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TABLE OF CONTENTS

ADMINISTRATIVE

ATMOSPHERIC

LIQUID

TERRESTRIAL

ISSUED BY THE MANAGER ENVIRONMENTAL AND OCCUPATIONAL SAFETY	SUBJECT IMPLEMENTATION	RHO-MA-139

1.0 New facilities designed after January 1978 shall meet standards in this manual.

1.1 Existing facilities should meet standards as soon as economically practical.

(Judgment will be needed to determine what is economically practical. Guidelines to be considered are degree of safety hazard, facility longevity and total cost.)

1.2 Environmental Protection shall be responsible for maintaining this manual.

(An active review program will keep this manual in tune with changes in safety practices and operational requirements.)

9212556049 5

ISSUED BY THE MANAGER ENVIRONMENTAL AND OCCUPATIONAL SAFETY	SUBJECT OBJECTIVES AND RESPONSIBILITIES	RHO-MA-139

Objectives

2.1 Rockwell will measure radionuclides released to the environment.

2.2 Rockwell will maintain surveillance of operating facilities and storage sites to permit prompt detection and correction of unplanned releases.

2.3 Rockwell will reduce discharges to the environment to "as low as technically and economically practical" (ALATEP).

2.4 Rockwell will maintain an environmental surveillance program to determine the impact of operations on the environs.

2.5 Rockwell will comply with Department of Energy Manual Chapters 0510, 0511, 0513, 0524 and respective RL-appendices.

Responsibilities

2.6 Program Management (see RHO-MA-100, Policy #PM, PR 8-001)

1. Define program requirements to meet objectives 2.1 through 2.5.
2. Prepare and maintain a program plan for the development of innovative methods to achieve objectives 2.1 through 2.5.
3. Develop budgets and issue work packages which 1) bring Rockwell facilities into compliance with this manual, and 2) support objectives 2.1 through 2.5.

2.7 Production Operations and Other Facility Management

Each manager of a production group, processing facility, shop, laboratory, laundry, powerhouse, etc., is responsible for the following:

1. Assure that radioactive effluent streams discharged to the environment are measured for volume and radionuclide concentration.
2. Assure that discharge data are reviewed promptly and compared to discharge limits.
3. When releases are above limits, assure that corrective action is promptly taken according to emergency procedures in RHO-MA-111.
4. The Building Superintendent has the responsibility to prepare emergency procedures (see "Responsibilities Section" of RHO-MA-111).

5. Management has the responsibility to initiate corrective action whenever deficiencies are known to exist in either the effluent release, control systems or effluent measurement systems.

6. Implement action to reduce discharges to the environment "as low as technically and economically practical". A constant effort shall be maintained to seek innovative processes or procedure improvements to reduce the waste generated by Rockwell facilities.

2.8 Process Engineering

Process Engineering groups are responsible for the following:

1. Assure that effluent sampling systems are in compliance with standards in this manual.
2. Writing process specification and standards consistent with this manual.
3. Review of discharge data at a minimum frequency of once a day during operating periods.
4. Develop corrective action plans for noncompliance areas.
5. Develop systematic plans to prevent discharge violations.
6. Define and document effluent control systems.
7. Issue quarterly and annual reports on discharges.
8. Issue an effluent sample schedule.

2.9 Analytical Laboratories

Analytical Laboratories are responsible for:

1. Receiving samples.
2. Protecting sample integrity.
3. Maintaining identification of samples and sample results.
4. Analyzing air, liquid and solids for nonradioactive and radioactive constituents at the detection levels and accuracy and precision as specified in this manual.

5. Maintaining an adequate quality control program.

6. Verifying results and calculations.

7. Reporting high results to appropriate persons as specified.

8. Entering results into a computer data base management system.

2.10 Radiation Monitoring

Radiation Monitoring is responsible for the following environmental protection activities:

1. Routine surveying of all facilities and sites (including roads) to determine contamination status.

2. Routine semiannual surveying of all outdoor radiation zones to determine and document physical condition and radiation/contamination status.

3. Collecting samples for the Environmental Surveillance Program as documented in this manual. This includes taking routine liquid samples, mud samples, air samples, soil samples, vegetation samples and changing TLDs.

4. Changing air filters on stack exhaust samplers.

5. Notify supervision when inoperative sampling equipment is found or other abnormal conditions are noticed.

2.11 Quality Engineering

Quality Assurance (QA) activities relative to Environmental Protection (EP) shall be performed in accordance with applicable requirements of RHO-MA-150, "Quality Assurance Manual". QA participation in the EP program shall be primarily directed to areas of containment where radionuclides may be released to the environs, e. g. Quality Assurance Level I.

Most pertinent parts of ARH-MA-150 are:

Quality Assurance Level	Policy 2.3
Quality Assurance Audits	Policy 18.1
Corrective Action	Policy 16.1
Operation Control	Policy 19.1

9212556049 9

2.12 Research and Engineering

1. Research and Engineering is responsible for designing facilities, equipment, processes, instruments and systems to comply with pollution control regulations (Policy No. E-2, ARH-MA-154).

2. Facilities will be designed so that discharges to the environment are as low as technically and economically practical (ALATEP).

3. As-built drawings of facilities will be kept up to date so that engineering prints reflect effluent control systems.

4. Approve permits for excavations, core drilling and tie-ins

5. Prepare Environmental Assessments on those line items or major general plant projects which have a potential significant impact on the environment (Policy E-I, ARH-MA-154).

2.13 Research General

Develop and apply suitable risk analysis technology to provide basis for establishing sound defensible environmental protection criteria.

2.14 Statistical Sciences (Research Department)

To insure that analytical methods are capable of conforming to specifications set forth in RHO-MA-139.

Statistical Sciences are responsible for:

1. Validating proposed sampling plans.

2. Develop statistical technology to assess validity of environmental sampling plans, surveillance schemes, and data analysis.

3. Analyzing data as requested.

4. Verifying that conclusions drawn from data (inference) are appropriate.

5. Assisting analytical laboratory in developing proper quality control program.

2.15 Chemical Sciences (Research Department)

Chemical Sciences are responsible for:

1. Developing analytical methods capable of achieving the precision and accuracy statement set forth as standards of performance within RHO-MA-139.

2. Developing chemical standard technology necessary to qualify new analytical methodology to meet specifications of performance within RHO-MA-139.

3. Transfer technology to user organization upon certification that the technology complies to specifications.

2.16 Office of Drilling (Research Department)

Shall be responsible for the technical aspects of managing the 200 Area well drilling programs.

2.17 Environmental Sciences (Research Department)

Environmental Sciences shall be responsible for:

1. Developing atmosphere and biosphere sampling plans to monitor various radioactive and nonradioactive elements.

2. Developing necessary technology to provide the Company with near surface measurement systems capable of complying with specifications as required by Environmental programs.

3. Transferring technology to proper user organization upon certification that the technology complies to specifications.

2.18 Earth Sciences (Research Department)

Earth Sciences shall be responsible for:

1. Developing lithosphere and hydrosphere sampling plans to monitor various radioactive and nonradioactive elements.

2. Developing necessary technology to provide the Company with assurance that radioactive and nonradioactive elements can be monitored with sufficient accuracy to define location and predict movement in underground formations and waters.

3. Developing sound groundwater technology.

4. Transferring technology to proper user organizations upon certification that the technology complies to specifications.

3 ENVIRONMENTAL PROTECTION PROGRAM

3.0 Purpose

Section 3 describes the activities of Environmental Protection (EP). This description provides guidance to EP engineers while informing Rockwell employees on what to expect from Environmental Protection.

3.1 Standards

Environmental Protection is responsible for reviewing Federal, State and County regulations pertaining to releases to the environment. Regulations applicable to Hanford will be issued in this manual.

Sources for environmental regulations include 1) a notebook of Federal, State and County regulations compiled by DOE-RL, 2) DOE manual chapters, 3) DOE-RL appendices, 4) EPA guides, 5) NRC guides, 6) National Bureau of Affairs "Environmental Reporter", and 7) the Federal Register.

3.2 Reviews and Inspections

Environmental Protection reviews discharge data on a minimum basis of once a month. Inspections of effluent control systems include samplers, flowmeters, monitors and alarms and are made once a year. Inactive outdoor radiation zones are inspected at a minimum of once a year.

Reviews and inspections are made to determine compliance to RHO-MA-139 standards.

3.3 Corrective Action

Noncompliance to standards is the basis for corrective action.

Noncompliance will be brought to the attention of 1) program managers, 2) facility managers, and 3) process engineering. The recommended method is to hold a meeting with program and functional management to 1) discuss options, 2) select a course of action and 3) establish commitments.

Commitments should be summarized in a letter and sent to participants.

Periodic checks should be made by Environmental Protection to assure progress toward goals and to determine need for problem-solving sessions.

Roadblocks should be brought to the attention of management for resolution.

3.4 Compliance Reports

Reports listing compliance of active discharges shall be provided DOE-RL within 30 days of the end of each quarter. Quarterly reports will contain compliance of discharge streams and descriptions of corrective action work accomplished.

An annual report shall be issued by July 1 of the following year listing annual discharge averages and graphs. Airborne releases, liquid releases (to cribs and ponds), groundwater results, TLD results, vegetation results and soil results will be graphed. The emphasis on annual reports shall be trend analysis of the years data and comparison of annual averages to annual discharge limits.

3.5 Unplanned Release

Unplanned releases of radionuclides into the environment require the issuance of an occurrence report by the responsible facility manager. The facility manager issuing the occurrence report must develop suitable corrective action to prevent reoccurrence of the unplanned release.

When an unplanned release occurs, Environmental Protection engineers will investigate the incident, estimate the amount of radioactivity released, report the environmental consequence, and report the cause with corrective action to the Manager, Environmental Protection, within 48 hours. Unplanned releases which create a new radiation zone will be documented and 200 Area site maps will be updated.

If there is evidence to suggest that radionuclides may have been transported outside of the 200 Area fence line, the Battelle Environmental Evaluation team should be called. The Battelle team can make rapid determination of radionuclides in the field.

3.6 Assurance of Quality Work Within Environmental Protection Activities

Quality Assurance methodology is to be inherent in all Environmental Protection activities. The following questions contain key elements of quality assurance:

1. Is the environmental sample representative of the field being sampled?

2. Does the measurement satisfy the question being asked?

3. Are the right questions being asked?

4. Will the sampling procedures be correctly followed?

5. Who needs training to assure that procedures are followed? How often should this training be given?

6. What standards are needed to check lab performance and data reporting?

7. Has the data been subjected to a statistical evaluation?

Quality Assurance personnel will monitor the performance of Environmental Protection programs and make suggestions for upgrading quality of work.

3.7 Effluent Control Systems

Environmental Protection engineers should know the points of effluent release and feeder streams which contribute to release points. Control systems on both feeder and final streams should be defined in a notebook and recommendations made for upgrading. Upgrading considerations include a comprehensive list of inspection topics. These are listed below to serve as a guide for conducting a thorough review of the entire control system.

1. Reduction of radionuclide discharges.
2. Sampling; compliance to design criteria.
3. Monitoring; compliance to design criteria.
4. Locations where monitor alarms.
5. Sample handling.
6. Laboratory methods.
7. Standards for laboratory methods.
8. Blind standards.
9. Data review by lab., operations, engineering.
10. Notification when noncompliance detected.
11. Response to noncompliance.
12. Reporting and historical filing of data.

Deficiencies requiring new technology for corrective action will be referred to both the program manager and Research and Engineering for development studies.

3.8 Environmental Surveillance

Environmental Surveillance Programs shall be administered by Environmental Protection according to the standards found in this manual. Programs shall be established for standards, measurements and data tracking pertaining to the following environmental parameters:

Ambient Air
Soil and Vegetation Radionuclide Content
Surface Radiation (TLD Program)
Surface Water (ponds and ditches)

Technical assistance will be provided to Radiation Monitoring to perform these routine programs.

3.9 Groundwater Surveillance

A program of groundwater surveillance shall be established. This program includes writing standards for the wells, standards for the sampling methods and standards for interpreting the results.

Sample frequency and types of analyses shall be reviewed annually. A Rockwell Quality Assurance program shall be established for the sampling and analytical methods.

A well maintenance program shall be established. Technical coordination shall be achieved with Research Department and Battelle Northwest to assist the upgrading of groundwater monitoring programs.

3.10 Airborne Discharge Surveillance

Standards shall be written for measurement systems and discharge limits for airborne effluent release sites (stacks). An inspection program will be maintained so that status of deficiencies or corrective action is known.

Upgrading requirements will be provided program management for budget development and scheduling.

3.11 Liquid Discharge Surveillance

Standards shall be written for measurement systems and discharge limits for liquid release sites. An inspection program will be maintained to determine the level of technology present or needed.

Upgrading requirements will be provided program management for budget development and scheduling.

4.1 Basis

I. General

Atmospheric discharges of nonradioactive effluents from Rockwell Hanford Operations facilities shall comply with all local, state, and federal guidelines to the extent directed by the Department of Energy. Where specific Department of Energy direction is lacking, the local, State, and Federal regulations shall be assumed to apply.

II. Applicable Government Agencies and Regulations

A. Benton-Franklin-Walla Walla Counties Air Pollution Control Authority

1. General Regulation 75-7

B. Washington State Department of Ecology

1. Washington State General Air Pollution Regulations (Chapter 173-400 WAC)

2. Washington Emergency Episode Plan (Chapter 18-08 WAC)

3. Washington Open Burning Regulations (Chapter 18-12 WAC)

C. United States Environmental Protection Agency

1. Standards for Performance of New Stationary Sources (40CFR60)

2. National Emission Standards for Hazardous Air Pollutants (40CFR61)

4.2 Emission Standards

I. Maximum Permissible Emissions

A. The maximum permissible atmospheric emissions which have been established by government agencies are summarized in Table 4-1.

TABLE 4-1

STANDARDS FOR NONRADIOACTIVE EMISSIONS

Pollutant	Standard	Basis
Air Contaminants (general) and Water Vapor	Must not impact health, safety, or welfare of any person or damage property.	Chapter 173-400-040 WAC
Asbestos	No visible emissions. Minimize air suspension by wetting during handling.	Chapter 173-400-075 WAC 40CFR61
Beryllium	10 grams over a 24-hour period.	Chapter 173-400-075 WAC 40CFR61
Mercury	2300 grams per 24-hour period for mercury cell chlor-alkali plants. 3200 grams per 24-hour period for process wastewater treatment.	Chapter 173-400-075 WAC 40CFR61
Odors	May not interfere with use of adjoining property. Must minimize by recognized good practice and procedure.	Chapter 173-400-040 WAC
Opacity	20% >20% allowed for 15 minutes in 8 hrs. >20% allowed if due to condensed water droplets and particulates less than standard.	Chapter 173-400-040 WAC
Particulates	0.1 grains per standard dry cubic foot maximum. No significant impact from deposition beyond plant site. Reasonable precaution to prevent air-borne suspension of dust.	Chapter 173-400-040, 050, 060 WAC
Sulfur Dioxide	1000 parts per million	Chapter 173-400-040 WAC
Total Carbonyls	100 parts per million	Chapter 173-400-050 WAC

B. Many contaminants do not, at present, have specified maximum permissible emission standards. Release of these contaminants must not be detrimental to the health, safety, or welfare of any person, or cause damage to property. Release limits for such contaminants shall be determined by evaluating their impact on the ambient air standards covered by Standard 6.0 of this manual. The goal shall be to meet or be less than the ambient air standard at ground level.

C. For cases where ambient air standards are not available, emissions shall be limited based on not exceeding one percent of the threshhold limit value (TLV) for chemical substances established by the American Conference of Government Industrial Hygienists (ACGIH) at the annual average ground level concentration. Maximum ground level concentration should not exceed ten percent of the TLV.

II. Open Burning

A. Open burning refers to the combustion of material in the open, or in a container, with no provisions for the control of such combustion or the control of the emissions of the combustion products.

B. The use of open burning as a disposal practice should be minimized. Under no circumstances will open burning of radiologically contaminated material be permitted. When open burning must be used, the following materials shall not be burned in the open fire:

1. Garbage
2. Dead animals
3. Asphalt
4. Petroleum products
5. Paints
6. Rubber products
7. Plastics
8. Any substance, other than natural vegetation, which normally emits dense smoke or obnoxious odors.

C. Permits for open burning must be obtained in advance from the Hanford Fire Chief.

D. Open burning for the disposal of materials presenting a hazard to life, property, or public welfare may be allowed provided no approved practical alternative method of disposal is available.

E. Fires authorized by plant fire protection forces that are necessary for training purposes shall be allowed.

F. No open burning will be permitted during an air pollution episode (forecast, alert, warning, or emergency stages).

G. Conditions in Accident Prevention Bulletin NO. F-3 shall be adhered to.

III. Dust Generation

A. Reasonable precautions shall be taken to prevent dust generation when clearing, grading, leveling or excavation is being performed. Examples of such precautions are windbreaks and the periodic application of water.

B. Reasonable measures for permanent dust control shall be taken following the completion of clearing, grading, leveling, excavation, or construction activities. The preferred method for permanent dust control is revegetation but spreading gravel over the disturbed area is also acceptable.

9 2 1 2 5 5 6 0 5 0 9

4.3 Monitoring

I. Requirements

A. The use of continuous, on line monitors with alarm capability shall be required for systems which yield effluents greater than 50 percent of an applicable release standard.

B. Alarm annunciators for monitors shall be located in areas subject to continuous or frequent occupation during system operation.

C. Performance specifications for the following continuous effluent monitors have been enacted by the Environmental Protection Agency and are listed in 40CFR60 Appendix B.

Monitor	40CFR60 Appendix B
Opacity	Performance Spec. 1
SO_2 or NO_x	Performance Spec. 2
CO_2 or O_2	Performance Spec. 3

D. Performance tests shall be performed as applicable for all new facilities as described in 40CFR60.8. Such tests must utilize Environmental Protection Agency reference methods (or equivalent) as described in 40CFR60 Appendix A.

4.4 Sampling

I. Particulates

A. Source sampling for nonradioactive particulates shall be in accordance with Environmental Protection Agency Reference Method 5. (40CFR60 Appendix A)

B. If continuous sampling of particulates is to be performed, the design criteria given in Standard 5.0 of this manual are applicable.

II. Gases

A. Source gaseous effluent sampling shall be in accordance with Environmental Protection Agency reference methods (40CFR60 Appendix A).

B. If continuous gas sampling is required, the following criteria must be satisfied:

1. Minimize time from sample extraction to analysis.

2. Use of airtight sample transfer line.

3. Sample transfer line must be relatively non-reactive with gas.

4.5 Analytical Methods

A. Analytical methods for use in conjunction with source sampling and performance testing are found in Appendix A of 40CFR60.

B. Additional analytical methods for continuous monitoring of effluents may be used but are subject to verification by the EPA reference methods described above.

4.6 Data Review

A. Environmental Protection shall review nonradioactive discharge data for compliance with applicable standards.

B. Process Engineering and Operations shall review nonradioactive discharge data for impact on process operations.

4.7 Reports

A. Violations of local, State, or Federal regulatory standards shall be reported to the Department of Energy by Rockwell Environmental Protection through the Rockwell Hanford Operations management structure.

4.8 Quality Assurance

A. Activities related to the discharge of nonradioactive pollutants to the atmosphere shall be audited in accordance with the requirements of RHO-MA-150.

ISSUED BY THE MANAGER ENVIRONMENTAL AND OCCUPATIONAL SAFETY	SUBJECT RADIOACTIVE ATMOSPHERIC DISCHARGES	RHO-MA-139

9212556051 2

5.1 Standards for Radioactive Atmospheric Discharges

I. Basis

A. Department of Energy MC 0511 - "Radioactive Waste Management".
B. Department of Energy MC 0513 - "Effluent and Environmental Monitoring and Reporting".
C. Department of Energy MC 0524 - "Standards for Radiation Protection".

II. Application

The operational objective for the management of Rockwell Hanford Operations' gaseous effluents is to control activity concentrations of radionuclides released to the environment as low as technically and economically practical (ALATEP).

A. Annual Release Limits

1. Facilities built prior to 1977-

Annual average concentrations of radionuclides released to the environment in gaseous effluents shall not exceed Table I values of DOE MC 0524, Annex A, at the point of release.

2. Facilities not built prior to 1977-

Annual average concentrations of radionuclides released to the environment in gaseous effluents shall not exceed Table II levels of DOE MC 0524, Annex A, at the point of release.

B. Release Guides

1. Facilities built prior to 1977-

Average weekly and daily concentrations of radionclides released to the environment in gaseous effluents should not exceed Table I levels of DOE MC 0524, Annex A, at the point of release.

2. Facilities not built prior to 1977-

Average and daily concentrations of radionuclides released to the environment in gaseous effluents should not exceed Table II levels of DOE MC 0524, Annex A, at the point of release.

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5.2 Sampling and Monitoring

I. Basis

A. ANSI N13.1-1969, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities"
B. ANSI N13.10-1974, "Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents"
C. ARH-CD-498, "Interim Radioactive Gaseous Effluent Sampling and Monitoring Criteria for ARCHO Facilities"
D. Department of Energy MC 0513, "Effluent and Environmental Monitoring and Reporting"

II. Purpose

Rockwell Hanford Operations is required by Federal and State regulations to maintain accurate and complete written records of radioactive materials discharged to the atmosphere. Discharges to the atmosphere must be made under conditions which insure that effluent radionuclide concentrations in air in uncontrolled areas do not exceed standards specified in applicable Federal and State regulations when averaged over a period of one year.

III. Scope

This standard applies to all exhaust air discharges which contain, or potentially contain, radioactive material. This includes exhaust air discharges from inactive as well as active processing or support facilities.

IV. Objectives

A. Record Sample

A record sample shall be collected from all stacks that discharge exhaust air to the environment to measure the amount of radioactivity released during the sampling period. A representative sample of the gaseous effluent must be obtained if the record sample is to be accurate.

B. Monitored Sample

A continuously monitored sample shall be collected from all stacks or stack feeder streams that discharge exhaust air from an active processing or support facility. This is a separate sample used to alert Operations to off standard releases and provide process control. A monitored sample should not be used as a record sample since design considerations that allow the detector to be located near the collection media may obstruct the transport of sampled particles to the collection media.

V. Definition of Terms Used in This Standard

A. Airborne Radioactive Material

Radioactive material dispersed in the air in the form of dusts, mists, fumes, vapors, or gases.

B. Isokinetic

A condition of airstream sampling in which the flow of gas into the sampling probe has the same velocity and direction as the gas stream being sampled.

C. Monitored Sample

A sample that is continuously monitored by a radiation detector.

D. Sampling Period

The time over which a sample is collected.

E. Sampling

The withdrawal of a fractional part of an effluent stream.

F. Monitoring

Real time continuous measurement of the flow and/or radioactivity in an effluent stream.

G. Record Sample

A sample that is collected for laboratory analysis and is used as the basis for reporting the amount and concentration of radionuclides exhausted.

I. Uncontrolled Area

Any area that is accessible to the general public or to employees who are not occupational radiation workers.

IV. Design Criteria for Sampling and Monitoring Systems

A. General Criteria

1. Facilities designed and constructed after 1976 shall have separate record sampling and effluent monitoring systems. Ideally, these systems should be capable of completely independent operation.

2. Facilities designed and constructed prior to 1977 shall be modified for independent record sampler and effluent monitoring systems to the extent technically and economically practical as determined by Environmental Protection in conjunction with Process Engineering and Operations.

3. System designs or modifications shall be reviewed by Environmental Protection prior to fabrication.

4. Complete and distinct blueprints of sampling and monitoring systems with sample flow rate and transport lines clearly shown.

5. Specific component design criteria for sampling and monitoring systems are included in the following sections. Criteria for record sampler systems are generally more restrictive than for monitored sample systems since a monitored sample is to alert Operations to deviations from the normal condition, whereas a record sample is used for determining actual quantitive discharges.

B. Sample Probe

1. Location

a) The record sample probe shall be at least 5 but preferably 8 to 10 duct diameters downstream of any major flow disturbance. It should also be at least 2 duct diameters upstream of any major flow disturbance.
b) The record sample probe should be located as close to the effluent release point as is reasonable consistent with the above criteria.
c) The monitored sample probe shall be at least 2 but preferably 5 or more duct diameters downstream of any major flow disturbance.

2. Design

a) Must withdraw an isokinetic sample.
b) Must withdraw a sample which is representative of the particulates present in the air stream.

i. Number of sampling points (probe nozzles) depends on physical dimensions of the stack.

FOR ROUND STACKS

Duct Diameter in Inches	Minimum Number of Points
2 - 6	1
8 - 12	2
14 - 18	3
20 - 28	4
30 - 48	5
50 and larger	6

9 2 1 2 5 5 6 0 5 1 6

FOR RECTANGULAR STACKS

Duct Area	Suggested Number of Points
Less than 0.5 sq.ft.	1
1 - 2 sq.ft.	4
2 - 25 sq.ft.	6 - 12
> 25 sq.ft.	20

ii. Each sample point in circular ducts should be centered in equal annular areas of size equal to the cross-sectional area of the stack divided by the number of probes.

c) Nozzles shall have tapered knife-edges (15° taper - outside edge of orifice) and face directly into the exhaust stream.

i. Orifice shall be located on straight portion of nozzle that is approximately five times the diameter in length.

ii. Each nozzle bend shall have a radius of greater than five times the orifice diameter.

d) The sampling probe shall be fabricated of stainless steel.

e) Tubing size shall be selected to minimize particle deposition due to gravitational settling and/or impaction.

f) Nozzles shall be sized to provide isokinetic sampling when the sample flow rate is typically 3 cfm for a weekly sampling period.

C. Transport Line

1. Tubing size shall be selected to minimize particle deposition due to gravitational settling and/or impaction.

2. The transport line shall be fabricated of stainless steel or other material not reactive to the effluent.

3. Total length of line between the sampling probe and the filter holder shall be as short as physically practical.

4. Horizontal runs shall be minimized.

5. Bends shall be minimized and have a radius of at least 10 times the inside diameter of the transport line. Record sample systems should have no more than one smooth bend (not greater than 90°). Monitored sample systems should have no more than two.

6. Use of pipe or tubing fittings between the sample probe and filter holder shall be minimized.

7. Thermostatically controlled electrical heat tracing shall be used on transport lines where condensation is a potential problem.

9212556051 8

D. Filter Holder

The record sample filter holder shall:

1. Be located as close as practical to the probe.

2. Be fabricated of materials to minimize electrostatic deposition (aluminum, stainless steel, etc.).

3. Be sized for 47mm filter paper.

4. Consist of tapered expansion and contraction cones upstream and downstream of the sample filter.

5. Have a permanently mounted porous filter backing, free of sharp edges and protrusions.

6. Have a compression sealing ring designed to provide an airtight and uniform seal around the filter paper.

7. Be easily opened and closed.

E. Other Sample Collection Media

1. Other sample collection media (for tritium, iodine, etc.) shall be used as applicable.

F. Sample Flow Measurement and Control

1. Instrumentation shall be downstream of the filter holder.

2. Instrument should maintain a constant flow rate, regardless of filter loading.

3. Flow rate maintained should ensure isokinetic sampling conditions and be distinctly marked on the instrument. A feedback control of the vacuum source may be desirable.

4. Instrument shall be calibrated prior to installation and should be recalibrated every six (6) months thereafter. (NOTE: This is not a design criteria, but must be done routinely to ensure that the system operates as designed.)

G. Vacuum System

The vacuum system for sampling shall:

1. Be capable of pulling flow rates high enough to guarantee isokinetic sampling conditions.

2. Operate continuously whenever, and only if, air is being exhausted from the stack or duct. (NOTE: If the vacuum system is operated for contamination detection purposes when the stack is not exhausting air to the atmosphere, the sample collected shall not become part of the emission record.

3. Have the same emergency power back-up capabilities as the exhaust system.

4. Have audio and visual alarms, signaling the loss of vacuum, with alarming capability in an area subject to continuous or frequent occupation.

H. Monitoring Instrumentation

1. The monitoring instrumentation shall be specific for the types of radiation exhausted from the stack.

2. The instrumentation should be consistent with the generally accepted state of the art of design.

3. A sharp edged stream splitter shall be used to evenly divide the sample stream if multiple monitoring units are required.

4. The instrumentation shall have:

   a) Audio and visual high level release alarms capable of alarming both locally and in an area subject to frequent or continuous occupancy.

9212556051 9

b) Audio and visual failure alarms capable of alarming both locally and in an area subject to frequent or continuous occupancy.
c) Continuous strip chart recording capability.
d) Capability to transmit a real time measurement to a remote location.

5. Alarm trip points should be established such that significant deviations from normal effluent activity will be detected and an alarm sounded if conditions approach those defined as emergencies in ARH-222, "Emergency Procedures".

I. Sample Identification

1. Each stack shall have a unique engineering identification number assigned by Design Engineering.

2. Each sample point (record sample, monitored sample, etc.) shall have a unique electronic data processing (EDP) Code assigned to it by Environmental Protection.

J. Stack Flow Measurement

1. Provision shall be made by design to allow periodic measurement of stack flow rate by in-stack traversing.

2. Continuous stack flow recording devices should be incorporated into the stack design where practical.

5.3 Sample Measurements

I. Sample Flow Measurements

Stack air samples shall be collected at a high enough sample flow rate and over a sufficient amount of time to allow the laboratory or a continuous monitor to perform analyses in accordance with Section II below and Section III on the following page.

Sample flow measurements and adjustments to the sample flow rate shall be made on a routine basis. Sample flow rate should not vary by more than ± 10 percent over the sampling period.

II. Continuous Monitors

Continuous stack air monitors should be able to detect Table I concentrations as given in DOE MC 0524, Annex A, in a four hour period at a sample flow rate of 2 cfm.

III. Laboratory Analysis of Stack Samples

The analytical method used to measure the activity collected by stack samples should have the capability to detect the appropriate radionuclides at the following levels:

A. Daily Stack Sample

When the stack sample is collected over a 24-hour period at 2 cfm, the minimum detection limit should be at least as low as Table II values in MC 0524, Annex A.

B. Weekly Stack Sample

When the stack sample is collected over a 168-hour period at 2 cfm, the minimum detection limit should be at least as low as 10 percent of Table II values in MC 0524, Annex A.

5.4 Data Review

A. Analytical Laboratories shall review stack emissions on a daily basis for emissions exceeding Table I concentrations of Department of Energy MC 0524, Annex A. Notification of such emissions shall be given to Radiation Monitoring, Operations, and Process Engineering personnel.

B. Radiation Monitoring shall review emissions on a daily basis for short-term compliance with applicable standards.

C. Process Engineering and Operations shall review emissions on a continuing basis for impact on facility operations, and shall develop and implement corrective actions required for compliance to standards.

D. Environmental Protection shall review emissions on a continuing basis for long-term compliance with applicable standards and identification of long-term trends. Notification of noncompliance, potential noncompliance or upward trends shall be given to Process Engineering and Operations.

5.5 Filter System Design

A. General Design Criteria

1. All normally contaminated gaseous effluents shall be filtered by at least two stages of HEPA filters before being discharged to the environment.

2. Facilities having potential for contamination shall exhaust through a single HEPA filter and have sampling capability.

3. The first stage of HEPA filters should usually be preceded by a prefilter to reduce dust loading.

4. Provisions shall be made to limit moisture from reaching HEPA filter(s).

5. New facilities shall have a redundant system which allows switching the total flow from one system to another to facilitate filter changes without shutting down the facility unless the ventilation system can be safely shut down for filter changes.

6. Provisions should be made for sampling between filter stages.

7. Pressure drop shall be measured across each stage of filters.

8. Provisions shall be made for performing DOP Tests of all HEPA filters in accordance with RHO-CD-125, "Standard for In-Place Efficiency Testing of Gaseous HEPA Filter Systems".

B. Plutonium Processing or Storage Facilities

1. In addition to the above General Criteria, new facilities should have three or more stages of HEPA filtration between the source and the environment.

5.6 Filter Testing

I. Basis

A. RHO-CD-125 Rev 1 - "Standards for the In-Place Efficiency HEPA Filter Systems"
B. ANSI 510-1975 - "Testing of Nuclear Air Cleaning Systems"
C. Department of Energy 76-21 - "Nuclear Air Cleaning Handbook" (Design, Construction, and Testing of High-Efficiency Air Filtration Systems for Nuclear Application)

II. Application

All stack facility HEPA filter systems operated by Rockwell Hanford Operations that serve as the final means of gaseous effluent cleaning shall be efficiency tested utilizing the dioctyl phthalate (DOP) method described in RHO-CD-125.

A. Schedule for DOP Tests

1. All standby and on-line gaseous effluent HEPA filter systems shall have an in-place DOP test before initial startup, after each filter change, and at least annually thereafter.

2. Those systems handling high levels of radioactivity and/or are exposed to extreme hostile environments such as high moisture loadings, chemical fumes, or high temperatures shall be inspected on a semi-annual, quarterly, or monthly basis as dictated by the operational requirements of the system.

3. The schedule for DOP tests is listed as an appendix to RHO-CD-125, Rev 1.

B. Performances of DOP Tests

1. DOP tests shall be performed by the Ventilation and Air Balance Group in accordance with RHO-CD-125, Rev 1.

2. At least 99.95 percent of the DOP particles 0.5 microns in diameter shall be removed by the HEPA filter system. The minimum standard acceptable test efficiency is 99.95 percent for removal of 0.5 micron diameter DOP particles.

3. Each HEPA filter stage should be tested individually.

4. A copy of the results of each DOP test shall be sent to Environmental Protection.

5.7 <u>Stack Flow Measurement</u>

A. Frequency

1. Each stack shall have its flow rate measure prior to hot startup and at least quarterly thereafter. A new stack flow reading shall be taken at the completion of each DOP test.

2. Continuous stack flow recorders should be included in the design for new or upgraded stacks.

B. Responsibility

1. Stack flow rates shall be measured by the Ventilation and Air Balance Group.

2. Documentation of stack flow rates shall be sent to Environmental Protection and Analytical Services (Counting Room Supervisor).

3. The Counting Room Supervisor shall update stack flow rates as soon as possible after receiving them. These stack flow rates will be used to calculate emissions from each stack.

5.8 Quality Assurance

Monitoring activities related to radioactive atmospheric discharges shall be audited in accordance to the requirements of RHO-MA-150.

Where appropriate, Quality Assurance Level (QAL) I designs shall be processed in accordance with the requirements of RHO-MA-150.

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ISSUED BY THE MANAGER ENVIRONMENTAL AND OCCUPATIONAL SAFETY	SUBJECT AMBIENT AIR SURVEILLANCE	RHO-MA-139

6.1 Ambient Air Surveillance Program

I. General

A. An Ambient Air Surveillance Program for the 200 Areas shall be established and maintained to determine:

1. Whether containment and control of local operating facilities are functioning as planned.

2. Whether and to what extent environmental levels of radioactivity and other toxic pollutants released from local operating facilities comply with applicable standards.

3. The overall impact of operations on the environment.

B. Monitoring for the Environmental Protection Agency and State of Washington designated nonradioactive air pollutants is to be part of the Surveillance programs only if the 200 Area stack emissions are anticipated to affect the ambient air quality.

C. Before start-up of a new facility in the 200 Areas, the Ambient Air Surveillance Program shall be modified for the affected area to establish background information with respect to those toxicants likely to be released and those parameters likely to be affected by operating the facility.

II. Responsibility

A. The Ambient Air Surveillance Program shall be established and maintained by Environmental Protection in conjunction with the Research Department.

B. The Radiation Monitoring group shall provide the necessary manpower to collect air samples.

C. The Research Department shall provide technical support with respect to procedures, monitoring, sampling, and data processing.

D. Judgment regarding the extent of Ambient Air Surveillance is to be exercised by Environmental Protection in conjunction with the Research Department based on hazard potential, quantities, and concentration of materials released, and specific public interest or concern.

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III. Applicable Regulations and Standards

A. Washington Carbon Monoxide Standards (Chapter 18-32 WAC, Effective February 24, 1972)
B. Washington Suspended Particulate Standards (Chapter 18-40 WAC, Effective February 24, 1972)
C. Washington Photochemicals, Hydrocarbons, Nitrogen Dioxide Regulations (Chapter 18-46 WAC, Effective February 24, 1972)
D. Washington Fluoride Standards (Chapter 18-48 WAC, Adopted May 20, 1970)
E. Department of Energy MC 0524, Standard for Radiation Protection, April 1975
F. National Primary and Secondary Ambient Air Quality Standards (40CFR50, July 1976)
G. Ambient Air Monitoring Reference and Equivalent Methods (40CFR53, July 1976)

6.2 Limits

I. Nonradioactive Air Pollutants

When applicable, the ambient air shall be monitored to insure that the concentrations listed in Table 6-1 are not exceeded. (See page 3 of this standard)

II. Radioactive

Ambient air samples shall be collected in the 200 Areas and analyzed to insure that the concentration of radionuclide in the ambient atmospheres do not exceed the limits listed in the Department of Energy MC 0524, Annex A, Table II for air. (See Standard No. 21)

6.3 Ambient Air Sampling

I. Sampling Equipment

A. Nonradioactive

The sampling equipment for the applicable nonradioactive air pollutants shall comply with the reference or equivalent methods described in 40CFR50 and 40CFR53.

B. Radioactive

The equipment for sampling ambient air for determining the concentration of radionuclides shall consist of a sampling medium (a collection device), an air flow meter, and a system to draw air through the sampling medium at a prescribed rate.

TABLE 6-1

STANDARDS FOR NONRADIOACTIVE AIR POLLUTANTS

Pollutant	Standard	Basis
Carbon Monoxide	9 ppm (10 mg/m^3) average for eight-hour period where people exposed eight hours or more (Not to be exceeded more than once per year)	Chapter 18-32 WAC
	35 ppm (40 mg/m^3 average for one hour (Not to be exceeded more than once per year)	
Suspended Particulates	60 μg/m^3 annual geometric mean	Chapter 18-40 WAC
	150 μg/m^3 - maximum 24-hour concentration (Not to be exceeded more than once per year)	
Photochemical Oxidants	0.08 ppm (160 μg/m^3) average for one hour	Chapter 18-40 WAC
Hydrocarbons (nonmethane gas phase)	0.24 ppm (160 μg/m^3) for any three consecutive hours between 6 a.m. and 9 a.m.	Chapter 18-40 WAC
Nitrogen Dioxide	0.05 ppm (100 μg/m^3) annual arithmetic mean	Chapter 18-40 WAC
Fluorides	3.7 μg/m^3 average for any 12 consecutive hours	Chapter 18-48 WAC
	2.9 μg/m^3 average for any 24 consecutive hours	
	1.7 μg/m^3 average for any 7 consecutive days	
	0.84 μg/m^3 average for any 30 consecutive days	
Sulfur Dioxide	0.4 ppm by volume average for one hour (Exceed only once per year)	Chapter 18-56 WAC
	0.25 ppm by volume average for one hour (Exceed two times in seven consecutive days)	
	0.10 ppm by volume average for 24 hours (Exceed only once per year)	
	0.02 ppm by volume average for one year (Annual arithmetic mean)	

II. Sample Site and Frequency

A. Nonradioactive Air Pollutants

1. The location of the sample site for the continuous ambient air monitors for the criteria pollutants and the frequency the monitors are to operate shall be established on the basis of the following factors:

   a) Type of operating plants and nature of pollutants being discharged.
   b) Location of operating plants.
   c) Plant operating hours.
   d) Local meteorological conditions.
   e) Location and height of plant discharge stack with respect to the buildings in the area.

2. The operating frequency and the location for the continuous ambient air monitors for nonradioactive pollutants shall be described by the Environmental Surveillance program.

B. Radioactive

1. The frequency and location of the ambient air samplers for measuring the atmospheric radionuclide concentration shall be established on the basis of the following factors:

   a) Location of the radioactive waste treatment facilities.
   b) Location of radiation zones.
   c) Local meteorological conditions.
   d) Location of other environmental surveillance sites, that is soil sample sites and TLD locations.

2. The sample frequency and location of radioactive ambient air samplers shall be described by the Environmental Surveillance Program.

III. Sample Handling and Techniques

As part of the Environmental Surveillance Program, procedures shall be established to describe the techniques, equipment, and material to be used in sample collecting and handling.

6.4 Analytical Methods

I. Criteria Air Pollutants

The criteria air pollutants shall be measured by Federal reference or equivalent methods or Washington State Department of Ecology approved methods. (See following Table 6-2 for listing of reference methods):

TABLE 6-2

Reference Methods for Criteria Air Pollutants

Pollutant	Method	Regulation
Sulfur Dioxide	The Manual West-Gaeke-Sulfamic Acid Method	40 CFR, Part 50, Appendix A
Total Suspended Solids	The High Volume Method	40 CFR, Part 50, Appendix B
Carbon Monoxide	The Non-Dispersive Infared Method	40 CFR, Part 50, Appendix C
Photo-Chemical Oxidants (Ozone)	A Continuous Chemiluminescence	40 CFR, Part 50, Appendix A
Nitrogen Dioxide	A Chemiluminescence Method	40 CFR, Part 50, Appendix F
Fluorides	Sampled by the Sodium Bicarbonate Tube Method. Analyzed by Technicon Auto Analyzer or Modified Willard-Winter Distillation Method	Chapter 18-48 WAC
Hydrocarbon (corrected for methane)	Gas Chromatographic Flame Ionization Technique (More Economical Methods are Becoming Available)	40CFR, Part 50 Appendix E

II. Radioactive

The analytical method used to measure the activity collected by ambient air samples shall have the capability to detect the appropriate radionuclides to 0.01 of the concentration levels listed in Department of Energy MC 0524, Annex A, Table II.

6.5 Data Review

Environmental Protection shall review all ambient air data to identify changes in the environment due to operations and violations of State or Federal ambient air standards.

6.6 Reports

I. Violations

Violation of State or Federal ambient air standards shall be reported to the Department of Energy by Environmental Protection through the Rockwell Hanford Operations management structure.

II. Annual

An annual summary of concentrations of radionuclides and applicable nonradioactive air pollutants measured in the ambient atmosphere will be included in the 200 Areas Environmental Protection report.

6.7 Quality Assurance

Ambient Air Surveillance activities shall be audited in accordance with the requirements of RHO-MA-150.

7.1 Limits

I. Basis

A. Department of Energy MC 0510, "Prevention, Control, and Abatement of Air and Water Pollution"
B. Department of Energy MC 0513, "Effluent and Environmental Monitoring and Reporting"
C. Washington Water Quality Control Standards
D. Federal Water Pollution Control Act Amendments of 1972, Section 402, "National Pollutant Discharge Elimination System" (NPDES)

II. Liquid Discharges to Navigable Waters

A. All industrial liquid waste discharges to the Columbia River fall under the authority of the National Pollutant Discharge Elimination System (NPDES) and as such must be in compliance with the Washington Water Quality Control Standards and applicable discharge permit limitations.

B. Any modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in the existing permit, by notice to the permit issuing authority of such changes. Following such application or notice, the permit may be issued or modified to specify and limit pollutants of concern.

III. Liquid Discharges to Non-navigable Waters

A. All sanitary wastes shall be disposed of in an environmentally acceptable manner with the approval of Environmental Protection.

B. The discharge of nonradioactive pollutants through liquid effluent streams shall be controlled to levels as low as technically and economically practical (ALATEP).

C. Toxic and deleterious material concentrations shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the biota.

D. Environmental Protection shall be notified in the event of unplanned chemical or toxic substance releases and shall initiate necessary action upon evaluation of the release.

7.2 Sampling

I. Basis

A. Department of Energy MC 0513, "Effluent and Environmental Monitoring and Reporting"
B. "Standard Methods for the Examination of Water and Wastewater - 14th Edition"
C. "1976 Annual Book of ASTM Standards, Part 31 - Water"
D. "Chemical Analysis of Water and Wastewater"

II. Criteria

A. Sampling of liquid effluent streams where required for nonradioactive pollutants shall be performed in a manner that provides representative measurements of the volume and concentration of pollutants released to the environment as a basis for:

1. Determining compliance with applicable discharge and effluent control guidelines.

2. Evaluating the adequacy and effectiveness of waste treatment and control efforts towards achieving levels of releases to as low as technically and economically practical.

3. Compiling an annual inventory of the nonradioactive pollutants in liquid discharges to the environment.

B. The measurement of volume, flow rate, pollutant concentrations, etc. should be made at that point which most closely represents what is being released to the environment.

C. Automatic, flow proportional sampling shall be warranted on all liquid effluent streams where the flow or the pollutant concentrations fluctuate. Dip (grab) sampling shall be acceptable in cases of a batch discharge or where the nonradioactive pollutant discharge is due to a non-routine condition.

7.3 Analytical Methods

Methods for the analysis of liquid samples for nonradioactive pollutants shall be one of the standard analytical methods found in References B, C, or D above, or an equivalent.

7.4 Data Review

Nonradioactive liquid effluent discharge data shall be provided to Environmental Protection by the analytical laboratory. Environmental Protection shall be responsible for data review for compliance with applicable discharge limits.

7.5. Reports

I. Monitoring reports shall be summarized monthly on a Discharge Monitoring Report form (EPA No. 3320-1) for those discharges under the NPDES program and submitted quarterly to the Environmental Protection Agency (EPA) through the Department of Energy, Richland Branch (DOE-RL).

II. If the limitations set forth in the NPDES permit are not met, a notification of noncompliance shall be issued to DOE-RL by Environmental Protection.

III. Non-routine chemical releases to the controlled ponds and ditches shall be reported by Environmental Protection in the Environmental Protection Quarterly Report.

7.6 Quality Assurance

Discharge of nonradioactive pollutants through liquid disposal systems shall be audited in accordance to the requirements of RHO-MA-150.

8.1 Limits

I. Basis

A. Department of Energy MC 0511, "Radioactive Waste Management"
B. Department of Energy MC 0513, "Effluent and Environmental Monitoring and Reporting"
C. Department of Energy MC 0524, "Standards for Radiation Protection"

II. Application

A. Annual Concentration Limits

The operational objective for the management of Rockwell Hanford Operations liquid effluents is to control activity concentrations of radionuclides released to the environment as low as technically and economically practical (ALATEP).

1. Facilities built prior to 1977:

a) Annual average concentrations of radionuclides released to the environment in liquid effluents shall not exceed Table I levels of DOE MC 0524, Annex A, at the point of release.[1]

2. Facilities built subsequent to 1977:

a) Annual average concentrations of radionuclides released to the environment in liquid effluents shall not exceed Table II levels of DOE MC 0524, Annex A, at the point of release.

b) In addition, as soon as technically and economically practical, the use of natural soil columns (such as cribs, seepage ponds, and similar facilities) shall be replaced with other treatment systems.

[1] The point of release for liquid effluents is considered to be the end of the pipe.

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c) Adequate diversion systems shall be provided to assure that normally releasable streams, which as a consequence of accident or operational upsets exceed Table II, Annex A, DOE MC 0524, automatically detected and diverted to controlled holding areas and are recycled or processed to yield a releasable stream.

B. Release Guides

1. Facilities built prior to 1977:

a) Average weekly and daily concentrations of radionuclides released to the environment in liquid effluents should not exceed Table I levels of DOE MC 0524, Annex A, at the point of release.

2. Facilities built subsequent to 1977:

a) Average weekly and daily concentrations of radionuclides released to the environment in liquid effluents should not exceed Table II levels of DOE MC 0524, Annex A, at the point of release.

8.2 Sampling

I. Basis

A. Department of Energy MC 0511, "Radioactive Waste Management"
B. Department of Energy MC 0513, "Effluent and Environmental Monitoring and Reporting"
C. Department of Energy MC 0524, "Standards for radiation Protection"
D. "Standard Methods for the Examination of Water and Wastewater"
E. "The 1976 Annual Book of ASTM Standards, Part 31-Water"

II. General

Sampling and flow measurement of liquid effluent streams shall be conducted in a manner which provides accurate measurements of the amount and concentration of radionuclides in the liquid effluent released from a particular facility as a basis for:

A. Determining compliance with applicable discharge and effluent control limits (DOE MC 0524, Annex A).

B. Evaluating the adequacy and effectiveness of waste treatment and control efforts toward achieving levels of radioactivity which are as low as practical.

C. Compiling an annual inventory of the radioactivity released in effluents from a given facility.

III. Sampling Locations

Measurement of volume, flow rate, radionuclide concentrations, etc. shall be made at a point which most closely represents that which is being released to the environment from a given facility. For those waste streams composed of two or more contributing sources, sampling individual sources shall be preferable to sampling the total waste stream in those instances where bulk dilution in the total stream would result in diluted concentrations attributable to a given source.

IV. Type and Frequency of Sampling

The type and frequency of sample collection shall be determined by joint consideration of the flow and radionuclide concentration characteristics of the effluent stream and the purpose for which the data are being obtained. Automatic, flow proportional sampling capabilities shall be warranted on all continuously flowing effluent streams where there exists or is the potential for a variation in the radionuclide concentrations or fluctuations in the flow rate.

V. Sampling Equipment Criteria

A. The automatic sampler shall be capable of operating on a flow proportional basis as controlled by a flow measurement system.

B. The sampler shall have a sufficiently high transport velocity to assure accurate collection and transport of suspended solids to the sample collector.

C. The sampler shall be equipped to minimize cross-contamination and assure a clean sample is taken, i.e., pre- and post-purge cycles.

D. Sampling probes shall be suspended in the water so as not to pick up particulate matter from the bottom of the stream or pond.

E. The flow metering device shall be equipped with a flow totalizer for recording total effluent volume released from a given source.

F. The sampling system shall have adequate emergency power back-up capabilities to ensure that no unsampled releases occur due to power failure.

8.3 Monitoring (To Be Written)

8.4 Analytical Methods

I. Overall Measurement System

The overall measurement system shall be such that the reported values of the total quantities of radionuclides discharged to the environment are truly representative of the actual releases.

II. Sampling

Samples shall be of sufficient volume to allow the laboratory to perform all required analyses on the material with the desired accuracy, precision and concentration detection limit.

III. Laboratory Measurements

The laboratory methods used for the analysis of liquid radioactive discharges should have the capability to measure for appropriate radionuclides in concentration ranges at least one order of magnitude lower than those values stated in Table II, Annex A, DOE MC 0524.

8.5 Data Review

I. Environmental Protection shall be responsible for reviewing the liquid discharge data to determine compliance with applicable discharge limits and the identification of long-term trends which may indicate the adequacy and effectiveness of waste treatment and control efforts.

II. Process Engineering and Operations shall review radioactive liquid discharge data to determine impact on plant operations.

8.6 Quality Assurance

Radioactive discharges (liquid) sampling and monitoring activities shall be audited in accordance to the requirements of RHO-MA-150.

9.1 Groundwater Monitoring Program

I. Basis

A. Monitoring of radionuclide contamination levels in the groundwater beneath the 200 Area is required to determine the impact of liquid waste discharge from fuel reprocessing and waste management operations on the subterranean environment, to monitor the performance of certain waste disposal sites, and to provide data input for the evaluation of hydrologic models.

B. The 200 Area Groundwater Monitoring Program is based upon U. S. Department of Energy (DOE-RL) requirements that monitoring be performed on all effluents and on-site discharges. These requirements are stated in ERDA MC 0511, 0513, and 0524. The 200 Area program supplements the above ground monitoring performed in facilities and at environmental release points and does not substitute for such monitoring.

C. The 200 Area Groundwater Monitoring Program is separate and distinct from the Hanford Groundwater Monitoring Program managed by Battelle-Northwest which estimates and evaluates the impact of Hanford groundwater contamination on the general public. Special research projects also may utilize groundwater sampling or monitoring independent of the routine monitoring program.

II. Responsibilities

A. The Rockwell Environmental and Occupational Safety (E&OS) Department shall be responsible for administration and management of the 200 Area Groundwater Monitoring Program, including routine evaluation of analyses, modifications to the routine sampling or analysis schedule, and maintenance and repair of the well structures.

B. The Rockwell Hanford Operations Research Department and Office of Drilling and Sampling Technology shall act as technical consultants for the program. Topics of consultation should include additions or deletions to the well sampling program, repair of existing wells, construction of new wells, plugging or destruction of existing wells, and general hydrologic considerations.

C. The Rockwell Quality Engineering Department shall be responsible for performing timely audits of the administration and management of the program.

III. Program Description

A. The 200 Area Groundwater Monitoring Program shall utilize a standardized well sampling network and analysis schedule. Wells included in the network shall be properly constructed and maintained per criteria given or referenced by these standards.

B. Sampling, analytical, data response, and quality assurance aspects of the program shall be carried out in accordance with the guidelines included in these standards.

C. A formal review of the 200 Area Groundwater Monitoring Program shall be held on an annual basis to evaluate the effectiveness of the program, recommend improvements, and anticipate future needs. Such a review shall be chaired by the program administrator from the E&OS Department and include representatives of the Research and Quality Engineering Departments as well as any other interested parties.

9.2 Groundwater Well Structures

I. Location

A. The location and elevation of all well structures shall be established with reference to the Hanford coordinate system, U. S. Geologic Survey, or both.

B. Well location shall be shown on a topographic map with access routes indicated.

C. Office of Drilling and Sampling Technology shall be responsible for maintaining records of well location and elevation.

II. Design

A. All wells drilled in the 200 East or West Area shall be specifically designed to avoid the potential for further contamination of the groundwater flow systems. Well design shall be reviewed and approved by the Rockwell Office of Drilling and Sampling Technology.

B. Well design must meet or exceed criteria given in the following documents:

1. "Minimum Standards for Construction and Maintenance of Water Wells", Chapter 173-160 WAC, State of Washington, Department of Ecology, 1973.

2. "Groundwater Monitoring Program for the 200 East and 200 West Areas", ARH-CD-293, R. E. Gephart and P. A. Eddy, 1976.

C. Well structures shall have caps or covers adequate to prevent down-hole contamination from rain, dust or other foreign material. Locked caps should be provided for all wells.

D. Well structures shall be permanently marked with the well number and an identifiable elevation reference point.

E. Access to wells shall be provided in an environmentally acceptable manner consistent with the anticipated useage.

III. Maintenance

A. Routine maintenance shall be provided for wells as determined by the program administrator based on consultation with the Research Department and the Office of Drilling and Sampling Technology. Minimum maintenance for each well being actively monitored should include measuring the depth to the well bottom and swabbing the casing to remove encrustation every five years. Additional maintenance may include but should not be limited to the following:

1. bailing out sedimentation
2. casing reperforation
3. screen installation
4. cave-in repair
5. cement plug installation

B. Wells shall be inspected for structural integrity and general condition as determined by the E&OS program administrator. Visual inspections of well condition and markings should be performed at two year intervals. Down-hole television camera inspection should be performed when the structural integrity of the well is in doubt.

C. Destruction of obsolete wells or wells posing interflow contamination potential shall be performed per criteria given in "Groundwater Monitoring Program for the 200 East and 200 West Areas", ARH-CD-293.

9.3 Groundwater Sampling

I. Sampling Frequency

A. Groundwater samples shall be taken at intervals which will not allow significant changes in water quality to go undetected, and to provide a continuous history of data for network wells. In determining the sampling frequency for a well, consideration must be given to well location, history of the site being monitored, and trends evidenced by sample analysis.

B. Areas where radionuclide or toxic chemical concentrations above background are present or where insufficient data is available should be sampled and evaluated frequently while regions showing only background concentrations with little probability for change may be sampled at widely spaced intervals.

C. The following are suggested guidelines for determining sampling frequency for wells included in the routine monitoring network.

1. Wells monitoring active liquid waste disposal sites should be monitored on a monthly frequency.

2. Wells indicating above background contaminations and having a history showing upward or erratic trends or analyses should be sampled on a monthly or bimonthly frequency.

3. Wells indicating above background contamination and showing stable or declining trends should be sampled on a quarterly basis.

4. Wells indicating background contamination should be sampled on either a quarterly or semiannual frequency.

5. All wells included in the monitoring network should be routinely sampled for at least five years.

II. Techniques

A. Samples collected shall be representative of the groundwater in the vicinity of the well being sampled and shall be collected according to documented procedures by either pumping or bailing unless otherwise specified.

B. Copies of all sampling procedures shall be reviewed and approved by the E&OS program administrator.

C. The following criteria should be addressed by sample collection procedures:

1. The preferred method of sample collection is by pumping, but the bailing technique may be used until such time that an efficient and reliable pumping system is installed on applicable wells.

2. When using the pump technique, sufficient water should be flushed to remove any foreign contamination from the well structure, and draw into the well water from sediments immediately adjacent to the structure. Limitations on disposal of water in certain areas may prohibit such flushing.

3. When the bailing technique is used, the sample shall be taken from just below the surface of the water unless otherwise specified. This method will not yield as representative a sample of the aquifer as the pumping method.

4. The quantity of water collected should be of sufficient volume to allow completion of all specified analyses and a repeat analysis if required.

5. Before field, use all sample containers shall be clean and free of foreign matter. Containers shall remain sealed until the sample is to be taken. A field survey shall be made of each sample with a GM survey meter to determine if radiation work procedures apply and the reading recorded on the log.

6. Immediately after sampling, the container shall be resealed and labeled with the date sampled and the well or sample identification. A log shall be kept to include the well sampled, sample identification, date and time of sampling, visual appearance of the sample, field GM survey, and the name of the person collecting the sample. Copies of this log shall be provided to the person requesting the sample, within ten days of completion of sampling.

7. Samples shall be field prepared for subsequent analysis as required.

D. Conditions preventing the collection of samples shall be reported to the program administrator for determination of appropriate action.

III. Sampling Quality Control

A. The establishment of sampling quality control measures and determination of their frequency of performance is the responsibility of the E&OS program administrator. Sampling quality control may consist of next day sampling by different crews, audit for compliance to procedures, or other methods acceptable to the program administrator.

9.4 Analytical Methods

I. Analysis Schedule

A. Each sample from the routine 200 Area Groundwater Monitoring Program shall be analyzed in accordance with the established monitoring network analysis schedule.

B. The monitoring network analysis schedule shall be supplemented by additional analyses as required and may be modified by the program administrator as required.

II. Analytical Procedures

A. Laboratory analyses shall be performed according to documented procedures using techniques described by the current edition of the following references:

1. American Society for Testing and Materials, ASTM Standards, Water.

2. American Public Health Association, Standard Methods for the Examination of Water and Waste Water.

3. Environmental Protection Agency, EPA Methods for Chemical Analysis of Water and Wastes.

4. Health and Safety Laboratory, HASL Procedures Manual.

B. Special research or experimental analytical techniques may be used for routine well surveillance providing prior approval by the program administrator is given.

C. Analytical procedures should be reviewed on an annual basis to evaluate technical accuracy and acceptance measured against state of the art techniques.

D. Copies of analytical procedures shall be provided to the program administrator for review and approval.

III. Measurements

A. The analytical methods used for detection of radionuclides in groundwater should have a minimum sensitivity of one percent of the concentration guides given in ERDA MC 0524, Annex A, Table II.

B. Minimum sensitivity for detection of nonradioactive constituents of groundwater should be one percent of the Environmental Protection Agency 1977 standards for drinking water unless other sensitivities are specified. Laboratory analyses and measurements should be traceable to the technician performing the analysis, and the reference standard.

IV. Data Reporting

A. Analytical results shall be reported by the laboratory to the program administrator. Reporting should be done in a timely manner, typically within 30 days after sampling.

B. An annual report summarizing the activities and results of the 200 Area Groundwater Monitoring Program shall be prepared by the administrator and distributed to interested parties. Such a report may be included as part of a general 200 Area environmental report.

V. Analytical Quality Control

A. Procedures for assessing analytical variables and performing routine laboratory calibrations shall be the responsibility of the analytical staff.

B. Analytical quality control should be verified by submission of spiked samples, replicate samples, routine calibration, and participation in exchange of traceable calibration standards with outside laboratories.

C. Annual audits to verify compliance with procedures and maintenance of records should be performed by the program administrator.

D. Laboratory Quality Assurance controls shall be documented and available for review from the program administrator.

9.5 <u>Data Review and Response</u>

A. The E&OS program administrator shall be responsible for reviewing and comparing the analytical results with established histories and concentration guides.

1. Analytical results for radionuclides shall be compared to DOE MC 0524, Annex A, Table II concentration guides. Total alpha and total beta concentrations shall be interpreted as ^{239}Pu and ^{90}Sr unless specific analyses are available.

2. Where significant contamination above background is present, specific nuclides shall be identified.

B. Effort shall be made to determine the cause of anomalous results. Such effort should include but not be limited to review of sampling and analytical techniques, and evaluation of possible sources of groundwater contamination or changes in water quality.

C. Appropriate response shall be made based on interpretation of analytical results. Such response may include any or all of the following:

1. Modification of sampling and analysis schedule or techniques.

2. Performance of check analyses.

3. Notification of appropriate management personnel of actual changes in water quality.

4. Determination of corrective action.

5. Evaluation of impact on the environment or public.

6. Other action as deemed appropriate by the program administrator.

D. The use of underground liquid waste disposal sites shall be terminated when long-lived radionuclides are detected in the ground water beneath the site in concentrations at or exceeding the following levels:

Americium-241	4×10^{-6} µCi/ml
Cesium-137	2×10^{-5} µCi/ml
Cobalt-60	3×10^{-5} µCi/ml
Plutonium-239	5×10^{-6} µCi/ml
Strontium-90	3×10^{-7} µCi/ml

9.6 <u>Quality Assurance</u>

A. All aspects of the 200 Area Groundwater Monitoring Program shall be subject to both internal and external quality assurance audits.

B. Internal audits should be performed on an annual basis for each aspect of the routine program. This may be done as a series of independent audits or a single comprehensive audit. The following should be verified by internal audits:

1. Compliance with sampling and analytical procedures.
2. Documentation and retrievability of analytical results.
3. Evidence of data review and response.
4. Documentation of well structure condition and maintenance.
5. Internal audit reports including a checklist of critical items for all audits.

C. Internal program audits are the responsibility of the program administrator who shall determine the need and perform or request performance of specific audits. Between 5 and 15 percent of the program effort should be directed to internal quality assurance.

D. External quality assurance shall be provided by a program quality verification plan. Development and implementation of this plan shall be the responsibility of Rockwell Quality Engineering.

E. Consultants external to Rockwell Hanford Operations should be utilized as deemed necessary by the program administrator and other interested parties.

ISSUED BY THE MANAGER ENVIRONMENTAL AND OCCUPATIONAL SAFETY	SUBJECT SURFACE WATER SURVEILLANCE SYSTEM	RHO-MA-139

10.1 Surface Water Surveillance Program

I. General

A. An environmental surveillance program for the 200 Areas open disposal sites for low-level radioactive liquid waste shall be maintained to determine:

1. Whether containment and control of local operating facilities are functioning as planned.

2. Whether and to what extent environmental levels of radioactivity and other toxic pollutants released from local operating facilities comply with applicable standards.

3. The overall impact of operations on the environment.

B. Environmental monitoring for nonradioactive toxic pollutants is to be part of the program only if it is not possible to determine compliance with applicable Federal, State, or local standards on the basis of effluents monitoring.

C. Before start-up of a new facility in the 200 Areas, the Environmental Surveillance Program for surface water sampling shall be modified for the affected ponds and ditches to establish background information with respect to those toxicants likely to be released and those parameters likely to be affected by operation of the facility.

II. Responsibility

A. The Environmental Surveillance Program shall be established and administered by Environmental Protection in conjunction with the Research Department.

B. The Radiation Monitoring group shall provide the necessary manpower to collect samples.

C. The Research Department shall provide technical support with respect to Quality Assurance, sampling and analytical procedures, and data processing.

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D. Judgment regarding the extent of environmental monitoring is to be exercised by Environmental Protection in conjunction with the Research Department based on hazard potential, quantities and concentration of materials released, specific public interest or concern and extent and type of utilization of the affected disposal site.

III. <u>Applicable Regulations and Standards</u>

A. Department of Energy MC 0511, "Radioactive Waste Management".

B. Department of Energy MC 0513, "Effluent and Environmental Monitoring and Reporting".

C. Department of Energy MC 0524, "Standards for Radiation Protection".

D. Washington Water Quality Standard (Chapter 173-201 WAC, Effective July 19, 1973).

E. Code of Federal Regulations Title 40, Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants".

F. Code of Federal Regulations Title 40, Part 129, "Toxic Pollutant Effluent Standards".

10.2 Surface Water Sampling

I. <u>Water Sampling Procedures</u>

Water samples shall be taken according to documented procedures using techniques described by the current edition of the following references:

A. American Society for Testing and Materials, <u>ASTM Standards, Water</u>.
B. American Public Health Association, <u>Standard Methods for the Examination of Water and Wastewater</u>.
C. Environmental Measurements Laboratory, <u>HASL-300 Procedures Manual</u>.

II. Sample Site and Frequency

A. Surface water surveillance samples shall be taken from all 200 Areas open ponds and ditches that are receiving liquid waste or that contain surface liquids.

B. The specific location and number of sample sites at each pond or ditch shall be determined by Environmental Protection based on recommendations in writing by Environmental Sciences and described in the Environmental Surveillance Program. The sites chosen are to be selected with extreme care so that the best representative samples are taken.

C. Surface water samples shall be taken at intervals which will not allow significant changes in levels of contamination in the ponds and ditches to go undetected. In determining the sample frequency, consideration must be given to:

1. Site location.

2. History of discharges to the disposal site.

3. Status of current environmental data on the disposal site.

10.3 Analytical Methods

I. Laboratory Procedures

A. Laboratory analyses shall be performed according to documented procedures using techniques described by the current edition of the following references or other acceptable Standard Analytical Methods:

1. American Society for Testing and Materials, ASTM Standards, Water.

2. American Public Health Association, Standard Methods for The Examination of Water and Wastewater.

3. Environmental Protection Agency, EPA Methods for Chemical Analysis of Water and Wastes.

4. Environmental Measurement Laboratory, HASL-300 Procedures Manual.

B. Special research or experimental analytical procedures may be used providing prior approval is given in writing by Environmental Protection.

C. The analytical methods used to measure radioactivity in surface water samples should have a minimum sensitivity of one percent of the concentration guides in Department of Energy MC 0524, Annex A, Table II.

D. The analytical methods used to measure nonradioactive toxic pollutants in surface water samples should have a minimum sensitivity of ten percent of the Environmental Protection Agency 1977 Drinking Water Standard when applicable.

II. Administrative Control

A. The Research Department shall review procedures used in environmental analyses on an annual basis to evaluate technical accuracy and acceptance with respect to current state and federal standards and guides.

B. Analytical procedures used in Environmental analyses shall be provided to Environmental Protection for review signatures prior to being revised and issued.

10.4 Data Review

Environmental Protection shall review all surface water sample data to identify changes due to operations.

10.5 Reports

I. Out of Standard

Surface water contamination levels that exceed Department of Energy MC 0524, Annex A, Table II limits or other applicable state or federal standards shall be reported to the Department of Energy by Environmental Protection through the Rockwell Hanford Operations management structure.

II. Annual

An annual summary of concentrations of radioactive and applicable nonradioactive toxic pollutants in surface water will be included in the 200 Area Environmental Protection report.

10.6 Quality Assurance

Surface Water Surveillance System activities shall be audited in accordance with the requirements of RHO-MA-150 to assure proper administration of radioactivity controls.

ISSUED BY THE MANAGER ENVIRONMENTAL AND OCCUPATIONAL SAFETY	SUBJECT NONRADIOACTIVE WASTE BURIAL	RHO-MA-139

12.1 Criteria

I. Introduction

Nonradioactive wastes (those radiation levels considered to be natural background or less) are routinely collected from contractors on the Hanford Reservation, compacted, and disposed of in the Central Landfill. Operation of the landfill should be in accordance with regulations set forth by the United States Environmental Protection Agency in 40 CFR Part 241, "Guidelines for the Land Disposal of Solid Wastes". Efforts to minimize the volume of waste going to the nonradioactive waste burial site are necessary and it is up to the individual contractors to see that such efforts are implemented. It is the purpose of this standard to ensure that the nonradioactive waste burial site is operated and maintained in an environmentally sound manner.

II. Basis

A. Federal Regulation 40 CFR Part 241, "Guidelines for the Land Disposal of Solid Wastes"

B. ARH 3032 REV 1, "Specifications and Standards for the Packaging, Storage, and Disposal of Richland Operations Solid Wastes"

III. General Criteria

A. Routine nonradioactive wastes generated by the contractors on the Hanford Reservation shall be collected, compacted, and disposed of in the Central Landfill by Rockwell Hanford Operations.

B. Rockwell Hanford Operations, subject to the requirements of the responsible agencies, must determine what waste shall be accepted and shall identify any special handling requirements.

C. The site shall be utilized consistent with Public Health, air, and water quality standards and operated at all times in an aesthetic manner.

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D. The land disposal site shall be operated in such a manner as to protect the health and ensure the safety of the personnel associated with the operation.

E. The site shall be identifed by a sign which shall include the hours of operation and those wastes which are unacceptable.

F. An all weather road shall be maintained to the disposal site and temporary roads must be maintained within the site to ensure the accessibility of the current burial trenches.

G. Adequate protection must be provided to ensure that ground and surface (where applicable) water is not contaminated by the operation of the landfill.

H. Any and all radioactive waste must be excluded from the Central Landfill.

I. No open burning shall be permitted.

J. Litter fencing shall be maintained to ensure the containment of blowing litter in the area.

K. Litter shall be removed from fencing periodically and buried to avoid unsightly accumulation.

L. Conditions shall be maintained which are unfavorable for the harboring, feeding, and breeding of vectors.

M. The solid waste shall be covered with earth at the end of each operating day and when deemed necessary to minimize detrimental environmental effects due to combustion and/or wind-scattering.

N. Deactivated trenches shall be covered with not less than two feet of topsoil quality earth and graded to meet the natural contour of the land.

O. Backfilled trenches shall be revegetated as soon as practical and should be revegetated annually if need be.

P. The Environmental Surveillance Program shall include an audit of the Central Landfill site at least semiannually, to be conducted by Environmental Protection.

Q. The above standards are to be used in conjunction with ARH-3032 REV 1, "Specifications and Standards for the Packaging, Storage and Disposal of Richland Operations Solid Wastes", and 40 CFR Part 241, "Guidelines for the Land Disposal of Solid Wastes".

IV. Hazardous Chemicals

A. Burials of hazardous and/or toxic materials (chemicals) shall be approved by Environmental Protection prior to burial in the special "Hazardous Chemical" or "Asbestos" trenches located within the Central Landfill. Customers requiring disposal of hazardous wastes shall submit a "Request Disposal of Hazardous Materials" permit to Environmental Protection, Rockwell, for evaluation and approval prior to disposal.

B. Guidelines for disposing of hazardous and/or toxic material shall be provided by Environmental Protection as needed.

C. Pesticides and pesticide containers shall be disposed of in accordance with 40 CFR Part 165, "Regulations for the Acceptance of Certain Pesticides and Recommended Procedures for the Disposal and Storage of Pesticides and Pesticide Containers".

D. Nonflammable liquid wastes shall be absorbed onto sufficient absorbant material (i.e., vermiculite, discasorb) or packed in sufficient absorbant material and sealed in a metal container to preclude leakage if the container were to be damaged.

E. Highly flammable liquid wastes shall be disposed of through the Rockwell Hanford Operations Fire Department upon the approval of the Fire Department and the Environmental and Occupational Safety Department (E&OS) following an assessment of their degree of hazard to the environment and public health.

F. Any hazardous material that cannot be handled in a manner such that it will not remain a hazard to the environment or the health and safety of operating personnel shall not be accepted for disposal in the Central Landfill.

G. A list of those hazardous chemicals which are disposed of in a common container shall be provided to Environmental Protection for recordkeeping purposes.

H. The "Hazardous Chemical Trench" shall be posted as such by a sign at the head end of the trench.

V. Asbestos Material

A. The "Asbestos Trench" shall be posted as such by a sign at the head end of the trench.

B. The asbestos material must be wetted, plastic bagged, and either sealed in labeled boxes or double bagged in plastic, and stored in specially marked "asbestos only" dumpsters prior to disposal in the "Asbestos Trench" at the Central Landfill.

C. Fiberglass insulation material should be handled in a manner similar to that of asbestos material.

12.2 Monitoring and Records

I. Radiation Monitoring service shall be carried out at the Central Landfill on a weekly basis to ensure that radiological limits are maintained. (Natural background or less.) In the case of the discovery of higher readings or increased activity, the frequency of monitoring will be increased and investigations made until the problem has been defined and corrected.

II. Records of monitoring data, plot of burial trench locations and contents shall be maintained by the Manager, Road Maintenance and Heavy Equipment which shall include the following:

A. radiation monitoring data
B. depth of fill
C. volume of wastes on a monthly basis
D. type and location of wastes, by trenches
E. vector control efforts
F. operational problems

III. Records of hazardous materials disposed of in the Central Landfill shall be kept by Environmental Protection.

12.3 Quality Assurance

Nonradioactive Waste Burial - Central Landfill shall be audited in accordance with the requirements of RHO-MA-150 to assure proper administration of radioactivity controls.

ISSUED BY THE MANAGER ENVIRONMENTAL AND OCCUPATIONAL SAFETY	SUBJECT RADIOACTIVE WASTE BURIAL	RHO-MA-139

13.1 Criteria

I. Introduction

Rockwell Hanford Operations (Rockwell) receives and stores or disposes of radioactive solid wastes for all Department of Energy (DOE-RL) contractors on the Hanford Reservation. Upon special request from DOE, Rockwell also accepts solid radioactive wastes from offsite DOE contractors for storage or disposal. Solid waste is packaged, handled, and stored or disposed of according to its radioactivity content, size, source, and chemical and isotopic composition. Efforts to minimize the volume of radioactive solid waste being disposed of are essential and shall be the responsibility of the contractor generating the waste. It is the purpose of this standard to ensure that the radioactive wastes are disposed of in a manner which will not result in significant exposure or risk to the public and which will not have a significant detrimental effect on the environment.

II. Basis

A. Department of Energy MC 0511, "Radioactive Waste Management".
B. ARH-220, "Radiation Protection Standards and Controls".
C. ARH-3032 REV 1, "Specifications and Standards for the Packaging, Storage, and Disposal of Richland Operations Solid Wastes".

III. General Criteria

A. The contractor generating solid wastes in an DOE-RL operation shall be responsible for minimizing the volume waste and the radioactivity content of the waste.

B. The Manager, Tank Farm Support Operations Group is the custodian of the radioactive burial trenches and questions relating to disposal or storage practices should be directed to him.

C. Radioactive waste containers shall be surveyed at the facility generating the waste. These readings shall be recorded on the burial record.

D. Exterior surfaces of the waste package shall be free of smearable contamination (less than 200 cpm beta-gamma and less than 500 dpm alpha per 100 cm^2) or have contamination fixed with an adherent film (except for transuranic wastes) or contained by additional packaging.

E. Those containers having radiation emissions of less than 100 mR/hr at one foot are classified as "routine" burials.

F. Non-routine burials (emissions greater than 100 mR/hr at one foot) shall be scheduled with Tank Farm Support Operations personnel.

G. Containers shall be labeled according to ARH-220, "Radiation Protection Standards and Controls", DOE MC 0529, "Safety Standards for the Packaging of Fissile and Other Radioactive Materials", and ARH-MA-101, "Radioactive Materials Shipping Manual".

H. If the weight of any container exceeds 25 kilograms (55 pounds), the estimated gross weight of the container shall be marked on the container.

I. An assay to determine the fissile content of the waste shall be performed on those wastes which are generated by facilities where plutonium, ^{233}U, ^{235}U or other fissile material could be present in significant quantities.

J. Incompatible or highly reactive materials shall not be packaged in the same waste container.

K. Small volumes of liquid wastes must be absorbed into sufficient absorbant material (i.e., vermiculite, discasorb) or packed in sufficient absorbant material and sealed to preclude leakage if the container were to be damaged.

L. No flammable absorbed liquids shall be disposed of in caissons.

M. Any solid waste containing beryllium shall be double contained, closed and labeled as to contents.

N. Unreacted alkali metals shall not be included with solid wastes going to radioactive burial grounds.

O. Active disposal sites shall be accurately marked according to DOE-RL 0511, "Radioactive Waste Management," and AC-5-40, "Hanford Architectural-Civil Standards".

P. Backfilling of open burial trenches shall be conducted to reduce radiation and/or prevent the spread of contamination to the environs.

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Q. Backfilling shall be done immediately upon encountering dose rates of 100 mR/hr or greater at the edge of the trench to reduce surface readings to less than 100 mR/hr.

R. Deactivated waste burial sites shall meet those requirements found in Section 14, "Inactive Sites", of this manual.

S. Backfilled trenches shall be revegetated as soon as practical and should be revegetated annually if need be. Shallow rooted grasses shall be used for revegetation to preclude the growth of deep rooted vegetation.

T. The above standards are to be used in conjunction with ARH-3032 REV 1, "Specifications and Standards for the Packaging, Storage and Disposal of Richland Operations Solid Wastes".

IV. Transuranic Waste Burial

A. A special segregated waste storage area shall be provided for all solid wastes containing or suspected of containing greater than 10 nanocuries of transuranic (all isotopes above uranium in the periodic chart and uranium-233) contamination per gram of solid waste including the sorbing and packaging material.

B. Transuranic wastes to be stored shall be packaged according to HWS-8823 REV 3 (unclassified) "Specification for Procurement of 55-Gallon Drums for Storage of Radioactive Materials", ARH-CD-353, (unclassified) "Design Criteria, Transuranic Dry Waste Burial Containers (Steel and Reinforced Concrete)", and DOE MC 0529 and RL-0529, and RHO-CD-72, "Design Criteria, Burial Containers for Transuranic Dry Waste (Wood and Plywood with Fiberglass Reinforced Polyester Coating)".

C. Transuranic waste containers, except caissons, shall be so labeled as to allow identification of their contents by cross-referencing with permanent records. Proper label format shall be obtained from Waste Engineering Unit.

D. The integrity of the packing containers shall be such that the packages can be readily retrieved in an intact, contamination-free condition for 20 years.

E. Combustible and non-combustible transuranic solid wastes shall be packaged and stored separately as defined by DOE MC 0511, "Radioactive Waste Management".

F. Small items shall be stored on an asphalt pad, or in either trenches or caissons in the 200 Areas after being packaged in approved containers.

G. Large items or failed equipment shall be packaged in approved containers and stored in segregated transuranic trenches.

H. Transuranic trenches shall be covered with a minimum of four feet of earth, the final two feet of which are of the original topsoil quality.

V. Nontransuranic Waste Burial

A. Nontransuranic solid low-level radioactive wastes are disposed of in nontransuranic 200 Areas dry waste burial trenches.

B. All waste packages to be used for nontransuranic solid waste burials shall be approved by Rockwell Hanford Operations.

C. Wastes to be buried shall be packaged according to ARH-CD-767 (unclassified), "Design Criteria, Burial Containers for Nontransuranic Solid Radioactive Waste".

D. Beta-gamma trenches shall be backfilled with a minimum of eight feet of earth. The top two feet of this cover shall be of the original topsoil quality.

13.2 Monitoring and Records

I. Rockwell solid waste burial form numbers 54-6500-028 (3-77) or 54-3000-581 (3-77) must be completed by the originators of the waste and accompany the shipment to burial and/or storage.

II. If transuranic wastes are present, either of the above forms shall be accompanied by Rockwell form BC-6800-076 (10-75).

III. DOE-RL authorization numbers (Requests for Services) are to be recorded on the burial forms.

IV. Questions concerning the completion of the above forms should be directed to Waste Engineering Unit personnel.

V. A complete description of the property including property control numbers, referenced to the supporting Property Disposal Request Control Number, is to be shown in the description block of the Burial Record form to provide documentation and control on the burial of capital property and powered hand tools classified as sensitive.

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VI. The "Disposal Site" section of the solid waste burial record and the transuranic dry waste storage form shall be completed upon acceptance of the waste shipment at the burial ground. Completed forms shall be sent to the Waste Engineering Unit.

VII. Official records of solid wastes committed to all burial sites shall be maintained by the Waste Engineering Unit. Reports of burials shall be made at least quarterly by the above personnel.

VIII. Drawings of all solid waste burial sites showing land used shall be reviewed and updated at least annually.

13.3 Quality Assurance

Radioactive Waste Burial activities shall be audited in accordance with the requirements of RHO-MA-150.

14.1 Criteria

I. Definition

Those sites (liquid discharges, burial grounds, unplanned releases) which are no longer in service and which are not expected to be put back into service in the future are considered inactive terrestrial sites.

II. Basis

A. Hanford Standards, "Architectural - Civil Standards," AC-5-40 and AC-3-25.

B. ARH-220, "Radiation Protection, Standards and Controls."

C. ARH-3032 REV 1, "Specifications and Standards for the Packaging, Storage and Disposal of Richland Operations Solid Wastes."

D. Department of Energy MC-RL-0511, "Radioactive Waste Management".

III. Criteria

A. All process lines into the inactive site shall be cut and capped to preclude any accidental releases to the site.

B. All existing vents and/or risers on the site shall be cut and capped below grade.

C. Surface radiation levels shall be reduced to less than one millirem per hour at grade and free of contamination.

D. A minimum of four feet of earth shall be provided between the contaminated material and the ground surface, the top two feet of which shall be of the quality of the original topsoil.

E. A bio-barrier shall be provided beneath the clean two feet of topsoil to prevent biological transport of contamination where applicable.

F. The surface of the deactivated site shall be contoured to the existing terrain and stabilized by revegetation with shallow rooted grasses such as Siberian Wheatgrass or Cheatgrass to preclude the growth of deep rooted vegetation, notably, Russian Thistle.

G. Deactivated radioactive waste disposal site boundaries shall be accurately and permanently marked with concrete posts as specified in Hanford Standard AC-5-40. If it is determined that no significant radioactivity will exist after five years, and with the approval of the Manager, Radiation Monitoring, the site may be marked with "Radiation Underground" as specified in Hanford Standard AC-3-25 rather than concrete posts as called for above.

H. Concrete boundary posts shall be located at every change in direction and spaced no more than 100 feet apart along the site boundary itself.

I. Access into the site shall be limited. A dry moat shall be used to prevent vehicle traffic from disturbing the site.

14.2 Monitoring and Records

A. Deactivated solid waste disposal sites shall be periodically monitored by personnel of Radiation Monitoring to insure that the above radiological conditions are being maintained (at least semiannually). Deficiencies noted upon inspection shall be corrected by Tank Farm Operations Section.

B. Modifications, improvements, or changes in status of the site shall be recorded with personnel of Environment and Occupational Safety.

14.3 Quality Assurance

Inactive Site radioactivity monitoring activities shall be audited in accordance with the requirements of RHO-MA-150.

15.0 Soil Sampling

This standard is written to provide guidelines to obtain the total amount of airborne contaminants that has fallen out in a given area and to assess long-term buildup of long-lived radioactive contaminants in the environment. It does not apply when it is necessary to evaluate the unusual case where excessive accumulations occur in low spots, at the foot of slopes, or in flooded areas. Special procedures should be developed to evaluate these conditions.

15.1 Environmental Surveillance Program for Soil Sampling

I. General

A. An environmental surveillance program for soil sampling in the 200 Areas shall be established and maintained to determine:

1. Whether containment and control of local operating facilities are functioning as planned.

2. Whether and to what extent environmental levels of radioactivity and other toxic pollutants released from local operating facilities comply with applicable standards.

3. The overall impact of operations on the environment.

B. Environmental monitoring for nonradioactive toxic pollutants is to be part of the program only if it is not possible to determine compliance with applicable Federal, State, or local environmental quality standards on the basis of effluent monitoring.

C. Before start-up of a new facility in the 200 Areas, the Environmental Surveillance Program for soil sampling shall be modified for the affected area to establish background information with respect to those toxicants likely to be released and those parameters likely to be affected by operation of the facility.

II. Responsibility

A. The Environmental Surveillance Program for soil sampling shall be established and administered by Environmental Protection in conjunction with the Research Department.

B. The Radiation Monitoring section shall collect samples.

C. The Analytical Laboratories, and the Research Department shall provide technical support with respect to Quality Assurance, sampling and analytical procedures, statistical analysis and data processing.

D. Judgment regarding the extent of environmental monitoring is to be exercised by DOE-RL office and Rockwell Hanford Operations Environmental Protection based on hazard potential, quantities and concentration of materials released, specific public interest or concern and extent and type of utilization of the effected disposal site.

III. Applicable Regulations and Guides

A. Department of Energy MC 0511, "Radioactive Waste Management."

B. Department of Energy MC 0513, "Effluent and Environmental Monitoring and Reporting."

C. Department of Energy MC 0524, "Standards for Radiation Protection."

D. Nuclear Regulatory Guide 4.5, Measurement of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil.

E. Nuclear Regulatory Guide 4.6, Measurement of Radionuclides in the Environment, Strontium-89 and Strontium-90 Analyses.

15.2 Sampling

I. Soil Sampling Procedure

A. No single soil-sampling method is adequate to sample all soil types at all locations. Therefore, it is necessary that each situation be handled on a case-by-case basis and that the procedure be adjusted appropriately in given situations.

B. Documented procedures prepared by Environmental Protection shall be used as guides for collecting soil samples.

C. Procedures may be in accordance with but not limited to the following references:

1. Nuclear Regulatory Guide 4.5, Measurement of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil.

2. Environmental Measurement Laboratory, HASL-300 Procedure Manual.

II. Sample Site and Frequency

A. Sampling locations and frequency shall be chosen on a statistically sound basis.

B. The specific locations and frequency for soil sampling in the 200 Area shall be determined by Environmental Protection in conjunction with the Research Department and described in the Environmental Surveillance Program.

C. Environmental Protection shall use the following guidelines to select soil sampling sites for routine environmental surveillance:

1. The sites should be nearly level with moderate to good permeability.

2. There should be little or no runoff during heavy rains and no overwash at any time.

3. The sites should not be near enough to buildings or trees to be sheltered during blowing rains.

4. The sites should be selected so that they can be resampled at a later time for continuing surveillance.

5. The site selected should be undisturbed and little or no disturbance should be expected.

6. The precise location of each site should be measured and identified according to an established coordinate system ($\pm$ one foot).

7. The site selected should have as few rocks as possible.

8. Site selections should be made to include areas on the upwind and downwind direction of operating facilities. The main emphasis should be on the downwind side of the facilities.

15.3 Analytical Methods

I. Laboratory Procedures

A. Laboratory analyses shall be performed according to documented procedures using techniques described by the current edition of the following references or other acceptable Standard Analytical Methods:

1. Nuclear Regulatory Guide 4.5, Measurement of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil.

2. Nuclear Regulatory Guide 4.6, Measurement of Radionuclides in the Environment, Strontium-89 and Strontium-90 Analysis.

3. Environmental Measurements Laboratory, HASL-300 Procedure Manual.

4. National Council on Radiation Protection and Measurements Report No. 50, Environmental Radiation Measurements.

B. Special research or experimental analytical procedures may be used providing prior approval by the Environmental Protection group is given.

C. The analytical methods used to measure radionuclides in soil samples should have minimum sensitivities of:

^{241}Am -- 0.005	pCi/gram of dried sample
^{144}Ce -- 0.5	pCi/gram of dried sample
^{60}CO -- 0.1	pCi/gram of dried sample
^{134}Cs -- 0.1	pCi/gram of dried sample
^{137}Cs -- 1.0	pCi/gram of dried sample
^{154}Mn -- 0.01	pCi/gram of dried sample
^{238}Pu -- 0.01	pCi/gram of dried sample
^{239}Pu -- 0.01	pCi/gram of dried sample
^{90}Sr -- 0.1	pCi/gram of dried sample

II. Administrative Control

A. The Research Department shall review procedures used in environmental analyses on an annual basis to evaluate technical accuracy and acceptance with respect to current State and Federal standards and guides.

B. Analytical procedures used in environmental analyses shall be provided to the Environmental Protection for review signatures prior to being revised and issued.

15.4 Data Review

Environmental Protection shall review all soil sampling data to identify changes in the environment due operations.

15.5 Reports

I. Special

Contamination levels found in the soil that have deleterious effects on the environment shall be reported to the Department of Energy by Environmental Protection through the Rockwell Hanford Operations management structure.

II. Annual

An annual summary of concentration levels of radionuclides and applicable nonradioactive pollutants in the environment will be included in the 200 Area Environmental Protection report.

15.6 Quality Assurance

Soil Sampling activities shall be audited in accordance with the requirements of RHO-MA-150.

18.0 Environmental Dose Assessment

This standard is written to provide guidelines for the use of thermoluminescence dosimeters (TLD) for measurement of x- and gamma-ray radiation exposure levels in the environment. It is recognized that other forms of radiation, including neutrons and beta particles can be detected with TLDs, but this standard is not concerned with these components. This standard should not be applied for direct measurement of absorbed dose to man or his critical organs for that is beyond the scope of the standard.

18.1 Dose Assessment Program

I. General

A. As part of Environmental Surveillance, a dose assessment program shall be maintained to determine:

1. Measurable levels of radiation within the 200 Area environment.
2. The 200 Area fence line exposure.
3. The radiation levels that result from normal operations, operational occurrences, and accidents.

B. Before start-up of a new facility in the 200 Area, the Dose Assessment Program shall be modified to establish detailed background information for the affected area.

II. Responsibility

A. The Environmental Dose Assessment Program shall be established and administered by Environmental Protection in conjunction with the Research Department.

B. The Radiation Monitoring section shall provide manpower to change TLD's.

C. The thermoluminescence dosimeters and calibration, testing, and evaluations service shall be provided by the Calibration Section of Battelle Northwest. Environmental Protection will provide Battelle with specification for these services.

D. Statistical Sciences will review calibration field and test data to determine the statistical validity.

II. Applicable Regulations and Standards

A. Nuclear Regulatory Guide 4.13, Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications.

B. ANSI N545-1975, American National Standard, Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry (Environmental Application).

C. 10 CFR 20, Standards for Protection Against Radiation.

18.2 Quality Assurance

I. Performance Specifications

A. The performance of the TLD system shall be determined under laboratory conditions in a known radiation field. Under these conditions, the measurement of an exposure equal to that resulting from an exposure rate of 10 μR/h during the field cycle shall agree with the known exposure to within 10 percent at the 95 percent confidence level.

B. The corrections applied to compensate for the errors expected under field conditions as determined from the testing procedures of this standard shall not change the exposure estimate by more than a factor of two.

C. The total system measurement error, after all corrections are made, shall not exceed 30 percent at the 95 percent confidence level.

II. Testing

A. General Testing Procedure

1. Unless otherwise stated, each test shall be performed under calibration conditions.

2. Unless otherwise stated, each test shall be conducted with the TLD system used as it would be for field application.

3. Exposures used for testing shall be within the region of linear response of the system.

4. The number of TLDs, or the number of replicates, used for each test shall be sufficient to assure compliance with the requirements of the test at the 95 percent confidence level.

5. The test should be repeated whenever there is any change in the system or the specific application.

B. Specific Test

1. Uniformity. Uniformity shall be determined by giving TLDs from the same field batch an exposure equal to that resulting from an exposure rate of 10 μR/h during the field cycle. The responses obtained shall not differ from each other by more than 30 percent.

2. Reproducibility. Reproducibility shall be determined by giving one TLD repeated exposures equal to that resulting from an exposure rate of 10 μR/h during the field cycle. The responses shall not differ from each other by more than 10 percent.

3. Dependence of Exposure Interpretation on the Length of the Field Cycle. Dependence on the length of the field cycle shall be examined by placing TLDs for a period equal to the field cycle and a period equal to exactly half the field cycle in an area where the exposure rate is known to be constant. The ratio of the response obtained for the field cycle to twice that obtained for half the field cycle shall be 0.90 to 1.10. This test shall be repeated under both the minimum and the maximum temperature conditions expected in the field. For these tests, the ratio of the response obtained for the field cycle to twice that obtained for half the field cycle shall be 0.85 to 1.15.

4. Energy Dependence. The response of TLD to photons shall be determined for several energies between 30 keV and 3 MeV. The response shall not differ from that obtained with the calibration source by more than 20 percent for photons with energies greater than 80 keV and shall not be enhanced by more than a factor of two photons with energies less than 80 keV.

5. Directional Dependence. The directional dependence of the TLD response shall be determined by comparing the response of the TLD exposed in the routine orientation with respect to the calibration source with the response obtained for different orientations. To accomplish this, the TLD shall be rotated through at least two perpendicular planes, using the center of the sensitive volume - that is, the phosphor(s) - of the TLD as the axis of rotation. For symmetrical dosimeters, this rotation need not be accomplished over the entire 360° ranges, but should be sufficient to represent the response as a whole. The response averaged over all directions shall not differ from the response obtained in the standard calibration position by more than 10 percent.

6. Light Dependence. Light dependence shall be determined by placing TLDs in the field for a period equal to the field cycle under the following conditions:

   (a) Unexposed
   (b) Unexposed and wrapped in standard household aluminum foil
   (c) Exposed to approximately 100 mR
   (d) Exposed as in (c) and wrapped in standard household aluminum foil

   The response of the TLDs for conditions (a) and (b) shall be subtracted from the response of the TLDs for conditions (c) and (d), respectively. The results obtained for the unwrapped TLDs shall not differ from those obtained for the TLDs wrapped in aluminum foil by more than 10 percent.

7. Moisture Dependence. Moisture dependence shall be determined by placing TLDs (that is, the phosphors packaged for field use) for a period equal to the field cycle in an area where the exposure rate is known to be constant. The TLDs shall be exposed under two conditions: packaged in a thin, sealed plastic bag, and packaged in a thin, sealed plastic bag with sufficient water to yield observable moisture throughout the field cycle. The TLD or phosphor, as appropriate, shall be dry before readout. The response of the TLD exposed in the plastic bag containing water shall not differ from that exposed in the regular plastic bag by more than 10 percent.

8. Self-Irradiation. Self-irradiation shall be determined by placing TLDs for a period equal to the field cycle in an area where the exposure rate is less than 10 μR/h, and the exposure during the field cycle is known. If necessary, corrections shall be applied for the independence of exposure interpretation on the length of the field cycle. The exposure inferred from the response of the TLD shall not differ from the known exposure by more than an exposure equal to that resulting from an exposure rate of 10 μR/h during the field cycle.

III. Calibration Procedures

A. General

TLD calibration involves interpretation of TL response in terms of exposure. Acceptable calibration techniques may be found in ANSI N545-1975, Appendix A.

B. Calibration Source

1. The exposure given to a TLD during calibration shall be known to within 5 percent.

2. The methods employed for determining the calibration exposure shall be documented.

3. The calibration source should be traceable to the National Bureau of Standards (U. S. A.), the National Physical Laboratory (U. K.) or similar institution.

4. The energy (or energies) of the photons emitted by the calibration source shall be within a range over which the response of the TLD is known to vary by less than 20 percent. Acceptable sources generally included in this range are ^{137}Cs, ^{60}Co, and ^{226}Ra in equilibrium with its daughters.

C. Choice of Calibration TLDs

Calibration TLDs shall be from the field batch as discussed in 18.3 IV.

D. Frequency of Calibration

Calibration TLDs shall be read out with each field batch or part thereof processed in a continuous readout session.

E. Calibration Exposures

Calibration exposures shall be within the region of linear response of the system.

18.3 TLD Field Procedures

I. Packing of Phosphors

A. The phosphor(s) shall be packaged in a manner such that electronic equilibrium is attained during calibration.

B. The phosphor(s) should be packaged in a manner such that the individual and combined errors introduced by the parameters will be minimized.

II. Siting of TLD's

A. In the field, the TLDs shall be suspended at a height of 1.0 meter ±0.3 meter above the ground in a manner that will minimize distortion of the radiation field. TLDs should be removed as far as possible from large or dense objects that may cause directional anomalies or otherwise perturb the radiation field. Acceptable methods of suspension include hanging from a wire fence, small tree or shrub, or lightweight post.

B. The TLD field site shall be chosen to be as representative as possible of the general surroundings. Acceptable sites include physically and radiologically uniform open areas not shielded by adjacent structures. Choice of site shall be made in conjunction with a site plan reviewed by Environmental Sciences and Statistical Sciences.

C. The requirements of A and B shall be satisfied under general environmental monitoring conditions unless the purpose is to obtain measurements at specific heights or sites different from those described in A and B.

D. The number of TLDs in the field shall be sufficient for compliance with the performance specifications.

III. Isolation of Field Exposures

A. All exposures received by the TLD as a result of storage or transit, or both, during the exposure cycle shall be subtracted from the total exposure to isolate the field exposure.

B. Control dosimeters shall be used to determine the exposure received by the TLDs during storage or transit.

D. Acceptable methods for using control dosimeters for isolations of field exposures are given in ANSI N545-1975, Appendix B.

IV. TLD Field Batch

A. Once the properties of a TLD field batch are established as specified 18.2. IIB., the batch should be retained as a batch and used only for environmental applications.

B. The batch should not be used where the exposure might be sufficiently large to cause a residual signal that would interfere with subsequent measurements of exposures at environmental levels.

C. The properties of the batch should be re-examined periodically.

D. TLDs used for calibration and as controls shall be chosen from within the field batch and shall be read out with the field batch.

E. The radiation and handling histories of the TLDs in a batch should be kept as uniform as possible.

V. TLD Field Cycle

A. The TLDs field cycle shall be determined by Environmental Protection.

B. The TLD's field cycle shall be for the same length of time as the specific tests are made.

18.4 Reports

An annual summary of the levels of radiation measured in the environment will be included in the 200 Area Environmental Protection report.

ISSUED BY THE MANAGER ENVIRONMENTAL AND OCCUPATIONAL SAFETY	SUBJECT MAXIMUM PERMISSIBLE CONCENTRATIONS	RHO-MA-139

The following tables are the maximum permissible concentrations for air and water above natural background levels. These are found in the Department of Energy Manual, Appendix 0524, Annex A.

Table I concentrations were derived from the dose standards for an individual continuously exposed for a period of 40 hours during a work week. The concentration guides should be used in evaluating the adequacy of health protection measures against airborne radioactivity in occupied areas.

Table II concentrations were derived from the dose standards for an individual continuously exposed for a period of 168 hours.

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Element (atomic number)	Isotope,* soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area† Column 1 Air (μc/ml)	Table II Uncontrolled Area† Column 2 Water (μc/ml)
Actinium (89)	Ac	227	S	2×10^{-12}	6×10^{-4}	8×10^{-14}	2×10^{-6}
			I	3×10^{-11}	9×10^{-3}	9×10^{-13}	3×10^{-4}
	Ac	228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}	9×10^{-5}
			I	2×10^{-8}	3×10^{-3}	6×10^{-10}	9×10^{-5}
Americium (95)	Am	241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am	242m	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	3×10^{-10}	3×10^{-3}	9×10^{-12}	9×10^{-5}
	Am	242	S	4×10^{-8}	4×10^{-3}	1×10^{-9}	1×10^{-4}
			I	5×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Am	243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am	244	S	4×10^{-6}	1×10^{-1}	1×10^{-7}	5×10^{-3}
			I	2×10^{-5}	1×10^{-1}	8×10^{-7}	5×10^{-3}
Antimony (51)	Sb	122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
			I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
	Sb	124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
			I	2×10^{-8}	7×10^{-4}	7×10^{-10}	2×10^{-5}
	Sb	125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	3×10^{-8}	3×10^{-3}	9×10^{-10}	1×10^{-4}
Argon (18)	A	37	Sub	3×10^{-3}		1×10^{-4}	
	A	41	Sub	2×10^{-6}		4×10^{-5}	
Arsenic (33)	As	73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	5×10^{-4}
			I	4×10^{-7}	1×10^{-2}	1×10^{-8}	1×10^{-4}
	As	74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
			I	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
	As	76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
			I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	As	77	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Astatine (85)	At	211	S	4×10^{-9}	2×10^{-5}	2×10^{-10}	2×10^{-6}
			I	3×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
Barium (56)	Ba	131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ba	140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}	3×10^{-5}
			I	4×10^{-8}	7×10^{-4}	1×10^{-9}	2×10^{-5}

*"Sub" means that values given are for submersion in a semispherical infinite cloud of airborne material.

†These values apply to individuals in uncontrolled areas. One-third of these values will be used for a suitable sample of the population.

NOTE: $\mu Ci/ml \times 10^{12} = pCi/m^3$; $\mu Ci/ml \times 10^3 = Ci/l$.

Approved: March 30, 1977

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Berkelium (97)	Bk	249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
			I	1×10^{-7}	2×10^{-2}	4×10^{-9}	6×10^{-4}
	Bk	250	S	1×10^{-7}	6×10^{-3}	5×10^{-9}	2×10^{-4}
			I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Beryllium (4)	Be	7	S	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
			I	1×10^{-6}	5×10^{-2}	4×10^{-8}	2×10^{-3}
Bismuth (83)	Bi	206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
			I	1×10^{-7}	1×10^{-3}	5×10^{-9}	4×10^{-5}
	Bi	207	S	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
			I	1×10^{-8}	2×10^{-3}	5×10^{-10}	6×10^{-5}
	Bi	210	S	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
			I	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Bi	212	S	1×10^{-7}	1×10^{-2}	3×10^{-9}	4×10^{-4}
			I	2×10^{-7}	1×10^{-2}	7×10^{-9}	4×10^{-4}
Bromine (35)	Br	82	S	1×10^{-6}	8×10^{-3}	4×10^{-8}	3×10^{-4}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Cadmium (48)	Cd	109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
			I	7×10^{-8}	5×10^{-3}	3×10^{-9}	2×10^{-4}
	Cd	115m	S	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
			I	4×10^{-5}	7×10^{-4}	1×10^{-9}	3×10^{-5}
	Cd	115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Calcium (20)	Ca	45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
			I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca	47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf	249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
			I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf	250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
			I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf	251	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf	252	S	6×10^{-12}	2×10^{-4}	2×10^{-13}	7×10^{-5}
			I	3×10^{-11}	2×10^{-4}	1×10^{-12}	7×10^{-5}
	Cf	253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
			I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf	254	S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
			I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
Carbon (6)	C	14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO_2)		Sub	5×10^{-5}		1×10^{-6}	
Cerium (58)	Ce	14.	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
			I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}

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Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Cerium (58) Cont'd.	Ce	143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce	144	S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
			I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs	131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
			I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs	134m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
			I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs	134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
			I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs	135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs	136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
			I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs	137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
			I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl	36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
			I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl	38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr	51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
			I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}
Cobalt (27)	Co	57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
			I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co	58m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
			I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co	58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co	60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
			I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu	64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
			I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm	242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
			I	2×10^{-10}	7×10^{-4}	6×10^{-12}	2×10^{-5}
	Cm	243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
			I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm	244a	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
			I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm	245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm	246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}

9 2 1 2 5 5 6 0 5 7 7

Element (atomic number)	Isotope, soluble (S): insoluble (I)		Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Curium (96) Cont'd.	Cm 247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm 248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm 249	S	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
		I	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
Dysprosium (66)	Dy 165	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
	Dy 166	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Einsteinium (99)	Es 253	S	8×10^{-10}	7×10^{-4}	3×10^{-11}	2×10^{-5}
		I	6×10^{-10}	7×10^{-4}	2×10^{-11}	2×10^{-5}
	Es 254m	S	5×10^{-9}	8×10^{-4}	2×10^{-10}	2×10^{-5}
		I	6×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
	Es 254	S	2×10^{-11}	4×10^{-4}	6×10^{-13}	1×10^{-5}
		I	1×10^{-10}	4×10^{-4}	4×10^{-12}	1×10^{-5}
	Es 255	S	5×10^{-10}	5×10^{-4}	2×10^{-11}	3×10^{-5}
		I	4×10^{-10}	8×10^{-4}	1×10^{-11}	3×10^{-4}
Erbium (68)	Er 169	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	Er 171	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Europium (63)	Eu 152	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	(T/2=9.2 hrs)	I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu 152	S	1×10^{-8}	2×10^{-3}	4×10^{-10}	8×10^{-5}
	(T/2=13 yrs)	I	2×10^{-8}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu 154	S	4×10^{-9}	6×10^{-4}	1×10^{-10}	2×10^{-5}
		I	7×10^{-9}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu 155	S	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
		I	7×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
Fermium (100)	Fm 254	S	6×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
		I	7×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Fm 255	S	2×10^{-8}	1×10^{-3}	6×10^{-10}	3×10^{-5}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	3×10^{-5}
	Fm 256	S	3×10^{-9}	3×10^{-5}	1×10^{-10}	9×10^{-7}
		I	2×10^{-9}	3×10^{-5}	6×10^{-11}	9×10^{-7}
Fluorine (9)	F 18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd 153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
		I	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd 159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Gallium (31)	Ga	72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Germanium (32)	Ge	71	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
			I	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
Gold (79)	Au	196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au	198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au	199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf	181	S	4×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
			I	7×10^{-8}	2×10^{-3}	3×10^{-9}	7×10^{-5}
Holmium (67)	Ho	166	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H	3	S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
			I	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
			Sub	2×10^{-3}		4×10^{-5}	
Indium (49)	In	113m	S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
			I	7×10^{-6}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In	114m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In	115m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In	115	S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
			I	3×10^{-8}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)*	I	125	S	3×10^{-9}	2×10^{-5}	8×10^{-11}	2×10^{-7}
			I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I	126	S	4×10^{-9}	3×10^{-5}	9×10^{-11}	3×10^{-7}
			I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I	129	S	8×10^{-10}	5×10^{-5}	2×10^{-11}	6×10^{-8}
			I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I	131	S	4×10^{-9}	3×10^{-5}	1×10^{-10}	3×10^{-7}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I	132	S	1×10^{-7}	8×10^{-4}	3×10^{-9}	8×10^{-4}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I	133	S	2×10^{-8}	1×10^{-4}	4×10^{-10}	1×10^{-6}
			I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}

*In the derivation of the concentration guides for soluble forms of iodine in Table II, a 2 gram thyroid (infants) and daily intakes of 3×10^{6} ml of air and 1×10^{3} ml of water (fluid water plus water contents of foods) assumed.

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Iodine (53) Cont'd.	I	134	S	3×10^{-7}	2×10^{-3}	6×10^{-9}	2×10^{-5}
			I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I	135	S	5×10^{-7}	4×10^{-4}	1×10^{-9}	4×10^{-6}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir	190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
			I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir	192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
			I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir	194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
			I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe	55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
			I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-3}
	Fe	59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
			I	5×10^{-9}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton (36)	Kr	85m	Sub	6×10^{-6}		1×10^{-7}	
	Kr	85	Sub	1×10^{-5}		3×10^{-7}	
	Kr	87	Sub	1×10^{-6}		2×10^{-8}	
	Kr	88	Sub	1×10^{-6}		2×10^{-8}	
Lanthanum (57)	La	140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
			I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb	203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb	210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
			I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb	212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
			I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu	177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn	52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
			I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn	54	S	4×10^{-7}	4×10^{-3}	1×10^{-8}	1×10^{-4}
			I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn	56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Mercury (80)	Hg	197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
			I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg	197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
			I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg	203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo	99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
			I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Neodymium (60)	Nd	144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
			I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd	147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd	149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
			I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}
Neptunium (93)	Np	237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np	239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni	59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
			I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-3}
	Ni	63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
			I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni	65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (Columbium) (41)	Nb	93m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
			I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb	95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb	97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
			I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
Osmium (76)	Os	185	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os	191m	S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
			I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}
	Os	191	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os	193	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	3×10^{-7}	2×10^{-3}	9×10^{-9}	5×10^{-5}
Palladium (46)	Pd	103	S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
			I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd	109	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P	32	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
			I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt	191	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt	193	S	1×10^{-4}	3×10^{-2}	9×10^{-3}	9×10^{-4}
			I	3×10^{-7}	5×10^{-2}	1×10^{-3}	2×10^{-3}
	Pt	193m	S	7×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
			I	5×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Platinum (78) Cont'd.	Pt	197m	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
			I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
	Pt	197	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Plutonium (94)	Pu	238	S	2×10^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-6}
			I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	239	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
			I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	240	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
			I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	241	S	9×10^{-11}	7×10^{-3}	3×10^{-12}	2×10^{-4}
			I	4×10^{-8}	4×10^{-2}	1×10^{-9}	1×10^{-3}
	Pu	242	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
			I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	243	S	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
			I	2×10^{-6}	1×10^{-2}	8×10^{-8}	3×10^{-4}
	Pu	244	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
			I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
Polonium (84)	Po	210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
			I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K	42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
			I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr	142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr	143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm	147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
			I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm	149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protactinium (91)	Pa	230	S	2×10^{-9}	7×10^{-3}	6×10^{-11}	2×10^{-4}
			I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa	231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa	233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
			I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra	223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
			I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra	224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
			I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra	226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
			I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}

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Element (atomic number)	Isotope		soluble (S); insoluble (I)	Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Radium (88) Cont'd.	Ra	228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
			I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn	220	S	3×10^{-7}		1×10^{-8}	
	Rn	222	S	1×10^{-7}		3×10^{-9}	
Rhenium (75)	Re	183	S	3×10^{-6}	2×10^{-2}	9×10^{-8}	6×10^{-4}
			I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re	186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re	187	S	4×10^{-6}	4×10^{-2}	3×10^{-7}	3×10^{-3}
			I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re	188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh	103m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
			I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh	105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb	86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
			I	7×10^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb	87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Ruthenium (44)	Ru	97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru	103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
			I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru	105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru	106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
			I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Samarium (62)	Sm	147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
			I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm	151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
			I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm	153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc	46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
			I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc	47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc	48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
			I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se	75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
			I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}

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Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area		Table II Uncontrolled Area	
				Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
Silicon (14)	Si	31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
			I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag	105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag	110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag	111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na	22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
			I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na	24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
			I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr	85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
			I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr	85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
			I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr	89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}	3×10^{-6}
			I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr	90	S	1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-7}
			I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr	91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr	92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S	35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
			I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta	182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
			I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}
Technetium (43)	Tc	96m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
			I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc	96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc	97m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc	97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
			I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc	99m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
			I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc	99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
			I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te	125m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Tellurium (52) Cont'd.	Te	127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
			I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te	127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Te	129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
			I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te	129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
			I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te	131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te	132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb	160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
			I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl	200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl	201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl	202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl	204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	Th	227	S	3×10^{-10}	5×10^{-4}	1×10^{-11}	2×10^{-5}
			I	2×10^{-10}	5×10^{-4}	6×10^{-12}	2×10^{-5}
	Th	228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
			I	6×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
	Th	230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
			I	1×10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	Th	231	S	1×10^{-6}	7×10^{-3}	5×10^{-8}	2×10^{-4}
			I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Th	232	S	3×10^{-11}	5×10^{-5}	1×10^{-12}	2×10^{-6}
			I	3×10^{-11}	1×10^{-3}	1×10^{-12}	4×10^{-5}
	Th-natural*		S	3×10^{-11}	3×10^{-5}	1×10^{-12}	1×10^{-6}
			I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
	Th	234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
			I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
Thulium (69)	Tm	170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
			I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}

*A curie of natural thorium means the sum of 3.7×10^{10} dis/sec from Th 232 plus 3.7×10^{10} dis/sec from Th 228. One curie of natural thorium is equivalent to 9,000 kilograms or 19,850 pounds of natural thorium.

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Element (atomic number)	Isotope, soluble (S): insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Thulium (69) Cont'd.	Tm	171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
			I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)	Sn	113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
			I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
	Sn	125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)	W	181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
	W	185	S	8×10^{-7}	1×10^{-3}	3×10^{-8}	1×10^{-4}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-5}
	W	187	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-3}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U	230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
			I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U	232	S	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
			I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U	233	S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U	234	S	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U	235	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	U	236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	U	238	S	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
			I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
	U	240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
	U-natural*		S	7×10^{-11}	5×10^{-4}	3×10^{-12}	2×10^{-5}
			I	6×10^{-11}	5×10^{-4}	2×10^{-12}	2×10^{-5}
Vanadium (23)	V	48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
			I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe	131m	Sub	2×10^{-5}		4×10^{-7}	
	Xe	133	Sub	1×10^{-5}		3×10^{-7}	
	Xe	133m	Sub	1×10^{-5}		3×10^{-7}	
	Xe	135	Sub	4×10^{-6}		1×10^{-7}	
Ytterbium (70)	Yb	175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}

*A curie of natural uranium means the sum of 3.7×10^{10} disintegrations per second from U 238 plus 3.7×10^{10} dis/sec from U 234 plus 1.7×10^{9} dis/sec from U 235. One curie of natural uranium is equivalent to 3,000 kilograms or 6,615 pounds of natural uranium.

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Element (atomic number)	Isotope, soluble (S): insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Yttrium (39)	Y	90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
			I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y	91m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
			I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y	91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
			I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y	92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y	93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
			I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Zinc (30)	Zn	65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
			I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn	69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn	69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
			I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr	93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
			I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr	95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
			I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr	97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.			Sub	1×10^{-6}		3×10^{-8}	
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.				3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above which decays by alpha emission or spontaneous fission.				6×10^{-13}	4×10^{-7}	2×10^{-14}	3×10^{-8}

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the guide values, for purposes of this annex, should be determined as follows:

Approved: March 30, 1977

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the guide otherwise established in this annex for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture will not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C, and if the applicable CGs are CG_A, CG_B, and CG_C, respectively, then the concentrations should be limited so that the following relationship exists:

$$\frac{C_A}{CG_A} + \frac{C_B}{CG_B} + \frac{C_C}{CG_C} \leq 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the guide values for purposes of this annex will be:

a. For purposes of Table I, Col. 1, 6×10^{-13}
b. For purposes of Table I, Col. 2, 4×10^{-7}
c. For purposes of Table II, Col. 1, 2×10^{-14}
d. For purposes of Table II, Col. 2, 3×10^{-8}

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in 2., above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration guide for the mixture is the guide specified in this annex for the radionuclide in the mixture having the lowest concentration guide, or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this annex are not present in the mixture, the concentration guide for the mixture is the lowest concentration guide specified in this annex for any radionuclide which is not known to be absent from the mixture, or

c.

Element (atomic number) and isotope	Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131 (I 133, Table II only) Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present		9×10^{-5}		3×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129 (I 131, I 133, Table II only) Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present		6×10^{-5}		2×10^{-6}
If it is known that Sr 90, I 129 (I 125, I 126, I 131, Table II only) Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present		2×10^{-5}		6×10^{-7}
If it is known that (I 129, Table II only) Ra 226 and Ra 228 are not present		3×10^{-6}		1×10^{-7}
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not present	3×10^{-9}		1×10^{-10}	
If it is known that alpha-emitters and Pb-210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}		1×10^{-11}	
If it is known that alpha-emitters and Ac 227 are not present	3×10^{-11}		1×10^{-12}	
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249, and Cf 251 are not present	3×10^{-12}		1×10^{-13}	

Approved: March 30, 1977

4. If the mixture of radionuclides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with 1., above, or those specified in 2. and 3., above.

a. For purposes of Table I, Col. 1, 1×10^{-10} μc/ml gross alpha activity; or 2.5×10^{-11} μc/ml natural uranium; or 75 micrograms per cubic meter of natural uranium in air.

b. For purposes of Table II, Col. 1, 3×10^{-12} μc/ml gross alpha activity; or 8×10^{-13} μc/ml natural uranium; or 3 micrograms per cubic meter of natural uranium in air.

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration guide for that radionuclide specified in Table II of this annex (CG_A) does not exceed 1/10, i.e.,

$$\frac{C_A}{CG_A} \leq \frac{1}{10}$$

and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed 1/4, i.e.,

$$\frac{C_A}{CG_A} + \frac{C_B}{CG_B} + \ldots \leq \frac{1}{4}$$

6. Conversion from μCi/cc to pCi/m³ for air and pCi/l for water are as follows:

a. Air – μCi/cc x 10^{12} = pCi/m³

b. Water – μCi/cc x 10^{9} = pCi/l

7. Concentrations may be derived for unlisted radionuclides provided yearly dose limits in part I, A. and part II, A. are used and the methods are consistent with those recommended by the FRC and ICRP.

ISSUED BY THE MANAGER ENVIRONMENTAL AND OCCUPATIONAL SAFETY	SUBJECT EXCAVATION - ENVIRONMENTAL PROTECTION	RHO-MA-139

22.1 Basis

Excavation within radiation zones may result in the exposure of contaminated material to the environment with the possibility of resuspension or biological transport of radionuclides. This standard provides guidelines for contamination control during such operations.

22.2 Responsibilities

A. The facility manager or the operations manager is responsible for the safe operation and contamination control when excavation work is conducted in or near radiation zones. This responsibility includes the following:

1. Pre-job safety planning in accordance with standard 2.0, ARH-221, Accident Prevention, to ensure that contamination control is reviewed, and that applicable standards and directives are followed.
2. Ensuring that adequate contamination control measures are maintained during and on completion of the job as outlined in Section 22.4 of this standard.
3. Implementing corrective actions when inadequate contamination control is discovered in work areas.

B. Radiation Monitoring is responsible for:

1. Reviewing excavation permits to determine the need for contamination control measures.
2. Providing contamination control input to pre-job safety plans, and radiation work procedures.
3. Conducting routine radiation surveys of excavation sites.
4. Notifying the operational managers and Environmental Protection of inadequate contamination control.
5. Providing input for corrective actions on those areas which do not have adequate contamination control.

C. Environmental Protection is responsible for:

1. Providing environmental control measures to pre-job plans.
2. Performing periodic audits of work in radiation zones to insure that contamination control is adequate and providing audit results to the facility or operations manager.
3. Investigating areas with inadequate contamination control and assisting in the development of corrective actions.

22.3 Excavation Permits

A. Excavation permits shall be issued and approved by the Manager - Plant Engineering for all excavation work in areas administered by Rockwell Hanford Operations.

B. Excavation permits shall be issued in accordance with Procedure No. EP-2 of ARH-MA-154, the Scientific, Technical and Engineering Manual.

22.4 Control Measures

The following control measures shall be included in pre-job planning and in work plans for work in radiation areas.

A. Measures to minimize resuspension and biological transport of radioactive contamination shall be employed at the conclusion of each work period. These measures may include but are not limited to:

1. Application of canvas, plastic, or wood over the contaminated surface.
2. Application of soil fixant.

B. Excavation sites shall be inspected and surveyed routinely to determine if contamination control is adequate.

C. Excavations shall be backfilled promptly upon completion of the jobs to not less than original grade, and to levels sufficient to reduce the surface dose rate to <1 mRem/hr.