory equipment is required. The use of the controls in this manual results in these signs rarely being needed. If needed, these signs shall contain the conventional three-bladed magenta symbol on yellow background and the words "CAUTION AIRBORNE RADIOACTIVITY AREA". This requirement to wear respiratory equipment shall also be included on a sign with the anti-contamination clothing requirements (see Figure V-1 in Section V of this manual). Radiological Work Permits or work procedures may be required in these areas.

4. When personnel not wearing respiratory equipment are likely to be exposed to airborne radioactivity above the limit of Article 402, a ventilation system shall be operated which will remove airborne particulate radioactivity to a controlled ventilation system or other system with a high efficiency filter. For example, during such operations as machining contaminated surfaces, vacuum cleaners fitted with high efficiency filters, or flexible ducts connected to a filtered ventilation exhaust shall take suction from within about one foot of the work. Experience has shown that some operations within containments, such as grinding on highly contaminated components, require exhausting the containment through a ventilation system with an installed high efficiency filter, such as by using a vacuum cleaner, to prevent high airborne radioactivity outside the containment.

   Exceptions to this requirement are permitted with approval of Radiation and Safety Officer when use of a ventilation system will cause spread of radioactive contamination.

5. a. High efficiency particulate air (HEPA) filters defined in Article 408 shall be installed in the ventilation exhaust from radioactive work areas in which work which could cause airborne radioactivity is in progress to prevent discharge of airborne radioactivity to the environment.

   b. HEPA filters shall be installed in the exhaust from contamination containments to prevent personnel from being exposed to high airborne radioactivity.

   c. HEPA filters shall be installed in vacuum cleaners used around loose surface contamination.

   d. HEPA filtered ventilation exhausts are not required if all radioactive work that could cause airborne radioactivity greater than the limits of Article 402 is performed within a contamination containment enclosure.

6. Monitoring for airborne radioactivity shall be performed in accordance with Articles 405, [illegible]

7. Oxygen breathing apparatus, air supply masks or hoods shall be worn when airborne particulate activity exceeds 100 times the limit of Article 402. The filter mask which does not have an air supply shall not be worn in this situation since it is only 99 percent efficient and the one percent penetration would be at concentrations greater than the limit of Article 402.

   Personnel shall not enter areas where the airborne particulate activity level exceeds 1000 times the limit of Article 402. This restriction applies even to personnel wearing oxygen breathing apparatus or air supply respirators since tests show that these personnel are likely to be exposed to airborne radioactivity above the limits of Article 402. If personnel entry is required to these areas, containment or filtered ventilation shall be used to reduce airborne radioactivity levels to below 1000 times the limit of Article 402.

   Exceptions to this requirement are permitted in emergency situations. In these situations it must be assumed that the air entering the individual's respiratory system exceeds the limits of Article 402. Personnel exposed to airborne radioactivity above the limits of Article 402 shall be monitored for internal radioactivity in accordance with Article 406.

404. HIGH AIRBORNE RADIOACTIVITY CASUALTY PROCEDURES

DISCUSSION: High airborne particulate radioactivity associated with CNSI operations can result from any of the causes in

Article 401. It can be indicated by an air particle detector alarm, by a portable air sample exceeding the applicable limit of Article 402, by an airborne radioactivity measurement using a portable radiation survey meter, or by an indication of a radioactive system leak or rupture. General procedures for controlling personnel exposure to airborne radioactivity are contained in Article 403. If it is suspected that the cause of an APD alarm is high natural background airborne radioactivity, the time period personnel are required to remain in respiratory equipment can be minimized by quickly taking an air sample external to the area to confirm the cause of the APD alarm is high natural background radioactivity.

REQUIREMENTS: The procedures in this article shall be followed for controlling high airborne radioactivity in locations as indicated below.

1. Particulate Radioactivity Above The Limits of Article 402 in Occupied Areas. Examples of operations that could produce high levels of airborne radioactivity include work in Hot Cells, Contaminated Areas, Machine Shops, Chemistry and Manufacturing Areas, or Critical Facilities.

   a. Immediate Action:

      (1) If the high airborne radioactivity is indicated by alarm of an APD monitoring a ventilation exhaust or a work area, check the recorder chart on the APD panel and the meter indication to determine that the APD alarm is not the result of circuit failure or an electrical transient. If the recorder chart shows circuit failure or if the meter indication is below the alarm setting, confirm airborne radioactivity is below the limit of Article 402 by taking a portable air sample. The subsequent actions of this casualty procedure need not be carried out if the airborne radioactivity is confirmed to be below the limit of Article 402.

      (2) If the high airborne radioactivity is indicated by an APD alarm, the recorder chart does not show circuit failure and the meter indication is above the alarm point, steps (3) through (8) shall be initiated simultaneously and completed as soon as possible. If the high airborne radioactivity is indicated by a portable air sample, steps (4) through (8) shall be initiated simultaneously and completed as soon as possible.

(3) Measure gamma radiation at the APD to determine if the APD alarm was caused by high radiation levels external to the APD. If radiation levels are high, determine the source of the high levels by conducting additional surveys and confirm airborne radioactivity is below the limit of Article 402 by taking portable air samples. (Action in the subsequent steps need not be taken if the alarm was caused by high external gamma radiation levels.)

(4) Stop operations which might be causing high airborne radioactivity until adequate control of airborne radioactivity is established.

(5) Evacuate unnecessary personnel from affected areas.

(6) Secure unfiltered ventilation from the affected spaces to other spaces. Secure unfiltered ventilation to the environment from affected spaces. Ventilation systems which contain high efficiency filters in exhaust ducts need not be secured. Where ventilation is necessary to prevent overheating of components, it is permissible to reinitiate ventilation after ensuring the criteria of paragraph b.(2), below, are met.

(7) Don respiratory equipment in affected areas in accordance with Article 407. If installed, secure air compressors in affected spaces which provide the air supply for emergency air breathing masks.

(8) Determine the extent of the airborne radioactivity by sampling the affected area and adjacent areas using portable air samplers.

b. Supplementary Action:

(1) Attempt to identify the radionuclide causing the airborne radioactivity, for example, by promptly measuring the sample for alpha radioactivity and determining the approximate half-life or by gamma energy analysis.

(2) In order to minimize the need for respiratory equipment, reduce personnel exposures to airborne radioactivity, or to prevent overheating of components, consideration shall be given to ventilating the facility with fresh air.

When ventilating, avoid spreading airborne radioactivity to other spaces if possible; if this is not possible, ensure that personnel in other spaces are not exposed to airborne radioactivity. If available, a portable or installed ventilation system with high efficiency filters shall be used to prevent contamination of the facility's ventilation system (see Article 410). Periodically monitor radiation levels on ventilation filters. To minimize contamination of the ventilation system while ventilating, operate the ventilation system in accordance with applicable procedures using the minimum number of fans to achieve stable conditions in the affected spaces.

(3) If air particle radioactivity continues to exceed the APD alarm set point, it is permissible to temporarily increase the alarm setting as discussed in Article 405.5.b. Reset the alarm when conditions return to normal.

(4) Measure and control surface contamination in areas affected by high airborne radioactivity.

(5) Perform gamma surveys of ventilation filters and ducts and measure surface contamination in the vicinity of the ventilation exhaust discharge point.

(6) When resuming operations, take portable air samples to verify that the cause of high airborne radioactivity is corrected.

(7) Check personnel exposed to high particulate radioactivity for internal radioactivity (Article 406).

4. Reports. A report of any incident involving high airborne radioactivity (above the limits of Article 402) other than fallout, airborne discharges from commercial reactor plants, or natural background in areas occupied by personnel not wearing respiratory equipment shall be sent to PNR. This report shall include the results of monitoring personnel for internally deposited radioactivity as required by Article 406. This report shall be similar to and forwarded in the same manner as reports discussed in Article 517.

405. MONTIORING FOR AIRBORNE RADIOACTIVITY

REQUIREMENTS:

1. Air particle surveys shall be performed with portable air samplers as follows:

a. At least every four hours (1) in radiological facilities when radioactive work is performed in these facilities,

(2) during radioactive work which has been known to cause or is expected to cause airborne radioactivity, and (3) in occupied areas where surface contamination exceeds the limits of Article 502. These portable samples are not required if continuous monitoring is performed in accordance with paragraph 5 following. If the installed continuous air particle detector for a ventilation exhaust is inoperative and radioactive work is being performed, portable sampling every four hours is required.

b. When opening a radioactive system to the atmosphere for maintenance. However, portable air samples are not required during normal liquid sampling operations or when opening the system into a containment enclosure equipped with a high efficiency filter.

c. Before initially entering tanks or voids containing potentially radioactive piping.

d. When first entering a critical facility after reactor shutdown.

e. Whenever airborne radioactivity levels above the limit of Article 402 are suspected.

2. Records of the above airborne radioactivity surveys could be required to serve legal purposes and therefore shall be maintained neatly and retained for three years. These records shall include at least the following information.

a. Date and time of measurement.

b. Location.

c. Reason for measurement (e.g., 4 hr. APD)

d. Instrument used (e.g., portable sample measured with HP-210).

e. Results of most recent response check and background radiation level when the HP-210 is used for measuring portable samples.

f. Airborne radioactivity in uCi/ml.

g. Remarks.

h. Signature of surveyor.

i. Signatures of persons reviewing records.

3. Portable air samples shall be taken as described below and measured using the HP-210 or PAC-4G portable survey instruments. When the HP-210 or PAC-4G is not avilable or background radiation levels are not low enough for counting a portable air sample, a counter-scaler shall be used. The precise location for portable air samples cannot be specified for all sitautions. However, the locations for portable air samples shall be based on the following: (1) the position of the sampler relative to the work zone and other operations which might contribute to the sample radioactivity; (2) the type of work being performed (for example, grinding); and (3) the containment enclosure arrangement used.

   a. The normal sample shall be approximately 1 cubic meter. Using a HP-210 at least a fifteen second count shall be used for instrument response time.

      Appendix E states that 100 cpm above background over a surface with the HP-210 indicates 450 pCi below the detector. For a 2 inch filter used for a 1.0 cubic meter (1×10^6 ml) air sample causing 100 cpm above background, the concentration is:

      $$\frac{450 \text{ pCi}}{1\text{m}^3} = \frac{4.5 \times 10^{-4} \text{ uCi}}{1.0 \times 10^6 \text{ ml}} = 5 \times 10^{-10} \text{ u Ci/ml}$$

      In the above calculation, the filter element is assumed to be 100 percent efficient.

      Airborne radioactivity levels above 5×10^{-10} can be determined by ratioing the count rate to 5×10^{-10} uCi/ml. If the count rate is less than 100 cpm, " 5×10^{-10} uCi/ml" shall be recorded on logs when using the procedure of this paragraph.

   b. For casualty situation samples shall be approximately 0.3 cubic meters.

      For a sample of 0.3 cubic meters, the concentration corresponding to 100 cpm is:

      $$\frac{450 \text{ pCi}}{0.3\text{m}^3} = \frac{4.5 \times 10^{-4} \text{ uCi}}{0.3 \times 10^6 \text{ ml}} = 1 \times 10^{-9} \text{ uCi/ml}$$

      Higher levels can be determined by ratioing count rate to 1×10^{-9} uCi/ml. For count rates less than 100 cpm, " 1×10^{-9} uc/ml" shall be recorded in logs. In a casualty situation, it is not necessary to take a 1 cubic meter air sample to verify the results of the 0.3 cubic meter sample.

c. Special Samples. It is permissible to use larger volume air samples and different analysis equipment than specified in paragraphs a and b above in unusual situations as considered necessary by radiological control personnel.

d. Airborne alpha radioactivity shall be determined by measuring the filter with the PAC-4G or instrument of equivalent sensitivity. A filter from a 0.3 cubic meter air sample reading 300 counts per minute corresponds to 1×10^{-9} uCi/ml of alpha radioactivity (300 counts per minute result from about 300 pCi). Appendix E states that the minimum sensitivity of PAC-4G is approximately 50 counts per minute or 50 pCi. This sensitivity limit is related to the accuracy of the instrument's response. A measurable count rate less than 50 counts per minute does not rule out the possibility of alpha emitting particles being present. To determine if any response is a result of alpha radiation, verify that the meter is not responding to beta or gamma radiation by inserting a sheet of paper between the sample and detector; if alpha, the reading will return to the background reading. If the meter is responding to beta or gamma radiation, the measurement shall be repeated with a different instrument.

e. Portable air particle sampling equipment shall be immediately available to sample air during abnormal conditions. These samplers shall be completely assembled and loaded with a filter, ready to use at all times so that they can be rapidly plugged into the power source. It is permissible for the sampler to be stored in its case.

5. Air particle detectors (APDs) equivalent to those described in Appendix E shall be used to continuously monitor air particle radioactivity if portable air sampling described in paragraph 2b. above is not performed. Many organizationsuse APDs to continuously monitor radioactive work, particularly work which has a high potential for causing airborne radioactivity, since continuous monitoring will provide earlier detection of high airborne radioactivity. Continuous air monitoring shall be conducted in accordance with the following requirements:

a. Continuous air monitor alarm points shall be set as close to the limits of Article 402 as practicable without causing excessively frequent spurious alarms.

b. In the following instances, it is permissible to temporarily increase the APD alarm setting. The purpose of this higher setting is to provide warning of further increases in airborne radioactivity or to prevent spurious alarms. In each case where the alarm setting is temporarily increased, it shall be promptly returned to the previous alarm setting when the condition necessitating the increase subsides.

(1) If an APD continues to alarm because of radioactivity associated with operations, it is permissible to temporarily increase the alarm setting to 50 percent above the indicated reading with the approval of the Radiological Control Officer.

(2) If the indicated reading of an APD approaches or exceeds the alarm set point and the increase is confirmed to be a result of radon daughter products from an atmospheric temperature inversion, it is permissible to temporarily increase the alarm setting to 50 percent above the indicated reading or present alarm set point with the approval of the Radiological Control Officer. Confirmation that the increase in airborne radioactivity is a result of radon daughter products shall include all of the following three indications: (1) detection of alpha radioactivity on a portable air sample, (2) an indication of noticeable decay of the radioactivity on a portable air sample filter in a short period of time (i.e., a short half life), and (3) an indication of equivalent levels of airborne radioactivity on a portable air sample taken outdoors upwind of ventilation exhausts.

c. Meter indications of continuous air particle detectors shall be recorded at least every four hours when a continuous air particle detector is operating. When continuous recorders are used, reading and separate recording of indications is not necessary. Use of continuous recorders is not required. Records of meter indications and recorders shall be retained as specified in paragraph 3. above.

d. Extension tubing on the APD inlet is permitted to monitor a work area. However, this tubing shall be less than ten feet in length, smooth and without sharp bends or internal obstruction to minimize radioactive particle deposition in the tubing which will cause the meter to read lower than actual concentrations.

e. APDs monitoring work areas from ventilation exhaust shall sample from an area where concentrations are representative of the work area.

f. The APD shall be located in low background radiation levels or shielded such that the APD alarm can be set as near the limit of article 402 as practicable.

g. When sampling areas where airborne radioactivity exceeding 1000 times the limits in article 402 is likely, the exhaust of portable air samplers or continuous monitors shall be exhausted through a high efficiency filter, returned to the monitored area, or returned to a controlled exhaust system to prevent contamination of uncontaminated areas.

406. MONITORING PERSONNEL FOR INTERNAL EXPOSURE TO RADIOACTIVITY

REQUIREMENTS:

1. Personnel monitoring for internal radioactivity shall be performed in accordance with the DOE Manual.

2. In addition to the requirements of the DOE Manual, the following record shall be prepared for any individual monitored for internal radioactivity. These record requirements are applicable to routine monitoring as well as monitoring following an incident.

   a. Name of individual involved.

   b. Date and time of monitoring.

   c. Basic monitoring data including instrument type and identifying number) used and minimum detectable activity.

   d. Radionuclide (s) involved, their chemical form, and, if known, anatomical location.

   e. Amount of radioactivity measured at time of monitoring.

   The following information is required only for monitoring after an incident:

f. Date and time of exposure.

g. Estimate of resulting exposure and the adjustment to whole body external exposure limits, if necessary, to prevent exceeding specific internal organ exposure limits.

h. Brief description of incident, including work being performed, cause of incident, work area radiation and radioactivity levels, and type of anticontamination clothing and respiratory equipment worn.

Copies of these records shall be kept with the individual's radiation exposure record since these records might be required to serve legal purposes. These records shall be prepared in such a manner that they do not require a security classification.

3. a. A report of any incident of detectable internal radioactivity associated with CNSI operations greater than one-tenth the permissible limit shall be submitted to the Project Manager. This report shall include action taken to prevent recurrence of such incidents as well as the information required in 2. above.

b. Any occurrence of internal radioactivity which monitoring results indicate might cause the person to exceed radiation exposure limits for a specific organ shall be reported immediately.

407. PROCEDURE FOR USE OF RESPIRATORY EQUIPMENT

DISCUSSION: Use of the procedures in this manual result in high airborne radioactivity which rarely occur. Respiratory equipment is thus not routinely used to control exposures to airborne radioactivity.

The Nuclear Regulatory Commission concentration guidelines for continuous exposure to airborne radioactivity of personnel occupationally exposed to radiation, are 3×10^{-11} uCi/ml for Thorium 232 equivalent to 1×10^{-8} uCi/ml for insoluble Cesium 137 and 9×10^{-9} uCi/ml for insoluble cobalt 60. These limits are all considerably higher than the limits of article 402 and are based on continuous exposures of 40 hours per week. Additionally, Nuclear Regulatory Commission regulations permit upward adjustment of these limits for exposure periods of less than 40 hours per week. When airborne radioactivity exists above the limits of article 402, the actions of article 404 limit its duration to short periods of time.

For the above reasons, respiratory equipment would not often be required by Nuclear Regulatory Commission regulations to ensure that personnel exposures to airborne radioactivity are below limits. Even though it would rarely be required, this manual requires the use of respiratory equipment as a supplementary control to keep personnel exposures as low as practicable. Accordingly, CNSI is not required to perform extensive testing of respiratory equipment required of organizations who use respiratory equipment as a primary control of personnel exposure to airborne radioactivity.

REQUIREMENTS:

1. Prior to wearing a mask, air fed respirator or hood in an area where airborne radioactivity exceeds the limit of article 402, personnel shall be trained in the use of this equipment. As part of this training, personnel shall demonstrate the proper procedure for putting on and removing masks, air fed respirators or hood, including leak checks for masks and air supplied respirators.

2. To assure that a proper seal between the individual's face and the mask of the respiratory equipment is obtained, the wearer shall check the mask fit with a negative pressure test each time a mask is donned. A test, for example, consists of covering the inlet opening with the palm of the hand or closing the opening, inhaling gently so that the face piece collapses slightly, and holding the breath for approximately ten seconds. If the face-piece remains in its slightly collapsed condition and no inward leakage is detected, the tightness of the mask is satisfactory.

3. When respiratory equipment utilizes filter canasters, these shall be replaced if damaged or when contact radiation levels are greater than about 0.1 mrem/hr. These canisters shall be inspected and monitored for radiation after each use in areas of airborne radioactivity. Contaminated canisters shall be disposed of as solid radioactive waste.

4. Half-face respirators shall be used only for work requiring unusual visual acuity because of the poor fit obtained for many users. Half-face respirators shall not be used for radioactive work unless prior approval is received from Rad Control Officer.

408. HIGH EFFICIENCY PARTICULATE AIR FILTER REQUIREMENTS

REQUIREMENTS:

1. The following requirements for ventilation system high efficiency particulate air filters apply:

   a. HEPA filters shall be tested at least annually.

   b. The HEPA filters are fragile and shall be handled carefully.

   c. Great care shall be used in installing HEPA filters to assure the filter material separators are in the vertical position, tight seals are made around the edges of the filters, and that filters are not damaged during installation. Minor damage, such as that shown in the figure below, will greatly reduce the efficiency of these filters.

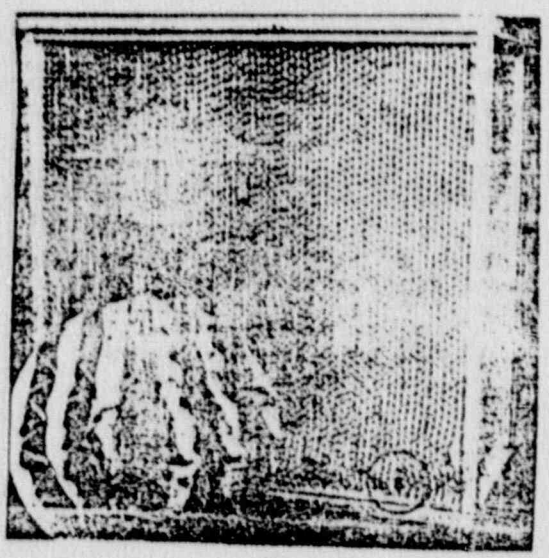

FIGURE IV-1

High Efficiency Filter Showing Defects

d. Used filters shall be disposed of as radioactive waste since loose surface contamination could be present on interior pleats.

2. HEPA filters used in vacuum cleaners and containment enclosures for radioactive work require the same degree of care in installation and removal as ventilation filters. HEPA filters installed in vacuum cleaners shall be efficiency tested:

   a. Whenever the seal required by paragraph 3. below is broken

   b. At least quarterly.

3. HEPA filters installed in both vacuum cleaners and ventilation systems shall be sealed with a label stating when the HEPA filter was tested. The seal may be wired or taped buy shall be designed so that the seal must be broken to remove the filter.

409. PORTABLE VENTILATION SYSTEM

DISCUSSION: A portable ventilation system can be constructed by adapting a portable electric blower with a high efficiency filter. Such a system can be used during maintenance or a high airborne radioactivity casualty to reduce airborne radioactivity without contaminating installed ventilation systems.

A vacuum cleaner with installed high efficiency filter can also be used effectively to reduce airborne radioactivity in a space by recirculating the air in the space through the high efficiency filter.

410. PROCEDURES FOR CONTROLLING RELEASE OF AIRBORNE RADIOACTIVITY TO THE ENVIRONMENT

REQUIREMENTS:

1. The ventilation exhausts to the environment from facilities which are normally used for radioactive work shall be monitored by a continuous air particle detector equivalent to that described in Appendix E. These facilities include but are not limited to, decontamination rooms, building where work on radioactive components is performed, and controlled surface contamination areas where contamination levels periodically exceed 10,000 pCi/100 cm^2. Continuous monitoring of these spaces is not required if infrequent operations are conducted in these spaces. In such cases, these spaces shall be monitored with portable air particle samplers in accordance with article 405 when

the infrequent operations are conducted. The purpose of this monitor is to verify that if airborne radioactivity is discharged to the environment it does not exceed concentrations allowed for persons in uncontrolled areas.

2. The intake piping for this monitor shall be located in the ventilation exhaust duct either upstream or downstream from the high efficiency filter or in the space where a representative sample of exhausted air can be obtained. If the intake piping is located in the exhaust duct, the intake piping shall be less than 50 feet in length, smooth and without sharp bends or internal obstruction. A longer length of intake piping is permitted in this application than is permitted in article 405.

3. If the monitor samples downstream from the filter, the monitor is not effective in warning of high airborne radioactivity which might exist in the radiological facilities since the monitor samples air after it passes through high efficiency filters; airborne activity in the spaces upstream of the filters would probably be more than 1000 times the activity measured by the monitor. (Control of airborne radioactivity in these spaces is discussed in article 405.)

4. The airborne radioactivity indicated by this monitor shall be read and recorded at least every four hours while radioactive materials are being handled in radiowork areas, except that when continuous recorders are used, reading and recording may be performed less frequently. However, continuous recorders are not required. These records could be required to serve legal purposes and, therefore, shall be maintained neatly. These records shall be retained for three years.

SECTION V SURFACE CONTAMINATION

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CONTENTS CONT'D

PART 1 SURFACE CONTAMINATION LIMITS

501. GENERAL

Radioactive contamination of surfaces (such as floors, equipment, clothing, and skin) may result from work operations, leaks of radioactive fluids, or gradual precipitation of airborne radioactive contamination onto exposed surfaces. The primary reason for limiting surface contamination is to minimize possible ingestion or inhalation of radioactivity. In addition surface contamination is limited to minimize buildup of radioactivity in the environment. In case of very high levels of surface contamination, control of external radiation exposure from this contamination is also necessary. Surface contamination is divided into two classes in this section: (1) loose contamination can be removed from surfaces by dry swipes and (2) fixed contamination remains on affected surfaces and is not further reduced by normal decontamination techniques.

Swipes are usually pieces of dry filter paper which are wiped over a surface and then measured for radioactivity. Materials which have become radioactive through exposure to neutrons are created similarly to those with fixed contamination when performing operations, (such as machining), which may spread radioactivity.

Part 1 of this section states the limits for surface contamination. Parts 2, 3, and 4 describe monitoring procedures, anticontamination clothing, and decontamination procedures, respectively. Procedures for controlling contamination during radioactive workwork are contained in part 5. Contamination control procedures should be considered in planning and performance of all jobs. However, the extent of the contamination control procedures used should be consistent with the amount of radioactivity being handled.

502. SURFACE CONTAMINATION LIMITS IN UNCONTROLLED AREAS

Radioactive loose surface contamination in uncontrolled areas shall not be (1) more than 450 pico curies per swipe of 100 square centimeters (450 pCi/100 cm^2) beta gamma radioactivity*, or (2) more than 450 pCi above background as measured within one-half inch of the material using the HP-210 probe or equivalent instrument described in Appendix E (in this case, both swipe and probe measurements are not necessary to verify a surface is uncontaminated);

* Excluding "fallout"

ARTICLE 502.

loose alpha radioactivity shall not be (1) more than 50 picocuries per swipe of 100 square centimeters (50 pCi/100 cm^2) or (2) more than 50 pCi above background measured in contact with or close to the material using the PAC-4G or equivalent instrument. The beta-gamma radioactivity limit is based on cesium 137 and swipes counted for comparison to this limit shall be reported as equivalent cesium 137. The alpha radioactivity limit is based on thorium 230 and swipes counted for comparison with this limit shall be reported as equivalent thorium 230. Monitoring for alpha radioactivity is necessary when the material has been exposed, or potentially exposed, to alpha contamination. As long as materials with loose surface contamination are properly wrapped to prevent spread of contamination outside the wrapping and carefully handled to prevent breaking the wrapping, such materials may be carried through or handled in areas which are not controlled for surface contamination. Control to levels lower than the above has been possible in the past; however, in view of the fact that that above limits are conservatively safe, control to lower is not considered warranted.

503. CONTROLLED SURFACE CONTAMINATION AREAS

1. Areas where surface contamination exceeds the limits of article 502 and areas where equipment or materials are handled with exposed parts exceeding these levels shall be designated controlled surface contamination areas until such areas, equipment, or materials have been adequately covered or decontaminated to meet these limits.

2. Access to a controlled surface contamination area shall be limited to allow only personnel in appropriate anticontamination clothing to enter. Choice of appropriate clothing is discussed in article 524.

   Open wounds shall be adequately protected from contamination prior to a person's working in a controlled surface contamination area.

3. Entrances to controlled surface contamination areas and potentially contaminated areas shall be posted conspicuously with signs, similar to that shown in figure V-1 stating the access restrictions, requirements for anticontamination clothing and masks, levels of loose surface contamination and radiation dose rates (or permissible stay times). These signs shall contain the conventional magenta three-bladed symbol on yellow background. If the entrance to a controlled surface contamination area is not at a door, barriers should be used to mark the affected area clearly.

4. Smoking, eating, drinking and chewing shall not be permitted in controlled surface contamination areas, or potentially contaminated areas. This provision is essential to minimize the possibility of transferring contamination from the hands or other areas to the mouth. For the same reason, hands should be kept away from the face, nose, mouth, and ears when in controlled surface contamination areas. Drinking water from a foot-operated fountain may be permitted in areas surrounding controlled surface contamination areas when special precautions are taken to avoid contaminating the water and fountain. Such precautions include locating the fountain where it will not become contaminated, frequently swiping the fountain, and posting signs stating the proper means to avoid spreading contamination to the fountain. Drinking shall be prohibited in controlled surface contamination areas.

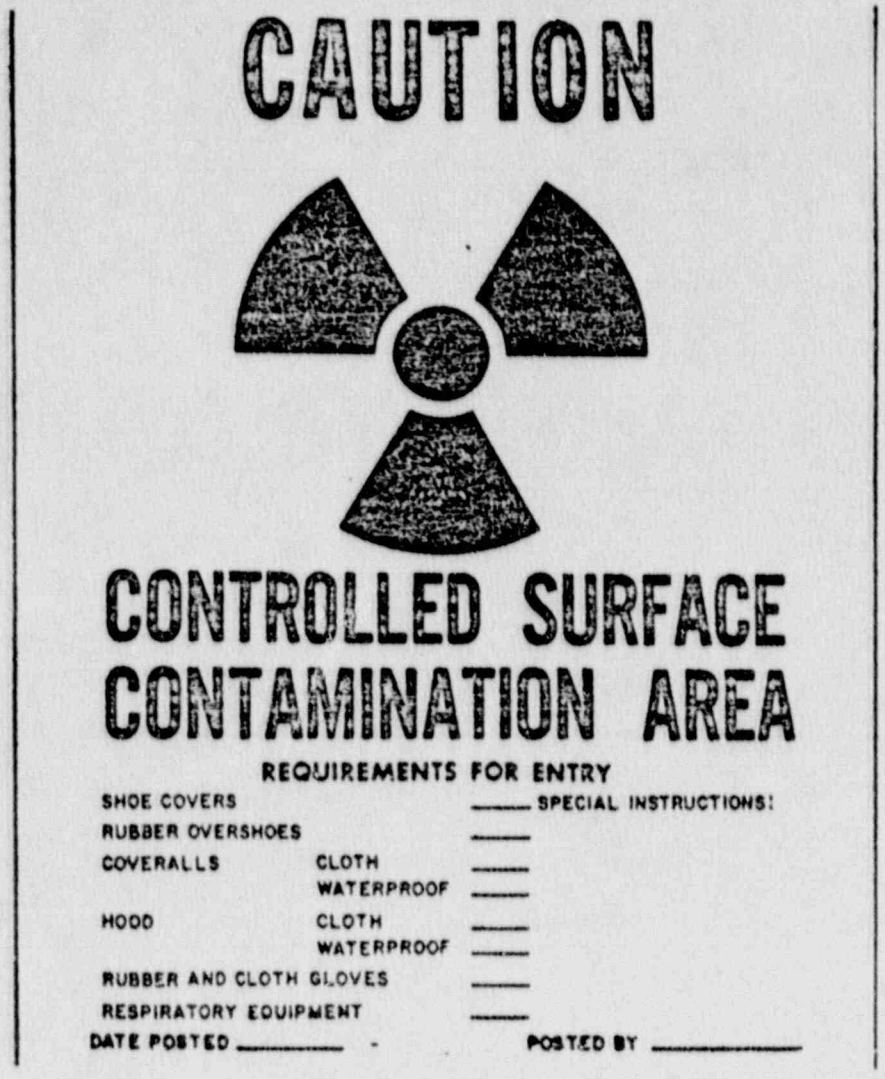

Figure V-1

Controlled Surface Contamination Area Sign

5. Where operations such as grinding or maching are being performed without containment on contaminated components or equipment, the areas of the operations shall be considered subject to the spread of loose contamination and shall be posted as a controlled surface contamination area.

6. Where surveys for loose contamination have not been made, but contamination is suspected, the area shall be posted as a controlled surface contamination area pending the results of contamination surveys.

7. Limits on the total radiation doses from fixed contamination or from the combination of fixed and loose surface contamination in controlled areas are set by the requirements of external radiation exposure in section II of this manual; areas with average dose rates exceeding 1 mrem/hour require posting as radiation areas ; personnel monitoring may also be required in accordance with other articles.

8. Levels and extent of loose surface contamination inside controlled surface contamination areas shall be limited to control possible airborne radioactivity, to facilitate limiting the spread of contamination, to simplify subsequent decontamination, and to minimize personnel radiation exposure. In some cases, a specific limit inside In some cases, a specific limit inside controlled surface contamination areas has been used. If used with common sense, the flexible criteria which is underlined above can be more effective than specific limits for controlling contamination inside contaminated work areas. For example, in some cases when levels over 1000 pCi/100 cm^2 have been measured, work has been stopped until these levels were cleaned up. This use of a specific limit has sometimes led to unnecessary radiation exposure in cleanup work and has significantly extended the overall time required for the job.

   a. Inside a small containment area in which a small radioactive valve is being cut from a pipe, taking swipes would increase the probability of spreading high levels of contamination. Contamination inside the enclosure is probably greater than 100,000 pCi/100 cm^2. Control of surface and airborne contamination in this case can be obtained by completely sealing the work area and working from outside a Contamination Containment Area (glovebag type

enclosure) with hands inside, or a plastic bag containing required tools can be sealed around the valve and tools manipulated from outside the bag. In either case, no limit would be used for contamination inside the enclosure, and contamination outside the enclosure could be readily controlled to the same levels as the rest of the area in which the work is being performed.

b. In work where a larger containment area is essential, one or more workers may be inside a tent covering the work area. Filtered ventilation exhaust (article 547) from this kind of enclosure is usually necessary since airtight sealing of a large tent is difficult. When heavy contamination (such as 10,000 pCi/100 cm^2) is suspected inside the tent, steps would be taken to limit spread of contamination by personnel and material leaving the tent; contamination surveys would be taken periodically (once per shift at least), double suits might have to be used, and the heavily contaminated portions removed before leaving the tent. Masks would probably be necessary for personnel inside the tent when levels of contamination are high. Outside the tent, contamination could readily be controlled to levels similar to the rest of the area in which the tent is located. Periodic contamination surveys of the travel route leaving the tent would be necessary to assure this control.

c. Contamination in work areas is normally maintained below the limits of article 502 for uncontrolled areas. The advantage of maintaining those conditions is that anticontamination clothing is then not necessary for much of the minor work inthe area. Without anti-contamination clothing, work can be performed more quickly and easily and less time is lost dressing and undressing. However, for work areas with existing contamination, the convenience of these low contamination levels must be balanced against the cost in time, money, and radiation exposure required to obtain this cleanliness. For major work in some of these previously contaminated work areas, it is possible that higher contamination levels will have to be accepted during and subsequent to the work and the entire area may have to be treated as a controlled surface contamination area.

9. Personnel leaving a controlled surface contamination area shall (a) remove their anticontamination clothing and (b) be monitored for surface contamination in accordance with article 514, at the exit of the controlled surface contamination area. Exceptions to these provisions are permitted in special circumstances in accordance with paragraphs 503.10 and 503.11 following.

10. If radiation levels do not permit personnel monitoring at the exit of the controlled surface contamination area (such as tents in high radiation areas) personnel exiting may be permitted to cross areas where personnel are not wearing anticontamination clothing provided:

    a. Personnel remove all anticontamination clothing (outer set if double anti-Cs are worn) at the exit of the controlled surface contamination area.

    b. Perso-nel go directly by designated passageways to the nearest monitoring station.

11. In order to minimize areas which are designated controlled surface contamination areas and the potential that contamination will be spread throughout these areas, it is normally desirable to establish small controlled surface contamination areas within the radiological facility. To promote work efficiency, it may be desirable to permit personnel to move between such small controlled surface contamination areas without completely removing anticontamination clothing. For example, consider a radiological control facility which contains a controlled surface contamination area in a tent. Provided the below listed conditions are met, personnel in anticontamination clothing may exit from the tent and move about in the areas surrounding the tent without requiring other personnel in the surrounding areas to wear anticontamination clothing. This exception to the requirements of paragraph 9 above, is permitted if the following additional controls are applied:

    a. Work in the controlled surface contamination area is performed primarily in Contamination Containment Areas (glovebag type enclosures), and contamination levels within the controlled surface contamination area but outside of Contamination Containment Areas are less than 10,000 pCi/100 cm^2 beta-gamma radioactivity or 1000 pCi/100 cm^2 alpha radioactivity.

b. The areas surrounding controlled surface contamination areas are controlled as radiological control areas and contamination levels in these areas are less than limits of article 502. These areas shall be posted with a sign stating "RADIOLOGICAL CONTROLS REQUIRED FOR ENTRY."

c. Personnel leaving controlled surface contamination areas remove at least outer gloves and shoe covers and are monitored for surface contamination.

d. All personnel leaving the area surrounding the controlled surface contamination areas remove all anticontamination clothing (if worn) and are monitored for surface contamination.

e. Surveys for loose surface contamination are performed at least daily in occupied areas surrounding controlled surface contamination areas where personnel may be exposed to loose surface contamination.

f. The controlled surface contamination areas and the areas surrounding them are enclosed to prevent release of radioactivity to the environment.

12. Radiologically Controlled Area - As used in this manual, the term "radiologically controlled area" shall apply only to controlled surface contamination areas, to an area which contains one or more controlled surface contamination areas or to an area which is established to allow personnel to utilize the exceptions in paragraphs 10 and 11 above. A radiologically controlled area shall have contamination control point(s) where all personnel and materials leaving the area are surveyed for radioactivity. Radiological control personnel or assistants trained in the applicable portions of article 108 shall be assigned the responsibility for the contamination control point.

504. BASIS FOR SURFACE CONTAMINATION LIMIT

Selection of the limit for loose surface contamination in article 502 was based on consideration of the following:

1. The limit should be low enough that personnel do not ingest significant amounts of radioactivity from normal contact with areas or parts contaminated at the limit.

2. The limit should be low enough that significant levels of airborne radioactivity do not result.

3. The limit should be near background levels of surface

contamination to prevent an increase in environmental radioactivity over large areas. This consideration is the most restrictive.

4. The limit should be such that measurements are as convenient as practicable.

The standard area for swipes of 100 cm^2 has been selected because (a) filter paper tends to disintegrate when wiped over a larger area, (b) this is convenient area to swipe, and (c) this area gives nearly an optimum efficiency for collecting and measuring contamination.

PART 2 MONITORING FOR SURFACE CONTAMINATION

505. PROCEDURE FOR MEASURING SURFACE CONTIMINATION WITH THE HP-210 PROBE AND ALPHA SURVEY INSTRUMENTS

REQUIREMENTS: The HP-210 probe (described in Appendix E) or an equivalent instrument will detect 450 pCi of radioactive beta-gamma surface contamination on materials and personnel by slowly scanning with the probe held within about one-half inch of the surface. Each 100 CPM increase above background corresponds to 450 pCi of radioactive surface contamination. When using the HP-210 for surveys and personnel monitoring required by this manual, the HP-210 probe shall be used in a background radiation level of less than 100 counts per minute with the shield on the probe. Use of the HP-210 is permissible in background radiation levels between 100 and 300 CPM provided the rate of probe movement is reduced so that low levels of contamination can be detected. If background radiation levels are above 300 CPM the HP-210 shall be relocated to an area of lower radiation levels or the area shielded to lower background.

Alpha-emitting contamination is normally monitored using the PAC-4G or the ASP-2A detectors. A count rate of 50 cpm above background corresponds to approximately 50 pCi over the 50 cm^2 effective detector area of the PAC-4G. The ASP-2A is normally used only for personnel frisking, and the meter readings corresponding to the personnel contamination limits are marked on each instrument.

506. PROCEDURES FOR TAKING SWIPES FOR LOOSE CONTAMINATION

REQUIREMENTS:

1. A swipe shall be taken by firmly wiping a piece of dry swipe material over about one hundred square centimeters (an area about 4 inches by 4 inches) of the surface being monitored. In controlled surface contamination areas and where contamination is suspected, rubber gloves shall be worn when taking swipes to limit contamination of the hands. Rubber gloves need not be worn in uncontrolled areas for taking swipes if contamination is not expected.

2. The swipe shall be counted for equivalent cesium 137 radioactivity using the HP-210 probe or instrument of equivalent sensitivity. A swipe paper which has been wiped over an area of 100 cm^2 and produces a meter response equivalent to 450 pCi when held within about one-half inch of the face of the HP-210 probe indicates loose surface contamination of 450 pCi/100 cm^2. To allow for instrument response time the swipe shall

be placed under the probe for at least five seconds; if there is no significant increase in audible or meter response, the radioactivity is less than 450 pCi. If a significant increase is noted the swipe shall be measured for at least 15 seconds to permit an accurate measurement.

Experience has shown that minor contact between the HP-210 probe and a swipe will probably not result in inadvertent contamination spread. Although personnel measuring swipes should be careful to minimize contact, extensive efforts such as two man counting stations and special probe holders are not warranted to prevent minor contact.

3. To measure alpha radioactivity, the swipe shall be counted using the PAC-4G alpha survey meter or other equivalent alpha counting equipment. Alpha contamination on flat surfaces shall be determined by holding the meter close to the affected surface; if an indication $\geq$ 50 CPM is noted, a swipe shall be taken to determine if the contamination is loose. Swipes for alpha activity shall also be taken when a surface is irregular or inaccessible to the meter.

4. When the item to be swiped has less than 100 square centimeters of surface area, the entire item shall be swiped and the contamination level reported as "pCi/swipe" instead of "pCi/100 cm^2". Since the efficiency of collecting loose contamination with a swipe varies considerably with the size of the area swiped, contamination measured with one size swipe area cannot be directly multiplied by the ratio of areas to obtain the result for a different swipe area. For example, if a swipe area from a 100 cm^2 area measures 2500 pCi, a swipe of 10 times the area (1000 cm^2) of the same surface might measure only 4 times the activity (10,000 pCi). In meeting limits of article 502 for swipes from less than 100 cm^2, the measured pCi/swipe results shall be used and shall not be multiplied by the ratio of 100 cm^2 to the area swiped.

5. Dry swipes are normally used to measure loose surface contamination since the results are more representative of the spread of contamination by personnel brushing past these surfaces than if wet swipes were used.

507. PROCEDURES FOR MONITORING FIXED CONTAMINATION

Fixed contamination may be measured with (1) the HP-177 probe or equivalent with closed window for gamma contamination, (2) the HP-177 probe or equivalent with open window or an RM-3 ratemeter with HP-210 probe for beta plus gamma contamination, and (3) the PAC-4G or equivalent for alpha contamination. Since these survey instruments alone do not differentiate between fixed and loose contamination, the measured fixed contamination levels are actually the total radioactivity and may include some loose contamination. For fixed beta-gamma contamination, levels are usually expressed in mrem per hour. When searching for fixed contamination, or when trying to find the most highly contaminated portion of contaminated materials or areas, earphones or audible instrument response should be used; visual meter indications respond more slowly than audible indication.

When removal of fixed contamination is of concern, during machining operations, for example, it may be desirable to express levels of fixed contamination in terms of total microcuries present, or total radioactivity that may be removed. The procedures described in article 505 may be used for such measurements.

508. PROCEDURES FOR MONITORING PERSONNEL CONTAMINATION

1. Personnel monitoring (frequently referred to as "frisking") shall be performed when leaving controlled areas in accordance with article 503 and after personnel decontamination. Monitoring of personnel for surface contamination shall be done with the HP-210 frisker or equivalent in accordance with article 505 and the limits of article 502 used for such frisking. The probe shall be moved slowly over the body with the probe within about one-half inch of the body surface; special attention shall be given to the face, throat, chest, back, and abdomen in order to obtain an indication of any internal deposited radioactivity (article 406). When monitoring personnel, searching for fixed contamination, or when trying to find the most highly contaminated portion of contaminated materials or areas, earphones or audible instrument response shall be used; visual meter indications respond more slowly than audible indications. Frisking for alpha contamination is performed using the PAC-4G, ASP-2A or equivalent probe in a manner similar to that described above except that light contact between the probe and surfaces being monitored should be maintained. Alpha friskers shall have a mark on the meter indicating the reading corresponding to the contamination limit.

2. Monitoring of personnel by taking swipes for loose surface contamination on the skin or clothing shall not usually be done since swipes may tend to imbed radioactive particles.

3. When personnel have been adequately trained in frisking procedures, requiring personnel to frisk themselves may be desirable. Self-frisking can reduce the number of radiological monitors required to perform a job. When self-frisking is used, arrangements shall be made such that personnel do not rely on meter response which may be slow.

4. If facial contamination is detected, if the HP-210 continues to indicate greater than 450 pCi after personnel decontamination, or if it is suspected that radioactive nuclides have been taken into the body even though no facial contamination is evident, the individual shall be monitored for internal radioactivity using the procedures of article 406. Measurements of the radioactivity of nose and throat swabs have sometimes been used as a substitute for the procedures of article 406; however, the radioactivity of these swabs cannot accurately be correlated to the amount of radioactivity in the body.

509. FREQUENCY OF SURVEYS FOR MONITORING SURFACE CONTAMINATION

Routine surveys of surface contamination shall be performed with the frequencies indicated below, or more often if necessary.

1. <u>During Routine Operations</u>

   a. Surveys shall be performed at least daily in occupied areas surrounding controlled surface contamination areas and particularly in the vicinity of exits from controlled surface contamination areas. Foot operated water fountains shall be included in the surveys. Surveys shall be performed at least daily in occupied controlled surface contamination areas.

   b. Surveys shall be performed at least weekly in all occupied radioactive material areas where there is frequent handling or short-term storage of radioactive materials. Long-term radioactive material storage areas shall be swipe surveyed at least monthly.

   c. Surveys shall be performed monthly on a revolving basis in work and storage areas of the organization where radioactive materials are not stored or worked on.

2. Sealed radioactive test sources are leak tested by swiping quarterly. For a sealed source that is stored in a container designed to minimize radiation levels from the source or in a complex device requiring extensive disassembly to expose the source, it is permissible to perform the required leak test at a location on the container or complex device. In this case, the source shall be tested by swiping when the container or device is next opened for other reasons.

3. In addition, operations such as the following require surveys:

   a. Decontamination of equipment.

   b. Inspection or maintenance on components and piping of radioactive or potentially radioactive systems.

   c. Areas where radioactive liquid leaks have occurred or where airborne radioactivity has exceeded the concentrations of article 402. Surveys are required to determine the need for anticontamination clothing and to determine the extent of contaminated areas.

   d. Upon initial entry into tanks or voids containing potentially radioactive piping (see article 226) and when opening ventilation exhaust ducting from radioactive work areas.

   e. In addition, any normally uncontaminated system which is suspected of radioactive contamination shall be surveyed when opened for inspection, maintenance, or repair. Contamination control procedures shall be used until the portion of the system being worked on is proven to be uncontaminated. Water strained or flushed from these systems shall be treated as radioactive unless radioactivity levels are less than the minimum detectable activity (MDA) of 1×10^{-8} uCi/ml.

   f. Contamination surveys shall be taken in plenums downstream of high efficiency particulate air filters during routine filter replacement or at least annually to check on radioactivity buildup in ducts downstream of filters.

g. Prior to replacing filters on inlet ducts to the radiological work areas, these filters shall be surveyed to determine if radioactivity is present. Such radioactivity can result from fallout and naturally occurring radioactivity.

h. Surveys for contamination fixed in paint shall be performed prior to removal of paint in potentially contaminated areas. These surveys shall be performed by counting paint scrapings for gross activity.

510. PROCEDURES FOR RADIOACTIVE SPILLS

This article contains general procedures to be followed in the event of small spills of radioactive liquids or solids (including finely divided particles which may disperse rapidly in air).

1. Since each spill will require different detailed actions for effective control and recovery, personnel shall be trained to take appropriate supplementary actions depending on the location and potential consequences of the specific incident. For locations where spills are most probable or would have the worst consequences, each Activity shall train appropriate personnel in controlling and recovering from radioactive spills. Spill kits should be prepared in advance and located in work areas; these kits shall contain at least the following radiological control equipment:

(5)	Yellow chicken bags
(5)	Yellow turkey bags
(5)	Diapers
(1)	Caution Radioactive Material sign
(1)	Caution Radiation Area sign
(1)	Caution High Radiation Area sign
(1)	Caution Airborne Radioactivity Area
(1)	Roll of yellow and magenta barrier tape
(10 ft)	Yellow and magenta barrier rope
(5)	Pair anti-C gloves
(5)	Pair cloth gloves
(5)	Pairs plastic shoe covers
(30)	Filter papers and envelopes
(5)	Wiping cloths
(2)	Pencils
(2)	Pads of paper
(1)	Roll of Tuck Tape

2. The following steps shall be followed in the event of a radioactive spill:

a. IMMEDIATE ACTION

If the spill is minor (for example, a few milliliters of water with low radioactivity spilled on a smooth surface), immediately cover the spill with the most convenient absorbent material available, such as absorbent paper or rags to soak up the liquid. For minor spills involving small amounts of radioactivity, wiping up the spill, even though gloves are not available, probably will not result in additional contamination of the individual; personnel shall be decontaminated.

After the spill is covered, follow portions of steps 1 through 5 and b below as necessary to keep the incident under control.

The senior man in each area is in charge until relieved by the Rad. Con. Officer. The man in charge shall organize the personnel available and initiate action to control and correct the spill. It is important that this individual makes both his presence and the fact that he is in charge known to all others at the scene. On arrival of designated man in charge, the status of corrective action taken or in progress shall be immediately brought to his attention. The person in charge shall perform or designate available personnel to perform the following immediate actions:

(1) Stop the spill: If the spill is from a system which may have more material (either airborne particulate radioactivity or fluids) to leak out, promptly stop the leak if possible. If the spill is from an overturned container, try to set it upright if the contents have not all escaped. The amount of time spent stopping a difficult leak should depend upon the radiation levels involved, the possibility of inhaling airborne radioactivity from the spill, and the consequences of not making a prompt closure. In some cases, a prompt closure may not be necessary.

(2) Warn other personnel: Other personnel who may become contaminated by the spill or who may be able to help control it should be warned immediately. Notify radiological control personnel and area supervisor of the spill.

(3) Isolate the spill area: Keep unnecessary personnel away from the area affected by the spill to minimize spread of contamination. This action may require closing doors, roping off the area, and verbally warning approaching personnel.

(4) Minimize personnel exposure to contamination and radiation: Personnel in the spill area should remain at the edge of the area until radiological control personnel advise otherwise. Personnel should keep to the edge of the affected area taking care to minimize spread of contamination. It may be advisable to step outside the area where a spill occurred and close the access.

(5) Secure ventilation in the spill area, other than filtered exhausts: It may be desirable also to shut down exhaust systems in adjacent areas to ensure that air flows into rather than away from the spill area. Filtered exhausts in the spill area should also be shut down if necessary to minimize spread of high levels of radioactive contamination. Ventilation supplies should be shut down when exhausts are turned off.

b. SUPPLEMENTARY ACTION:

Steps (1) and (2) below are actions to evaluate the extent of the problem and to recover from the spill. The designated supervisor shall consult with Radiological Control personnel to ensure the performance of specific portions of the steps below.

(1) Measure radioactivity levels: Measure contamination on personnel who may have been affected, make contamination surveys in the area adjacent to the spill, measure airborne radioactivity inside and outside the spill area, and measure radiation levels in affected areas, particularly on ventilation filters. Monitor ventilation systems to determine if the spill has caused them to be contaminated. If it is suspected that radioactive nuclides have been taken into the body or if facial contamination is detected, the personnel monitoring procedures of article 406 shall be followed.

(2) Take subsequent radiological control and cleanup actions in accordance with other appropriate articles in this manual: The designated supervisor shall minimize personnel radiation exposure and generation of radioactive waste consistent with the requirements to recover from the spill.

511. RECORDS OF CONTAMINATION

1. Records of the following abnormal spreads of radioactive contamination shall be maintained for three years unless noted otherwise.

   a. Any occurrences involving skin contamination of personnel exceeding 450 pCi beta-gamma or 50 pCi alpha as determined using the procedure of article 508 (contamination on anticontamination or personnel clothing need not be recorded). These records shall include the following information:

      (1) name of individual contaminated

      (2) date and time contamination was detected

      (3) level and location of contamination on the individual

      (4) work individual was performing

      (5) approximate work area contamination (before the incident, as result of the incident, and following the incident)

      (6) type of anticontamination clothing and mask worn

      (7) cause of contamination spread

      (8) effectiveness of decontamination of the individual

      (9) results of internal monitoring (if performed)

   Copies of these records shall be kept with the individual's radiation exposure record since these records may be required to serve legal purposes. These records shall be prepared in such a manner that they do not require a security classification.

b. Any occurrence which results in loose surface contamination greater than 450 pCi/100 cm^2 or 50 pCi/100 cm^2 alpha in uncontrolled areas with unlimited personnel access (such as office areas, shops, and corridors).

c. Any spread of contamination in radiologically controlled areas or controlled surface contamination areas which results in work being stopped for more than four hours or takes more than four hours to clean up.

These records shall be kept in the form of reports of the incident.

2. Records of surface contamination surveys shall be retained for three years. The survey information shall be recorded on a standard form if specified or on locally prepared forms which contain at least the following information:

a. Date and time of survey

b. Location (may be shown on a survey map or listed in a table)

c. Reason for survey and type of radiation measured (e.g., daily beta-gamma swipe survey)

d. Instrument used and results of daily response check (e.g., when the HP-210 is used for direct surface contamination measurements or used to count swipes the information from the daily response check required by information shall be included).

e. Background beta-gamma radiation level where measurements were made (background should be less than 300 cpm when the HP-210 is used for measurements)

f. Instrument reading, radioactivity level measured and if level is below minimum detectable activity, the numerical value of minimum detectable activity (e.g., surface contamination levels below the minimum sensitivity of HP-210 or PAC-4G may be listed as " $<$ 450 pCi/100 cm^2" or $<$ 50 pCi/100 cm^2.

g. Remarks

h. Signature of surveyor

i. Signature of persons reviewing logs (e.g., Radiological Control Foreman)

512. PROCEDURES FOR USING YELLOW PLASTIC BAGS AND SHEET

Yellow plastic bags or sheet shall be used for wrapping materials having, or which are suspected of having, loose radioactive contamination above the limits of article 502 where transfer or storage of such materials could result in spread of contamination to personnel, to other locations in a controlled surface contamination area, or to an uncontrolled area. If radioactive material without loose surface contamination is to be wrapped in plastic film material, the plastic shall be yellow. Totally contained radioactive material such as clad fuels are exempt from this requirement. Plastic film material used shall be transparent so that equipment will not have to be unwrapped for identification. Although they are intended as an additional aid in identifying radioactively contaminated items, marking with tags and labels as discussed in article 702 is required. The use of yellow colored bags and sheet for other purposes is prohibited.

1. Throughout this manual, wherever reference is made to use of plastic bags or sheet for contamination control, yellow colored materials shall be used.

2. Where items to be wrapped have sharp edges or projections which could damage plastic wrappers, a more durable material such as herculite may be used as the primary wrapper. The outer wrapper shall be yellow material to ensure adequate control.

3. Where light transmission is required, such as in a Contamination Containment Area or where visibility into and from a containment tent is required, clear plastic which is not easily torn or plexiglass may be substituted for yellow. However, clear plastic shall not be used in those portions of the enclosure (e.g., sleeves and parts which are attached to a component) which may be cut during installation, use, or removal.

4. Yellow bags and sheet are typically used to package materials removed from controlled surface contamination areas to prevent spread of contamination. Heavily contaminated materials are bagged before they are moved to minimize spread of contamination inside the controlled area; a second clean bag should then be used at the boundary of the controlled area to assure that the outside of the package is free from contamination. In bagging materials leaving a controlled surface contamination area, care shall be used to avoid contact between the outside of the bag and items known or suspected to be contaminated, such as gloves. Sheet is used to wrap items too large for bags. Bags and sheet can be heat sealed or taped to seal in the contaminated material.

5. To prevent misusing yellow wrapping materials for non-radioactive purposes, uncontaminated yellow wrapping materials requiring disposal shall either be disposed of as radioactive waste or physically destroyed.

513. REQUIREMENTS AND PROCEDURES FOR RELEASING PREVIOUSLY CONTAMINATED FACILITIES AND AREAS FOR UNRESTRICTED USE

The requirements and procedures of this article shall be applied when releasing previously contaminated areas or radiologically controlled facilities for unrestricted use (e.g., use of the area is not controlled by radiological control procedures). Typical areas and facilities include facilities used for decontamination and repair or assembly of contaminated equipment, radioactive waste processing facilities and systems, exhaust ventilation systems from radioactive work areas, radioactive material storage areas, and outside areas accidentally contaminated.

1. Criteria: Equipment, parts, materials and waste which have been exposed to radioactive contamination shall not be released for unrestricted handling until they are inspected and show compliance with the criteria of article 701. Earth (e.g., sand or soil), ground covering (e.g., asphalt or porous concrete), or paint which may have absorbed radioactive contamination shall not be released for unrestricted use until the area is inspected and samples do not exceed a concentration in μc/gram for the isotope in question using 10 CFR 20 Appendix A as a guide substituting gram for ml of water.

2. Procedures: In order to ensure compliance with the criteria of 1. above, the following procedures shall be followed as applicable:

   a. General: Prior to initiation of final surveys, records shall be reviewed and investigations made to determine if contamination existed in any area and was covered over to prevent its spread, such as by wall boarding, floor tiling, or paving. Such identified areas should be inspected and if contamination is present under such surfaces, action shall be taken to decontaminate the area below the criteria of 1. above, or dispose of the contaminated material as radioactive waste.

   b. Facilities: In certain areas where a potential existed for only low levels of radioactivity (less than 1000 pCi/100 cm^2) to be deposited on small areas as a result of accidental low-level spills such as in radioactive storage areas, controlled corridors and passageways, and controlled areas where only contained contaminated material was handled, it can be assumed that radioactivity normally would not be deposited or spread to inaccessible locations, such as in crevices, under floor tile, or in wall or ceiling joints to a degree to warrant detailed and complete examination. As a minimum, a complete survey shall be made with particular attention to potential

areas of contamination, such as along walls at shoulder and waist height, and over floor areas.

In other areas where a potential existed for higher levels of loose contamination (between 1000 and 10,000 pCi/100 cm^2) to be deposited at times on larger areas as a result of work on uncontained contaminated material such as in contaminated welding and machine shops, it might be expected that radioactivity could be deposited or spread to a few inaccessible locations. As a minimum, a thorough survey shall be made of all surfaces; selected floor tile shall be removed and selected wall joints shall be opened for survey along the heavy traffic routes and at the previous work stations.

For highly contaminated areas, such as decontamination rooms and liquid waste storage and processing areas, it is necessary to completely strip all floor coverings other than coverings without crevices, such as stainless steel, and open up and expose all wall and floor crevices and joints in order to perform a satisfactory survey.

c. Ventilation ducting usually can be surveyed internally. An adequate survey of internal surfaces may consist of spotchecking (1) the first few feet of the inlet and outlet ductwork, (2) a few feet upstream and downstream of a filter (after filter removal), and (3) in the vicinity of handhole openings. If contamination is found, a more complete survey is required.

d. Equipment such as drains, piping, tanks, and hoses which has been previously exposed to radioactive liquids usually shall be removed and discarded as radioactive waste if no longer useful since it is highly improbable that such equipment can be economically decontaminated. If an organization considers decontamination is feasible, the organization shall obtain approval for unrestricted release of such equipment by submitting comprehensive survey measurements which indicate the equipment meets the criteria of 1., above.

e. Outside earth or ground coverings shall be slowly scanned over the entire area surface with a gamma survey meter and representative samples shall be counted for gross activity. If the contamination has been covered over, it shall be re-exposed for a proper survey.

3. Radiation Warning Signs: After a facility or area has been determined to be free of radioactivity, all radiation or radioactivity warning signs and radiological control equipment shall be removed from the facility or area.

4. Records: A summary record of these surveys shall be forwarded for all facilities and outside areas released for unrestricted use if these facilities and areas have previously been used for radioactive work. Copies of these summaries shall be retained by Radiological Controls for 75 years since they may be required to serve legal purposes.

PART 3 ANTICONTAMINATION CLOTHING AND EQUIPMENT

514. GENERAL

Anticontamination clothing (often referred to as anti-C clothing) is used to help keep personnel from spreading radioactive contamination outside controlled surface contamination areas and to keep the wearer's body free from contamination. Anticontamination clothing is worn when either surface contamination or airborne radioactive contamination may exceed prescribed limits. In the following articles, the recommended type of anticontamination clothing is described and procedures for wearing it are given. In addition, miscellaneous equipment used to control radioactive contamination is described. Anticontamination clothing and radiological control equipment shall not be used for any other purpose than radiological control.

To prevent similar misuse by other organizations who may obtain these items, excess radiological control equipment bearing radiation symbols and anticontamination clothing shall not be transferred to any other organization not authorized to handle radioactive materials.

515. DESCRIPTION OF ANTICONTAMINATION CLOTHING

The anticontamination clothing shown in figure V-2 is designed to (1) protect the worker's head, neck and ears, body, and extremities from radioactive contamination, (2) eliminate clothing closure devices such as buttons, snaps, and zippers which could become separated from the garment and fall irretrievably into inaccessible openings, and (3) eliminate the profuse use of pressure sensitive tapes applied to clothing to seal fly fronts, pockets, and other openings, and secure gloves and shoe covers to the garment.

The articles in this set of clothing are described in 1 through 9 below. The design of clothing or clothing which provides equivalent coverage shall be used.

ARTICLE 515.

Figure V-2

Typical Anticontamination Clothing

Procedures for donning and removing the clothing are contained in articles 518 and 519.

1. The coverall is worn to prevent contamination of the body. The sleeves are longer than those of conventional coveralls so that when the arm is extended there is no tendency for the sleeve to pull up and expose the wrist. A stirrup strap is provided to prevent the coverall leg from pulling up during work. A left breast pocket is provided for a dosimetry badge and pocket dosimeter.

2. The hood is worn to protect the neck, head, and ears from contamination; it is shaped so that head movement is not restricted.

3. The plastic shoe covers are used primarily to protect the ankles and tops of shoes. They are made in a bootie shape from flexible vinyl film and will fit either the left or right foot. The plastic shoe cover is large so that it fits over large work shoes and is intended to be worn under the rubber overshoes described in 4. below.

4. The rubber overshoes are worn over the plastic shoe cover. Yellow patches or similar identification are applied to the shoe cover at the toe and heel to signify these are for radioactive use only. Because the rubber overshoe stretches in all directions, sizes small, medium, large, and extra-large will fit a range of shoe sizes from about 6 to 14.

5. Long cotton gloves are worn under rubber gloves. Cotton gloves provide no protection against contamination when worn without rubber gloves. Therefore cotton gloves shall not be worn without rubber gloves. These gloves can be worn on either a left or right hand and are worn under the coverall wristlet. The combination of the knit glove and jersey wristlet provides part of the gripping action for sealing the coverall at the wrist.

6. Rubber gloves protect the hands from both wet and dry contamination. They have a nonslip finish on the palm and fingers. Cuff dimensions are narrow to provide a snug fit over the coverall wristlet; it is the narrow wrist dimension which maintains the clothing seal so that no taping is necessary at the wrist. Surgical gloves are provided for jobs involving dexterity; due to their high cost, their use shall be limited to such jobs. Disposable plastic gloves may be useful during radioactive liquid sampling or swipe surveys.

7. Aprons are provided to minimize the soaking of contaminated liquids through the cotton coveralls in decontamination operations. For some operations, plastic suits are necessary.

8. Face shields are provided for some operations to prevent radioactive liquids splashing a person's face.

9. Anticontamination clothing shall be marked conspicuously to prevent its use for purposes other than radiological control. Most of the equipment described above is colored yellow for this purpose. Such identification is required to allow adequate control of anticontamination clothing that may contain fixed radioactivity after laundering.

516. DESCRIPTION OF CONTAMINATION CONTROL MATERIALS

Some typical materials used to help control radioactive surface contamination are listed in table 6. Since these items also become contaminated in use, solid radioactive waste shall be

minimized by avoiding use of excessive quantities.

TABLE 6

TYPICAL CONTAMINATION CONTROL MATERIALS

Bag, yellow, plastic 8" x 15" x .0015"
Bag, yellow, plastic 12" x 24" x .0015"
Bag, yellow, plastic 18" x 24" x .004"
Bag, yellow, plastic 18" x 40" x .004"
Contamination Containment Areas
- Type I, 30" Diameter
- Type II, 24" Diameter
- Type III, 24" Diameter
- Type IV

Paper, absorbent, white, 0.025" thick, 2 foot roll, 150 pound.
Plastic sheet, yellow 54" wide roll
Sleeving, yellow 4", 6", 8", 12", 14", 18", and 36"
Tape, cloth, 1/2", 1" and 2"
Tubing, tygon, 3/16" I.D.
Filter discs, package of 100

517. REQUIREMENTS FOR WEARING ANTICONTAMINATION CLOTHING

Radiological control personnel shall determine the appropriate requirements for anticontamination clothing based on the following:

1. When first entering an area which may be contaminated, prior to determining the extent and level of contamination, full anticontamination alothing shall be worn. Full anticontamination clothing constitutes hood, coveralls, rubber and cloth gloves, and shoe covers.

2. Full anticontamination clothing shall be worn when working in nighly contaminated areas (such as those with extensive beta-gamma contamination greater than 10,000 pCi/100 cm^2 or with alpha radioactivity greater than 1000 pCi/100 cm^2). Full anticontamination clothing may be required in areas with less contamination if personnel contamination is probable. In addition, if construction of the anticontamination clothing allows contamination to get through openings such as at wrists and ankles, these openings should be sealed with tape. (The clothing described in article 515 does not require taping.) Full anticontamination clothing is also necessary in other situations, such as when initially opening a radioactive system without containment.

3. A face shield, waterproof apron, and rubber gloves should be worn during operations such as sampling of radioactive waste tanks and processed water tanks.

4. a. When working in very highly contaminated areas (such as those with beta-gamma contamination of 100,000 pCi/100 cm^2), double suits of anticontamination clothing shall be worn. Double suits limit the contamination which may penetrate the material during work, and they also improve the ease of controlling spread of high levels of contamination. The outer suit is normally removed prior to leaving the region of very high contamination and the inner suit is normally removed at the boundary of the controlled surface contamination area.

   b. When only the hands and arms are in contaminated areas such as a glove box, rubber gloves attached to the glove box may substitute for the anticontamination clothing.

   c. When working in a contaminated wet area, or when contaminated liquid is likely to spray on the clothing, the outer coveralls shall be waterproof. These conditions might apply when entering a contaminated liquid waste collection tank, disconnecting a used demineralizer or resin column, or when opening a radioactive liquid system.

5. If contamination is confined to floors, or if personnel can pass through a controlled surface contamination area without touching other contaminated surfaces, it may suffice for personnel to wear shoe covers and rubber gloves (without the other anticontamination clothing). Such conditions might apply in entering a contaminated parts storeroom to store or remove a component or in entering the liquid waste disposal system operating stations.

   If wearing gloves without anticontamination coveralls, care shall be taken not to transfer contamination from the gloves to personal clothing.

6. It may be desirable to remove personal clothing before putting on anticontamination clothing for comfort when working in high temperature spaces. Removing personal clothing is not usually required for adequate radiological control as long as the anticontamination coveralls do not tear and the anticontamination clothing is taken off properly after use.

7. Masks shall be worn in conjunction with anticontamination clothing if the concentration of airborne radioactive particles may exceed the limits of article 402. Masks or face shields should be worn if covering is needed to avoid contamination of the face.

8. Normally anticontamination clothing shall be put on at the entrance to a controlled surface contamination area. However, under some conditions (such as when the area surrounding a controlled surface contamination area is also controlled) it may be desirable to allow personnel to walk through the surrounding area in clean anticontamination clothing.

9. When reading a pocket dosimeter in a contamination area, provisions shall be made so that the dosimeter is not contaminated. Use of a transparent plastic bag has been effective for this purpose.

518. PROCEDURE FOR DONNING ANTICONTAMINATION CLOTHING

The anticontamination coveralls, hood, shoe covers, and gloves described in article 515 and shown in figure V-2 were designed to eliminate the need for buttons, zippers, and taping normally used to provide garment closure and prevent closure devices from falling into inaccessible locations. These garments should be donned in accordance with the following procedures, other types of anticontamination clothing should be donned using similar procedures.

1. Plastic shoe covers should be put on first. These should extend up over the worker's lower pants leg.

2. Long cotton gloves are put on next and drawn up the forearm.

3. Don the coverall making sure they fit over the plastic shoe cover. (The coverall is worn over this shoe cover.) The sleeve wristlet should fit over the cotton glove.

4. Rubber overshoes are put on over the plastic shoe covers.

5. The hood is put on next and secured at the neck by pressing the Velcro tabs together. In attaching the Velcro tab located on the back of the hood to the coverall, bend the head forward slightly so that head movement is not restricted.

6. Rubber gloves should be put on last. These must fit over the coverall wristlet.

519. PROCEDURES FOR REMOVING ANTICONTAMINATION CLOTHING

Procedures for removing anticontamination clothing shall be posted at exits from controlled surface contamination areas or surrounding areas where radiological control personnel are not personally directing the removal. The following procedure should normally be used for removing full anticontamination clothing starting prior to leaving the area:

1. Remove tape (if used) and place in waste container (some types of garments still in use might require taping).

2. Remove rubber gloves (inside out) and place in designated container. Leave on cloth gloves.

3. Remove hood and mask and place in designated containers. To remove mask, grasp mask by canister or air inlet connection, bend head down, and remove by pulling out and away from body.

4. Remove rubber overshoes and place in designated container.

5. Remove coveralls inside out to avoid transferring contamination from the outside of the coveralls to personal clothing. Place coveralls in designated container. If feasible, considering design of coveralls and shoe covers, remove shoe covers as in steps 6 and 7 simultaneously with coveralls; this is feasible with the clothing shown in figure V-2.

6. Remove shoe cover from one foot and then place this foot on a designated step-off area. Shoe covers should not touch outside and clean shoes should not touch inside the controlled area.

7. Remove shoe cover from other foot and step on step-off area. Place shoe cover in designated container.

8. Remove cloth gloves (inside out) and place in designated container.

9. Frisk yourself or be frisked by radiological control personnel, paying particular attention to shoes, elbows, knees, palms and backs of hands, and face. Remain in designated step-off area while frisking. To avoid spreading contamination with the frisker, the frisker should not be allowed to contact the surfaces being monitored.

10. If frisking indicates contamination on clothing or shoes, these shall be removed. If the person is contaminated, contaminated portions of the body shall be decontaminated in accordance with article 524.

PART 4 RADIOACTIVE DECONTAMINATION

520. GENERAL

Decontamination may be required for components, tools and equipment, work areas, clothing, or personnel. Each of these subjects is discussed in the following articles. Alternatives to decontamination are also discussed in these articles; these include in some cases storage for decay, disposal without decontamination, or restricted use without complete decontamination. By its very nature, decontamination operations, the disposal of the waste radioactivity must be considered (see section III of this manual). Volumes of both solid and liquid wastes shall be minimized. Unauthorized chemicals shall not be used; these may cause difficulties in waste processing. It shall be noted that most radioactive contamination expected, except that on surfaces exposed to high temperature reactor coolant, can be removed by normal cleaning. This surface contamination is generally loose radioactivity dropped on a surface or spread around by hands or feet; wiping with a damp rag soaked with detergent will usually provide satisfactory decontamination.

If large variations in surface contamination levels exist on highly contaminated surfaces, cleaning shall be from less contaminated towards more contaminated areas (otherwise radioactivity might spread to less contaminated areas). Cleaning solutions and cloths used in these decontamination operations shall be disposed of as radioactive waste (see section III0. During decontamination operations, precautions shall be taken to limit the spread of contamination, such as by taking care not to splash solutions, by properly wearing anti-contamination clothing, and by wearing masks as necessary. Filtered exhaust ventilation is also normally required to minimize the possibility of contamination being breathed by personnel performing the decontamination.

521. DECONTAMINATION OF TOOLS AND EQUIPMENT

In decontaminating tools and equipment, appropriate radiological controls shall be exercised for spread of contamination, airborne radioactivity, and radiation exposure. In addition, radioactive wastes from these operations shall be treated in accordance with section III. The following procedures apply to decontaminating tools and equipment.

1. Tools and equipment which may be used again in contaminated areas may be temporarily stored in the contaminated area or in a contaminated tool room without decontamination. If certain tools are to be used solely in controlled surface contamination areas, such as a set of hand tools for the decontamination room, these tools shall be durable and distinctively marked to indicate they are always treated as potentially contaminated (article 702). Heavily contaminated tools can spread significant surface contamination within a controlled area; therefore, such tools shall normally be partially decontaminated, such as by wiping with a cloth. Heavily contaminated tools can be readily identified without taking swipes by measuring their radiation level or by using

the HP-210, PAC-4G or equivalent probe. Heavily contaminated tools can be decontaminated separately in an ultrasonic tank or treated as in the following paragraphs.

2. Many lightly contaminated tools may be treated together in an ultrasonic tank without time-consuming scrubbing by hand. These tools need to be swiped or frisked with the HP-210 or PAC-4G or equivalent probe only at completion of decontamination to verify the effectiveness of the treatment.

3. In some cases, the need for decontaminating tools may be minimized by taping some portions such as the handles prior to use and stripping off the contaminated tape after use. Large tools are often wrapped in plastic instead of tape. If tape is used to cover parts of tools, after tape removal, the residual adhesive shall be removed to minimize contamination that may be picked up in future uses of the tool.

4. Tools which are used solely in controlled surface contamination areas can normally be surveyed after decontamination with a beta-gamma or alpha survey meter instead of swipes. The purpose of decontaminating these tools will usually be to reduce their radiation levels rather than to remove all loose surface contamination.

5. When only a few tools require decontamination, wiping with cloths soaked in detergent is a convenient effective procedure. This method is also useful when only a portion of a tool is contaminated. A disadvantage of wiping procedures is the large amount of solid radioactive waste produced.

6. Dishwashers have proven effective for tool decontamination. Provisions must be made for disposal of contaminated wash water.

7. Mechanical decontamination methods, such as using abrasives which remove some of the surface of the tool, can be useful in special circumstances where contamination is not removed by chemical cleaning. In such cases control of possible airborne radioactivity is essential.

8. The cost of some tools may not justify efforts to decontaminate the tools. In such cases disposal as radioactive waste may be warranted or the tools may be retained solely for use in controlled surface contamination areas.

ARTICLE 521.

9. In decontaminating oily or greasy tools or equipment, consideration should be given to the fact that oil or grease will inhibit waste processing. Therefore, initial degreasing with rags, or with degreasing solutions which are disposed of by solidification, may be necessary.

522. DECONTAMINATION OF AREAS

Contaminated areas shall first be isolated and radioactivity then removed while being careful to avoid spreading contamination. Radioactive liquids may be dried up using paper towels or blotting paper which is then placed in watertight containers (such as plastic bags or 55 gallon drums) and disposed of as solid radioactive waste. In some cases tape may be used to lift loose contamination from the surfaces; this will minimize the contamination which may be spread by subsequent operations. Wiping with damp rags soaked in sudsless detergent is generally the most effective decontamination method. If contamination levels are not sufficiently reduced, use of solvents, strong chemicals, or mechanical removal of some of the surface may be necessary. In all cases where liquids are used in decontamination, care shall be exercised to avoid spreading radioactivity. To minimize taking a large number of swipes during cleanup operations, rags used for cleaning may be surveyed to provide an indication of the extent of the remaining contamination. If no radioactivity above background is found on the rag using the HP-210 or PAC-4G, further cleaning may not be required in the area in which the rag was used. However, the area shall be surveyed by direct survey with the HP-210 or PAC-4G or by swiping prior to release to ensure surface contamination is below the limit of article 502. On painted or covered surfaces, if washing will not remove the contamination, the paint or covering shall be removed and the surface repainted or re-covered. During the process of removing paint, control of the spread of airborne and surface contamination in dust and paint chips will be necessary.

Because of these radiological control problems, and because paint can chip or wear off exposing underlying contamination, painting is not normally considered an acceptable substitute for decontamination in controlling loose surface contamination.

Contamination areas shall be decontaminated as soon as practicable to minimize spread of contamination and to facilitate removal before the contamination is fixed on the surface. Normally, areas are decontaminated by starting at the edge and working toward the area of highest contamination. If high radiation levels from the contamination contribute significantly to personnel radiation exposure during cleanup, it may be desirable to decontaminate the most heavily contaminated area first.

523. DECONTAMINATION OF CLOTHING

Anticontamination clothing normally should be laundered before reuse to minimize the possibility of spreading radioactive contamination to the wearer. The services of a commercial laundry licensed by the Nuclear Regulatory Commission for laundering anti-contamination clothing is required.

524. DECONTAMINATION OF PERSONNEL

1. Immediate flushing of a minor wound is usually desirable to minimize absorption of radioactivity. Upon decontamination the wound area shall be monitored for internally deposited radioactivity and results of this survey shall be recorded with the description of medical treatment in the individual's medical record.

2. Skin shall be decontaminated using soap and water. Scrub brushes shall not normally be used since it is relatively easy to abrade the skin and thus work contamination into the skin. Washing may need to be repeated several times, monitoring after each washing.

PART 5 CONTROLLING SURFACE CONTAMINATION

525. GENERAL

This part identifies some of the problems which may be encountered in attempting to institute efficient detailed procedures for control of radioactive contamination. Procedures for coping with these problems are given; however, the initiative in finding effective and economical contamination control procedures and in uncovering other contamination control problems not covered in this manual must be left to personnel of the individual organization. Normally work procedures shall contain instructions to prevent spills and spread of contamination. These instructions should reflect the experience that most radioactive spills during work have resulted from improperly operated equipment and failure to follow procedures. The following articles describe procedures applicable inside and outside radiologically controlled areas.

In order that personnel will have the necessary training and skills in controlling contamination, particular attention shall be given to training personnel in operations such as work in glove bags. Experience indicates that glove bag training and practice greatly reduces the number of radioactive spills.

526. CONTAMINATION CONTROL POINT

A contamination control point is a location on the perimeter of a controlled surface contamination area or surrounding area through which all entries and exits are made and where action is taken to prevent the spread of radioactive contamination to adjacent uncontaminated areas. The dimensions and material requirements depend on the type of work to be performed, the number of personnel involved, the location of the work. The following items outline the basic considerations for establishing a contamination control point.

1. Determine the extent of the area to be isolated and the location where entry and exit will be controlled.

2. Plan for physical boundaries to prevent inadvertent or unauthorized access to the contaminated area. Boundaries shall be marked. Existing walls and equipment may effectively be used as boundaries.

3. Cover the floor of the contamination control point using paper or plastic sheet or other material provided for this purpose. The intent is to provide an easily removable walking surface within the contamination control point to prevent tracking of contamination from the area. Maintain a supply of the material to replace floor covering as necessary.

4. Provide a "step-off pad" at the exit from the contamination control point. This is to be used when removing clothing during exit from the area.

5. Provide easily accessible receptacles for radioactive waste and contaminated clothing at the contamination control point. A supply of plastic bags shall be available as necessary for receiving contaminated equipment and tools.

6. Provide radiac instruments for monitoring personnel and equipment. Frisking shall be performed in a low radiation background and where the audible response of the frisker can be heard.

7. Provide means of recording as may be required, entry of personnel to the areas. It may be necessary to provide a record of previous radiation exposures received by personnel entering a radiation area so that maximum allowable time in the radiation area can be determined.

8. Radiation tags or labels shall be available to identify contaminated items being removed from the area.

9. At the entrance to the contamination control point, it may be necessary to post information concerning radiation and contamination conditions, precautions for entry, precautions for exit, step-off points, clothing and waste receptacles, and personnel survey.

10. A person qualified shall be assigned the responsibility for the contamination control point. For those instances where the control point is maintained by Radiological Control, the Radiological Control Technician should ensure that personnel and equipment are adequately surveyed prior to leaving the area and that all logging requirements are met.

11. In some instances where high level contamination exists, it may be necessary to wear two sets of anticontamination clothing; the outer garments should be removed at a designated location close to the contaminated work to minimize tracking to the contramination control point.

12. When adequately trained, personnel may be permitted to assist in frisking other personnel and themselves.

527. RADIOACTIVE MATERIAL STORAGE

Storage of radioactive materials shall be in accordance with the following:

1. Fire Protection Practices:

   Proper selection of a fire resistant storage area for radioactive material will minimize release of radioactivity to the environment in event of a fire. However, the following additional fire protection practices shall be considered for storage of radioactive material to minimize the possibility of a fire and spread of contamination in event of a fire:

   a. Storage of radioactive materials in fire resistant containers is desirable to minimize contamination spread. In addition, containers of highly inflammable radioactive materials such as plastic bags of radioactive waste shall be stored in areas segregated from other storage to reduce the risk of spreading a fire.

   b. Smoking shall not be permitted in radioactive storage areas because radioactive materials are frequently wrapped in combustible materials.

   c. An up-to-date list of locations where radioactive materials are stored shall be available to personnel who might be called to fight a fire in such areas. This list shall also identify unusual problems which may be present such as item b., above.

   d. Periodic inspections of radioactive material storage areas shall be made to identify fire hazards by personnel trained in fire protection procedures. Deficiencies shall be promptly corrected.

   e. Fire drills shall be performed periodically with both fire fighting and radiological control personnel participating.

   f. Combustible materials shall be minimized inside radioactive material storage areas and shall not be stored next to surrounding walls. Welding, burning, or other operations which may cause a fire shall not be conducted inside or next to radioactive material storage areas without prior authorization of the Radiation and Safety Officer or his designated representative.

3. Contamination Control:

Contaminated items are often stored in plastic bags which might break, liquid inadvertently left in a container might leak out, and condensation of moisture from the atmosphere might drip on exposed, contaminated surfaces. Unless all contaminated surfaces of stored materials are appropriately wrapped or contained to prevent the spread of contamination, the storage location shall be considered potentially contaminated; personnel in these areas, particularly if they handle contaminated materials, shall wear necessary anticontamination clothing. When all contaminated surfaces are appropriately wrapped, personnel may walk through these areas without anticontamination clothing. Reasonable care shall be taken in packaging and storing contaminated items to prevent the spread of contamination and to ensure that entry to areas where such storage is permitted does not result in the contamination of personnel or other areas.

4. Radiation Exposure Control:

Storage of radioactive materials can result in possible personnel radiation exposure in the storage area and surrounding areas. For example, a component or bag of contaminated waste measuring 1 rem per hour, if stored at the entrance to the storage area would expose everyone who entered to high radiation levels; if stored in a far corner of the area, high radiation levels might be caused in surrounding areas. Activities shall store radioactive materials so as to minimize the radiation exposure of personnel entering or working in the area and of personnel in surrounding spaces. Radiation surveys of the storage area and of spaces immediately around the storage area are necessary to ensure proper posting of radiation areas and prevent inadvertent exposure of personnel in the storage space or surrounding spaces. When necessary, temporary shielding shall be used to reduce radiation levels.

5. Outdoor Storage:

Radioactive materials shall be stored where they are protected from adverse weather. Normally radioactive materials shall not be stored outdoors except during short periods (e.g., one day) while in transit. However, protection from adverse weather shall be considered in selection of these temporary storage locations. Large items which are designed for outdoor use, such as radioactive liquid collection tanks may be stored outdoors. However, mechanical joints or capped pipes which may leak radioactive liquids shall be wrapped with weather resistant materials. Radioactive materials packaged in accordance with DOT requirements may be stored outdoors for short periods (e.g., a few days) while awaiting shipment.

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6. Minimize Radioactive Material in Storage:

In order to minimize the complexities of accounting for a large amount of radioactive material and possibility of losing radioactive material, Activities shall consolidate radioactive materials in as few areas as practicable and minimize the amount of radioactive material in storage. If storage areas previously used for storage of radioactive materials are released for unrestricted use the requirements of article 513 apply.

7. Storage of Highly Radioactive Material:

a. Radioactive materials, particularly calibration and test sources, which contain more than a millicurie of radioactivity and can be easily stolen or mishandled because of their physical size, require special precautions to prevent theft or mishandling. Such highly radioactive materials shall be stored in locked areas with the number of keys and the number of personnel having access to the keys , dept at a minimum. A physical inventory shall be performed at least monthly, in addition to the control and accountability requirements of section VII. Results of the monthly inventory shall be reviewed by the Radiological Control Officer.

b. Materials in a. above and other radioactive materials, such as large components, shall be stored only in areas of low potential fire hazard. For example, a one curie alpha/neutron source shielded by highly flammable paraffin would represent both a radiation and a severe contamination problem in event of fire. Procedures of paragraphs 1 and 2 above shall be used to minimize potential fire hazard.

528. VENTILATION

The following apply to control of contamination associated with ventilation:

1. Ventilation shall be controlled during operations involving radioactivity to prevent spreading the radioactive contaminants throughout an area. The basic methods of controlling contamination by ventilation are by preventing supply air or recirculated air from blowing into the contaminated work area and by providing filtered exhaust ventilation close to the work or from a containment enclosure erected around it.

2. High efficiency filters are normally installed in permanent ventilation systems servicing radioactive work areas. High efficiency filters are provided in ventilation systems servicing areas most likely to have radioactive airborne contamination. These filters may become heavily contaminated so that dropping a used filter may spread levels of 100,000 pCi/100 cm^2. Therefore, great care shall be exercised when removing used filters. Filters may require replacement because of plugging (High pressure drop), high radiation level (in some areas contamination levels may cause significant personnel radiation exposure), or lack of effectiveness in removing radioactivity (usually caused by damage during or prior to installation).

   Filters may be significantly contaminated even though never used for radioactive work; contamination has been measured high efficiency filters from natural radioactivity in the air. Contaminated used filters are normally removed into plastic bags. Contamination in the adjacent duct shall be wiped up before it spreads during the subsequent new filter installation.

3. A buildup of detectable levels of surface contamination can occur through the deposition of activity from the air without having significant levels of airborne radioactivity. Therefore, even though the air particle detector has never alarmed, ventilation exhaust ducts or ventilation system ducts from radioactive work areas shall be considered potentially contaminated. (Refer to article 226.6 for posting requirements). When opening these potentially contaminated systems they shall be monitored with swipes and decontaminated as practical. One method of decontamination is to use a vacuum cleaner with high efficiency filter. For similar reasons if a portable exhaust blower is used in a contaminated space, surface contamination shall be checked on surfaces exposed to the filtered exhaust of this blower.

4. Exhaust blowers are normally used to exhaust air from many work areas, particularly when welding or grinding. To prevent spread of radioactive contamination when using a blower in a controlled surface contamination area, the intake to the blower shall be filtered through a high efficiency filter; a high efficiency filter is best installed at the intake side of the blower so that air is filtered prior to being exhausted and positive pressures upstream of the filter are avoided. It may be preferable to locate the filter inside the areas to minimize the amount of ducting which becomes contaminated. The blower exhaust shall be directed so as to prevent stirring up contamination in the area in which

it is used. When removing these blowers, flexible ducts, and filters, precautions are required to prevent spilling contamination from them.

5. When high efficiency filters are installed in ventilation systems for radioactive service, labels shall be prominently affixed verifying proper installation of the filters. These labels shall be located so that they are destroyed when the filters are removed.

6. Potentially contaminated air that has not passed through a high efficiency filter shall not be discharged to locations occupied by personnel or where supply ventilation can return it to an occupied area.

7. Consideration shall be given to controlling contamination which has been collected in ventilation equipment and systems not normally used for radioactive work including those systems in adjacent spaces which may become contaminated in event of a spill. Prior to work on these items, radiation measurements shall be taken, the items treated as contaminated, and radiological control precautions established to prevent spreading contamination.

529 RADIOLOGICAL WORK AREAS

1. Control of surface contamination during work on contaminated equipment in areas outside radioactive work areas is more difficult than inside, since subsequent cleanup to uncontrolled surface contamination levels is essential. As an example, the work required in setting up an area in a machine shop around a lathe, and cleanup and removal of the setup after use on contaminated equipment has required in some cases approximately 100 manhours of work. This manpower expenditure does not include requirements for radiological controls during the contaminated machining operations.

2. As far as practicable, contamination in radioactive work areas shall be maintained below the limits of article 502. In order to accomplish this, radioactive work shall be performed as much as practicable in containment areas.

3. Work areas which are normally not expected to contain contaminated equipment may be designed for occasional contaminated work. To minimize work involved in decontaminating such areas after radioactive work, the spread of contamination inside the area shall be limited through the use of enclosures and plastic sheet.

530. ENCLOSURES FOR CONTAINING CONTAMINATION

The most effective means of controlling radioactive surface contamination is through use of enclosures around the contaminated item to keep the radioactive material inside. Use of such enclosures has allowed workers to dispense with anticontamination clothing, thereby improving their working efficiency and reducing their radiation exposure. Containment shall be used as much as practicable when working on the surfaces of components which have been exposed to radioactive contamination. Similarly, containment shall be used on other contaminated equipment; for example, contaminated discharge piping or radioactive waste disposal systems. Plastic sheet, bags, or Contamination Containment Areas have also been used to enclose clean materials and prevent contamination of clean items inside the enclosure. The following specific requirement shall be followed when working on or handling contaminated equipment and materials:

1. Maximum practical use shall be made of containment enclosures when working on contaminated systems or contaminated equipment and material.

2. Procedures for using containment enclosures shall be in local procedures. These procedures shall be frequently evaluated especially in event of an incident involving these procedures. Results of these evaluations shall be incorporated in procedure revisions and training programs.

3. Containment enclosures shall be inspected by Radiological Control prior to use to determine if they are properly constructed and ready for use; enclosures shall then be marked to certify this inspection was completed. In addition, containment enclosures shall be inspected daily when in use and the marking updated. Personnel using containment enclosures should inform radiological control personnel of any damage to containment enclosures which occurs during work. When a containment enclosure is damaged or is unfit for use, the enclosure shall be conspicuously tagged to prevent its inadvertent use by personnel unaware of the problem. Containment enclosures shall not be removed or altered without approval of radiological control personnel.

SECTION VI PROCEDURES FOR HANDLING RADIOACTIVE MATERIALS

CONTENTS

601. GENERAL

DISCUSSION: This section presents procedures applicable to radiological safety considerations for controlling radioactive material associated with CNSI operations. Strict radiological control procedures are mandatory for such material to minimize the external and internal radiation exposure received by personnel and to prevent the uncontrolled spread of radioactivity to areas where the public might be affected.

DEFINITIONS:

a. Radioactive Material: Material identified by the criteria of paragraph 1. of this article.

b. Radioactive Material Area: An area or room in which radioactive materials are used or stored.

c. Radioactive Material (RAM) Zone: A group of Radioactive Material Areas which, being under the cognizance of one local organization, are considered to be collectively one area of control for radioactive material accountability purposes.

d. Transport: To hand carry or convey on a vehicle.

e. Shipment: Transport of radioactive material from CNSI work site or a delivery of radioactive material to a CNSI work site.

REQUIREMENTS:

1. Criteria for identifying radioactive material: Equipment, parts, material, and wastes which have been exposed to radioactive contamination shall be handled as radioactive and shall not be released for unrestricted handling until they are inspected and show compliance with (1) criterion a or b below and (2) with both criteria c and d below. If loose surface contamination is suspected to be in excess of these criteria on surfaces not accessible for measurement (e.g., valve internals), the material shall be handled as radioactive.

   a. (1) The highest radiation level caused by the material does not exceed one-tenth of one millirem per hour* above background as determined by an open-window beta-gamma survey meter (Eberline Instruments Corporation (EIC) Model E-500B equipped with an HP-177 probe or instrument of equivalent

* 0.1 mr/hr indicated reading called 0.1 mrem/hr

sensitivity) held within one-hald inch of the surface of that material; and

(2) The loose surface contamination** does not exceed 450 pico curies (1000 dpm) beta-gamma activity measured on a dry filter paper wiped over one hundred square centimeters of the most highly contaminated surface or over the total surface area if less than one hundred square centimeters. The measurement shall be made using the EIC Model HP-210 detector probe or instrument of equivalent sensitivity.

b. The highest radioactivity measurement of the material does not exceed 450 pCi (1000 dpm) above background as measured within one-half inch of the material using the EIC Model HP-210 detector probe or instrument of equivalent sensitivity as described in Appendix E.

c. Alpha radioactivity does not exceed 50 pCi using the EIC Model PAC-4G alpha survey meter or instrument of equivalent sensitivity by direct alpha radiation measurement on the material or loose surface contamination on items with surfaces not suitable for direct measurement shall not exceed 50 pCi by measurement of the dry filter paper used for the measurement in a above.

2. Radioactive material shall be handled only by organizations licensed or authorized to receive this material: Carriers (including transportation companies) and organizations acting solely as shipping agents handling material previously packaged in accordance with the Federal regulations referenced in article 603 are authorized in accordance with those Federal regulations and require no additional authorization or licensing to handle this packaged radioactive material.

3. An accountability system for radioactive materials is necessary (1) to ensure radioactive material is not lost or improperly handled during transfer outside radiologically controlled areas (i.e., controlled surface contamination areas or areas surrounding controlled surface contamination areas, article 503) and (2) to account for all radioactive materials stored outside radiologically controlled areas.

** Excluding "fallout"

The following articles describe an accountability system which meets these objectives. This system shall be used to account for radioactive materials associated with CNSI operations. Radioactive materials handled under procedures of the following document are excluded from the accountability control requirements of this section since this document provides accountability control systems equivalent to this section.

4. To ensure radioactive material is properly accounted for, subsequent articles in this section require cognizant CNSI management to designate the following in writing.

   a. Personnel authorized to physically receive radioactive material are to be listed by job site in writing.

   b. Storage areas for radioactive materials are to be designated per each facility.

   c. Personnel who may move radioactive material to another organization will be designated in writing.

602. RECEIPT OF RADIOACTIVE MATERIAL

DISCUSSION: Radioactive material received by CNSI requires special control procedures to ensure that adequate radiological safety precautions are observed, both in unpacking and in subsequent use of the material. Potential radiological problems can include external exposure, surface contamination, and airborne radioactivity. Some packaging material requires disposal as radioactive waste. In addition, special precuations are required if damage has occurred during shipment.

REQUIREMENTS: The following procedures shall be used for radioactive material received at CNSI.

1. Personnel authorized to physically receive radioactive material shall be specifically designated by name and in writing by CNSI.

2. When received, the material shall be inspected. This inspection shall be performed as soon as practicable after receipt, but no later than three hours after receipt if received during normal working hours or eighteen hours if received after normal working hours. This inspection shall consist of verifying radiation levels on the outside of the package and verifying that the package was properly transferred. For packages which are shipped, this inspection shall verify that the package was shipped in accordance with applicable shipping regulations.

3. The package is not opened solely for radiological purposes unless the package shows signs of damage. If damage to the radioactive material has occurred, Radiological Control shall determine the potential radiological consequences to the public during the shipment and to CNSI personnel.

4. Inconsistency between the observed contents (when a package is opened) and the contents indicated on the shipping documents shall be brought to the attention of the shipper of the material. If the possibility exists that radioactive material has been lost in shipment the organization originating the shipment or transfer, and carriers if any, shall be notified as soon as possible to allow initiation of searches,

5. Care shall be taken in unpacking to ensure all radioactive items in the package are accounted for and to ensure radiological control requirements are followed. Unpacking is sometimes performed in an area which is not a radiologically controlled area, but shipping containers, if suspected to be contaminated, and packing material shall be surveyed and meet the criteria of article 601 prior to release for unrestricted handling.

6. A receipt shall be returned promptly to the organization transferring or shipping the item, whether a receipt is requested or not.

603 SHIPPING RADIOACTIVE MATERIALS

REQUIREMENTS: All shipments or transfers of radioactive material over public areas (i.e., public highways, waterways, airways, etc.) including shipments made with private or government vehicles, must comply with appropriate Federal, State, and local transportation regulations.

The Radiological Controls Officer shall be responsible for maintaining cognizance of the regulations for transportation of radioactive material. This individual will also have the responsibility for training and certifying the individuals approved to certify radioactive material shipments in accordance with article 603.1b. These individuals will have the responsibility for ensureing complete compliance with transportation regulations for each shipment of radioactive material. If interpretation of these regulations is necessary, the shipping organization shall, prior to making the shipment, contact the individual assigned by the Manager, Radiological Controls & Engineering. This individual will contact PNR if further interpretation is necessary.

ARTICLE 603

1. Procedures for shipping radioactive material:

   a. Radioactive materials shall be shipped only to organizations licensed or authorized to receive these materials.

      The organization to which the material is transferred is the one to which the material is shipped, not the carrier or shipping agents. The organization shipping the radioactive material shall ensure that the organization to which the material is shipped is licensed or authorized to receive it prior to making the shipment. Sufficient verification can be a statement from the organization that it is licensed to handle the quantity and type of nuclide being shipped and the license number. A copy of the organization's license is not required since only the licensee or the Nuclear Regulatory Commission or Agreement State can properly interpret the conditions of the license.

   b. Shipment of the radioactive material shall be certified and authorized as follows:

      (1) Accountable materials which include nuclear fuels and other special isotopes shipped from CNSI work site are certified for compliance with shipping regulations.

      (2) Irradiated materials shipped directly from CNSI work site are certified for compliance with shipping regulations.

      (3) All other non-accountable radioactive materials shipments are certified for compliance with shipping regulations.

   c. In addition to the requirements of DOT regulations, bills of lading and other equivalent shipping papers shall state clearly that the shipment:

      (1) Requires radiological controls for unpackaging, and

      (2) Contains a stated number of curies of stated radionuclides. The following example is acceptable for shipping papers:

"Package contains the following radioactive material: 7 millicuries of metal corrosion products, primarily cobalt 60. Radiological controls are required for unpackaging".

(3) Curie content shall be estimated even if radiation levels are not measurable. If radiation levels are too low to be measured, the number of curies shall be stated as 1 microcurie.

d. The organization which directs or initiates actual shipment of radioactive material shall ensure that protective service is provided in order to ensure point-to-point control and traceability from shipper to consignee of each shipment. Examples of protective services available are:

Motor Carriers

(1) Sealed Van (exclusive use of vehicle) Service
(2) Signature Service (Signed Receipt for Custody Change)
(3) Hand to Hand (Courier Delivery)

Rail Carriers

(1) Sealed Car (exclusive use of car) Service

Water Carriers - Security Cargo (Hi Value)

e. When, for accountability purposes, a recipient will have to record the serial number of a radioactive component, the serial number shall be included with the description of the item in the shipping papers. If the description and serial number were not on these papers, the recipient might needlessly be exposed to radioactivity in unpackaging to inspect the material.

f. At the time of shipment, Shipping shall notify the consignee by telegram providing the shipment date and expected arrival date and request a written receipt upon arrival. The consignee shall be requested to notify CNSI by telephone or telegram upon receipt of the shipment or if the shipment has not been received within one day after the expected arrival date. In the latter case, trace action shall be initiated on the shipment. If the shipment has not arrived within four days of the expected arrival date, request the consignee to confirm this via receipted registered mail. Shipments that are not received or accounted for shall be reported as required by Department of Transportation Regulations.

g. In the event the radioactive material being shipped cannot be released for unrestricted handling by article 601 but is exempt from the requirements of transportation regulations, bills of lading shall be prepared as specified above and inside packaging shall clearly identify the material as radioactive.

2. Procedures for Shipments by U.S. Mail:

Shipments of radioactive material shall not be made by U. S. Mail.

3. Specific Procedures for Shipments by Truck, Rail, Air or Water Carrier:

Radioactive material being shipped by rail or truck shall meet the requirements of the Department of Transportation (DOT). These DOT requirements are contained in the Code of Federal Regulations title 49, Parts 100 to 199. The NRC issues certificates of compliance approving shipments not meeting the specific requirements of Parts 100 to 199; however, the organizations using the certificates of compliance shall process a copy and review it prior to each use to ensure all applicable provisions are complied with. If a certificate of compliance is considered necessary, the request for the certificates of compliance shall be forwarded via PNR in accordance with the DOE Manual.

Shipment of radioactive material shall not be made by passenger aircraft. Air shipments of radioactive material shall be restricted to cargo aircraft. Air shipments shall be in accordance with DOT Regulations (49 CFR Parts 100 to 199).

Water shipments shall be in accordance with the Code of Federal Regulations, Title 49, Parts 100 to 199. Packaging and labeling requirements for air and water shipments are similar to those of the DOT. Under some circumstances, these procedures for water shipments apply to movement of vessels containing radioactive systems or radioactive material over inland waters.

In addition to the above regulations, shipments shall meet other Federal, State and local regulations concerning transportation of radioactive material.

Shipment of radioactive materials over foreign highways or in foreign transportation systems is prohibited except in specific cases approved in advance by NRC.

ARTICLE 603

DISCUSSION: Following is a summary of a few of the types of requirements Federal transportation regulations contain:

1. Limitations on maximum quantities of radionuclides in a single container.

2. Limitations on dose rates on containers, at various distances from the container, and in truck cabs.

3. Designation of types of labels to be placed on the surface of the container.

4. Detailed descriptions of types of containers permitted for use. These descriptions include limitations on weight.

5. Removal of local radioactive material accountability and radiation warning tags from the outside of the container.

604. PROCEDURES AND REPORTING IN CASE OF LOSS OF RADIOACTIVE MATERIAL

REQUIREMENTS: If radioactive material associated with CNSI operations is lost, these procedures shall be followed:

1. Immediately conduct a search for the lost material. A primary purpose of this search is to ascertain that no persons will receive inadvertent internal or external radiation exposure from this material.

2. In consultation with NRC determine if a public warning shall be issued.

3. If the material cannot be located, an incident report shall be submitted to NRC. The incident report shall include the approximate curie content of the material and an assessment of its effect on the public and environment.

West Chicago Health Plaza
C4C-02061 Plan (21) b

This Document was superseded
by a new document

"Health Physics Manual
for the
Decommissioning and Stabilization
of the
Kerr-McGee Chemical Corporation
West Chicago Rare Earths Facility"

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