WORK PLAN
FOR THE REMEDIATION
OF THE LOW LEVEL
RADIOACTIVE CONTAMINATED MATERIAL
BUILDING 65 VENTILATION SYSTEM
FOR THE
ALUMINUM COMPANY OF AMERICA
CLEVELAND FORGE PLANT
CLEVELAND WORKS

March 1993

PREPARED AND SUBMITTED BY:
INTEGRATED ENVIRONMENTAL SERVICES
DIVISION OF NUCLEAR ENERGY SERVICES
44 Shelter Rock Road
Danbury Ct. 06810

B/4

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Prepared by: F. E. Rebmann

Frank E. Rebmann, Project Manager, NES/IES

Approved by: _____

Dennis Reisenweaver, Department Manager, NES/IES

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EXHIBITS

SCOPE

The purpose of this work plan is to provide a logical and safe method for the remediation of building 65 ventilation systems at the Cleveland Works site which contain low levels of radioactive material and perform a verification survey of the remaining areas.

This work plan is to be used as a guide in performing the remediation operations.

The overall project has been divided into tasks which are discussed in detail in this plan.

The goal of this plan is to remove and/or decontaminate all contaminated surfaces of the ventilation system to levels that are below the U.S. Nuclear Regulatory Commission (USNRC) unrestricted release limits stated in Table 1 of USNRC Regulatory Guide 1.86.

II SITE CONDITIONS

The ventilation system has been previously characterized by REMCOR Inc. in their 1992 radiological survey. REMCOR determined that contamination levels exceeding the 5,000 dpm/100cm^2 (DU) existed in exhaust, supply and fan housing locations. The maximum contamination level reported for this survey was 10,000 dpm by direct measurement in the second floor ventilation supply duct. Swipes were taken at various locations within the ventilation system where direct measurements were taken. The swipes were counted for both alpha and beta-gamma activity. The results of the wipe samples were reported to be less than the minimum detectable activities for the counting equipment.

The major isotopes of concern are U-238, Th-232, Cs-137 and K-40.

Gamma dose rate readings were taken on both floors of the building. The average dose rate reading for the first floor was reported to be 5.6 uR/hr and for the second floor 3.9 uR/hr.

The building 65 layout for floors one and two are contained in Exhibit A.

III CONTRACTOR RELATIONSHIPS

A. Aluminum Company of America (ALCOA) Incorporated.

1. ALCOA will be the waste generator for the purposes of manifesting the

radioactive waste shipments.

2. ALCOA will retain title to the waste until it is disposed at an approved low level radioactive waste site.

B. Nuclear Energy Services/Integrated Environmental Services (NES/IES)

1. NES/IES will provide all personnel, equipment and other resources necessary to remediate the contaminated Building 65 ventilation system.

2. NES/IES will manifest all radioactive waste shipments in accordance with USNRC and Department of Transportation (DOT) regulations.

3. NES/IES on behalf of the Aluminum Company of America Inc., has the responsibility for safety during the remediation operations.

IV WORK PLAN CONTROL SYSTEM

All activities and tasks must be conducted in accordance with this work plan and/or the appropriate NES/IES procedures. The overall work plan will be prepared by the Project Manager and approved by the designated ALCOA representative and reviewed by the U.S. Nuclear Regulatory Commission.

Any major changes which involve the deletion or addition of tasks, adverse impact on scheduling, or possible creation of new or greater potential hazards must be approved by both the Project Manager and the NES/IES Radiological Services Department Manager. Major changes must be reviewed and approved by the ALCOA and U.S. Nuclear Regulatory Commission representative.

Minor changes to the work plan (i.e., reordering of specific steps, allowing simultaneous tasks to be performed) must be approved by the Site Supervisor and the Project Manager informed of the change.

All changes will be documented and attached to the work plan.

Implementation of changes will be entered into the project journal and the journal will be made available at all times at the work site for review.

V. PERSONNEL

A. Training

1. Health Physics Technicians will be trained to meet the requirements of ANSI/ANS 3.1-1981.

2. Decontamination Technicians will be provided radiation worker training, which will include the following topics:

   a. Fundamentals of Radiation and Radioactivity.

   b. Biological Effects of Radiation.

   c. Detection and Measurement of Radioactivity.

   d. Radiological Controls.

   e. Personnel Responsibilities.

   f. Emergency Response.

B. Plan of the Day

1. At the start of each day a work briefing will be conducted. This meeting will be administered by the Site Supervisor or his designee.

2. The purpose of this briefing is to review work that was performed the previous day, discuss potential problem areas, and ensure that everyone understands the tasks that are to be performed during the current day.

3. The briefing will be used to check the following:

   a. The necessary tools and equipment are available.

   b. Each worker knows how to perform their assigned tasks.

   c. Each worker understands the radiological conditions of the area in which they will be working.

C. Key Personnel

1. Project Manager - Frank E. Rebmann

2. Site Supervisor - Paul Terp

3. Radiological Services Department Manager - Dennis W. Reisenweaver

VI. RADIOLOGICAL PROTECTION

The Building 65 Remediation Project will be performed under the established radiological standards and requirements of 10 CFR Part 19, 10 CFR Part 20, NES/IES Health and Safety Plan, and the Radiological Control Plan

A Radiation Work Permit (RWP) is a means of providing the radiological conditions under which work in a radiologically controlled area will be performed. The RWP provides controls to ensure the work is accomplished in a radiologically safe manner while maintaining personnel exposure to radiation and radioactive contamination as low as reasonably achievable (ALARA).

The RWP will be prepared by the Health Physics Technician based on expected and surveyed conditions. The RWP will be approved by the Site Supervisor prior to the start of the task.

All personnel making an entry under an RWP shall comply with the requirements, instructions and precautions of the RWP. All personnel entering the controlled area will be monitored using a thermoluminescent dosimeter.

Exhibit B provides an example of a RWP.

VII. CONTAMINATION CONTROL

The Controlled Surface Contamination Area will be isolated from the general work areas through the use of radiation barrier rope and posted warning signs. A step-off pad will be placed at the entrance/exit point of each Controlled Surface Contamination Area and equipped with a frisker. Surveys for removable surface contamination will be performed daily within the area and in areas immediately outside the posted area. Contamination levels within the posted area will be maintained As Low As Reasonable Achievable.

Whenever the removable alpha and beta-gamma contamination level exceeds 100 dpm/100cm^2 the areas of elevated activity will be decontaminated and resurveyed.

A container will be provided for the disposal of contaminated clothing and waste near the step off pad. Personnel will wear protective clothing prior to entering the controlled area and during any operation where personnel contamination is likely. The degree of protective clothing required for the specific operation will be detailed in the appropriate RWP.

Personnel leaving the controlled area shall survey themselves (frisk) with the appropriate instrumentation prior to leaving the Controlled Surface Contamination Area. The Health Physics Technician will be contacted if it is determined that an individual has become contaminated. The permissible contamination level for personnel is defined in Section VIII.

All material leaving the controlled area will be surveyed to ensure that the item is either not contaminated or properly handled for either decontamination or disposal as radioactive waste.

During the ventilation system dismantlement containment enclosures will be constructed around each section to be cut. The containment will be constructed of plastic sheeting. Containment seams will be sealed with self adhering tape. Sufficient slack will be left in the containment to allow umbilical cutting during component separation. Portable ventilation will be used to provide negative air flow through the containment. This engineered technique will allow the severed sections to be separated under contained conditions, significantly reducing the potential for contamination release. All openings in associated line trunks will be covered prior to separation. Each removed section or component will be properly contained so as not to spread contamination and then lowered into the pre-established Controlled Surface Contamination Area for further survey and decontamination.

Areas such as small rooms or cavities where component containments would not be practicable, will be draped with plastic curtains and lay-down areas to prevent contamination spread to clean surfaces.

The specific containment scheme and contamination monitoring regimen will be specified on the appropriate RWP.

Airborne contamination may be generated during the course of the ventilation system remediation operations. Air samples will be taken with portable air sampling equipment

within the work areas at frequencies specified in the appropriate RWP. The air samples will also be used to verify the effectiveness of contamination control practices and to verify that the operation is not spreading contamination.

If air concentrations as a result of the work process exceed 1E-11 uCi/ml for alpha emitters, workers will be removed from the area. Portable ventilation will be used to lower the airborne activity to acceptable levels before work is allowed to continue. NES/IES will not use the protection factors available for filter respirators. MPC hours will be monitored and documented in accordance with 10 CFR Part 20, paragraph 20.103. Respirators may be worn as a precautionary measure during duct removal operations.

Respirator fit testing will be administered to all individuals required to wear a respirator. A qualitative fit test will be accomplished on-site using a challenge atmosphere (e.g., irritant smoke test). In addition to the fit test, negative and positive pressure tests will be performed by each individual each time a respirator is donned.

All personnel who have the potential for inhaling radioactive material in the course of this project will be given a bioassay (urinalysis) prior to and immediately after the conclusion of operations. All in-vitro samples will be analyzed by TMA/Eberline Analytical, Inc. Reports of the analysis results will be provided for inclusion in individual exposure records. The reported TMA/Eberline minimum detectable activity for Cs-137 and K-40 is 10 pCi/l. Th-232 and total Uranium is 0.3 pCi/l and 5 ug/l respectively. If through sample analysis any individual is suspected to have an internal deposition of radioactive material they will be further evaluated to determine a committed effective dose equivalent.

Procedures for irritant smoke or banana oil test are contained in Exhibit C.

Procedures for negative pressure test for tight fitting facepiece are contained in Exhibit D.

Procedure for monitoring for airborne radioactivity is contained in Exhibit E.

VIII. LIMITS FOR RELEASE OF EQUIPMENT, AREA AND PERMISSIBLE CONTAMINATION LEVEL FOR PERSONNEL

The results of surveys will be compared to the applicable acceptable surface contamination limits specified in Table 1 of the United States Nuclear Regulatory

The alpha and beta-gamma contamination limits for release of equipment and work areas for this project will be:

Removable contamination	200 dpm/100cm^2
Average fixed contamination	1000 dpm/100cm^2
Maximum fixed contamination	3000 dpm/100cm^2

Equipment and areas must also meet the NRC exposure rate limit criteria for unrestricted use of less than 5 uR/hr above background at one meter from the surface of the area or item.

The permissible contamination level for personnel are:

Alpha	Non Detectable
Beta-Gamma	< 1,000 dpm/100cm^2

IX. WORK TASKS

TASK 1- MOBILIZATION

This task includes:

- Travel of workers to the site.
- Receipt of materials and equipment.
- Stage equipment.
- Set up office.
- Familiarize personnel with site.
- Setup radiological instrumentation.
- Setup counting instrumentation in a low background area.
- Perform initial photographic survey for historical purposes.
- Train and present site orientation.

- Issue contractor's identification buttons.

TASK 2 - **VENTILATION EQUIPMENT REMOVAL**

This task includes:

- Removal of ductwork and fans for six ventilation supply systems, fifteen ventilation exhaust systems and two air conditioning systems.

  Prior to dismantling the ventilation system ducting, determine the radiological status of the particular section to be worked. Establish a Controlled Surface Contamination Area under or around areas containing contaminated equipment. Take beta-gamma surveys at system openings. Seal off open contaminated openings. Plastic sheeting secured with self adhering tape will provide adequate closure. Determine system severance locations and construct a containment enclosure around the section to be cut. Leave enough slack in the containment covering the severed sections to allow the formation of a sleeve umbilical as the severed sections are moved apart. Make the umbilical cut leaving each severed ventilation duct section sealed for removal.

  Where appropriate, portable ventilation will be used to further reduce the potential for contamination release from the ductwork during operations. The portable ventilation system may be installed up-stream of the section to be separated using the existing ventilation ducting. This will provide negative air flow at the point of separation and prevent back flow through the contaminated ducting.

  The specific containment scheme chosen i.e., temporary tent, curtain, drop cloth, or catch containment, and complimentary portable ventilation will be dependent upon the nature of the work to be performed, the potential for contamination release, and the location and size of the equipment to be worked. If powered equipment is to be employed, i.e., a saw-z-all, ensure that the containment will accommodate the cutting equipment as well as the equipment or area being cut.

!!!CAUTION!!!

Ensure that the system component is securely supported against swinging free or falling during the dismantling operation. Ensure that associated component parts will not become loose and fall.

Remove only those component supports necessary to allow sealing of severed sections. Install necessary rigging on severed component, make umbilical cut in containment to separate sealed ends, remove remaining component supports and lower component down to the RCA.

!!!CAUTION!!!

Use safe rigging techniques during system dismantling. If a section or section component is to be hand lowered, ensure that the weight can be safely supported by one individual.

Repeat the process until the contaminated systems or components are removed.

- Survey and decontaminate the removed equipment to levels acceptable for unrestricted release.

- Package all removed equipment which cannot be decontaminated and all wastes incident to the work process for shipment and disposal.

TASK 3 - **FINAL RELEASE SURVEY OF THE VENTILATION SYSTEM AND IMMEDIATE AREA**

This task includes:

- The performance of the final release survey ensures that the contaminated equipment has been removed and the immediate surrounding area meets the unrestricted release criteria. The survey results will be documented in accordance with established procedures.

- The survey results will be compared to the release limits. Areas exceeding the unrestricted release limits will be decontaminated and resurveyed.

The survey will be performed using the survey techniques of NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination" and not NUREG/CR-2082, "Monitoring for Compliance with Decommissioning Termination Survey Criteria".

The details of the final release survey of the ventilation system and immediate area are

as follows:

(1) A number of random survey locations will be established using a suitable marker on the walls, ceiling and floor.

(2) Each location will be scanned with a GM pancake probe for beta-gamma contamination. Areas of elevated activity will also be scanned for alpha activity. A smear will be taken at each identified location and counted first for removable alpha beta-gamma contamination. If any area or item exceeds the limits satisfied in Section VIII, the location will be noted for further remediation.

(3) The results of all surveys will be recorded on standard survey forms. All documentation will be viewed by the site supervisor for accuracy and completeness. Copies of the survey forms will be included in the final report.

(4) Approximately three weeks following site mobilization a detailed survey plan will be submitted which will describe how surveys will be conducted for remaining building areas.

Survey counting procedures are contained in Exhibit E.

TASK 4 - **PREPARATION/SHIPMENT OF WASTE**

This task includes:

- Package of all radioactive materials normal to the work process in approved shipping containers. Containers will be either B-25 boxes or 55 gallon drums or a combination of the two. Shipments will be made in accordance with 49 CFR, 10 CFR and the State of Utah requirements.

- Survey each disposal container and documentation of the survey results.

- Load radioactive waste material for shipment to the Clive, Utah facility of Envirocare of Utah, Inc.

- All records of contaminated and clean waste shipments will be turned over to the client.

- Clean waste will remain on the site for disposal by ALCOA.

TASK 5 - **SITE DEMOBILIZATION**

This task includes:

- Survey/dismantle all RCA's.
- Package and removal of all equipment brought to the site.
- Removal of all rubbish and debris generated by the work process.
- All workers return to their homes.
- Perform final photographic survey for historical purposes.

TASK 6 - **PREPARE FINAL REPORT**

This task includes:

- Preparation of the final report in Danbury and submitted to ALCOA.
- The final report will include records of all laboratory sample analyses, survey data, and summarize waste shipment and disposal information.

X. RADIOLOGICAL INSTRUMENTATION

The following table indicates the type of radiological detection instruments that will be used to monitor the radiological conditions during the ventilation system remediation operations. Calibration records will be available on-site for audit and review purposes.

Instrument	Use
Thermoluminescent Dosimeter	Total personnel exposure
Self Reading Pocket Dosimeter	Daily personnel exposure
SAIC/Radeco Hi Vol HV809	Routine air samples during ventilation system dismantlement and decontamination

Ludlum 2220 w/ 43-5 scintillation probe	Personnel and surface survey for alpha contamination
Ludlum 2221 w/44-9 GM probe	Personnel and surface survey for beta/gamma contamination
Ludlum 2929 phoswich detector	Alpha, beta/gamma smear counter
Bicron uR meter	General area Gamma surveys

XI SHIPPING AND DISPOSAL

A. Packaging

1. All material will either be wrapped in plastic, have contamination fixed, or be otherwise treated to ensure that loose contamination is not on the outside of the package when it leaves a contaminated area.

2. All material will be placed in the disposal containers such that damage to the confinement barrier will be minimized.

3. No liquids will be packaged for shipping and disposal.

B. Shipping

1. Shipments will be made in accordance with 49 CFR and 10 CFR requirements.

2. Shipments will be made by a certified carrier.

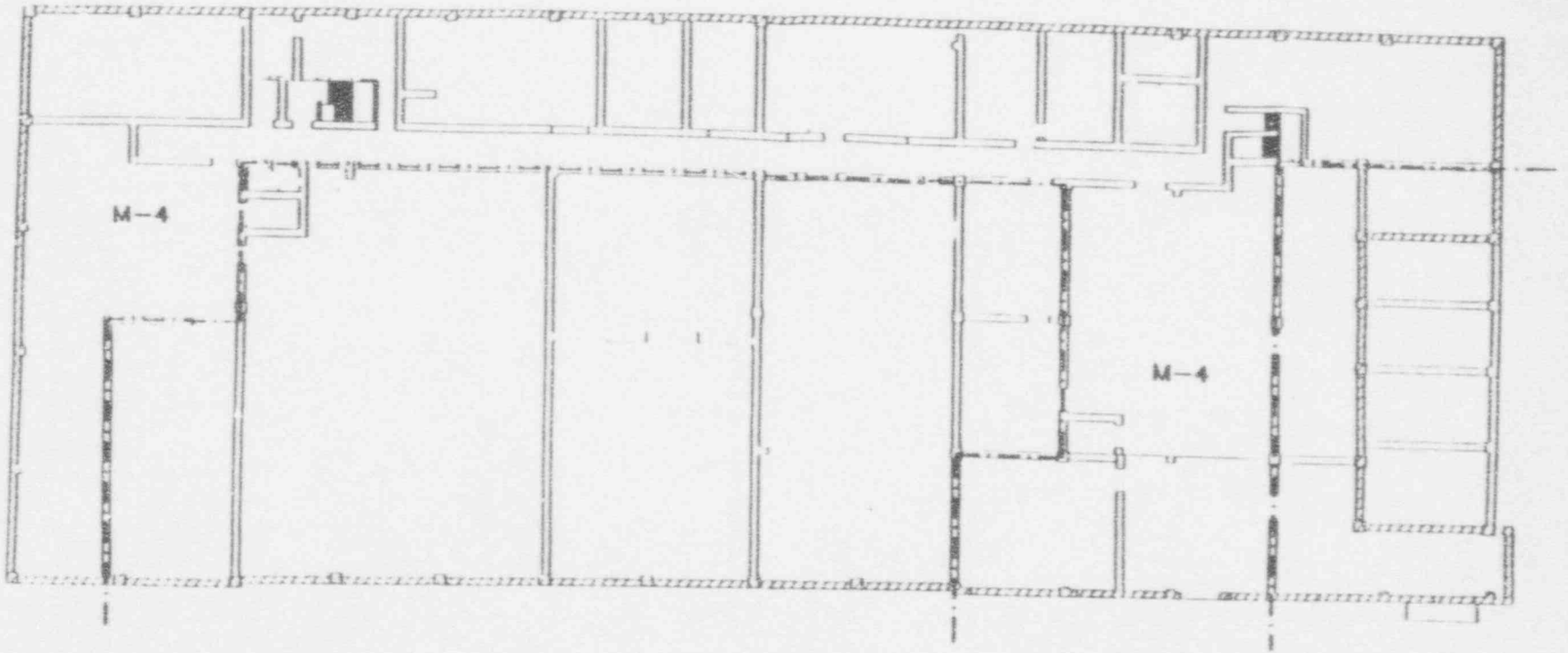
3. Containers will be either B-25 boxes or 55 gallon drums.

C. Disposal

1. All radiologically contaminated material will be disposed of at Clive, Utah facility of Envirocare of Utah Inc.

EXHIBIT A

BUILDING LAYOUT



APPROXIMATE SCALE FEET

0 30

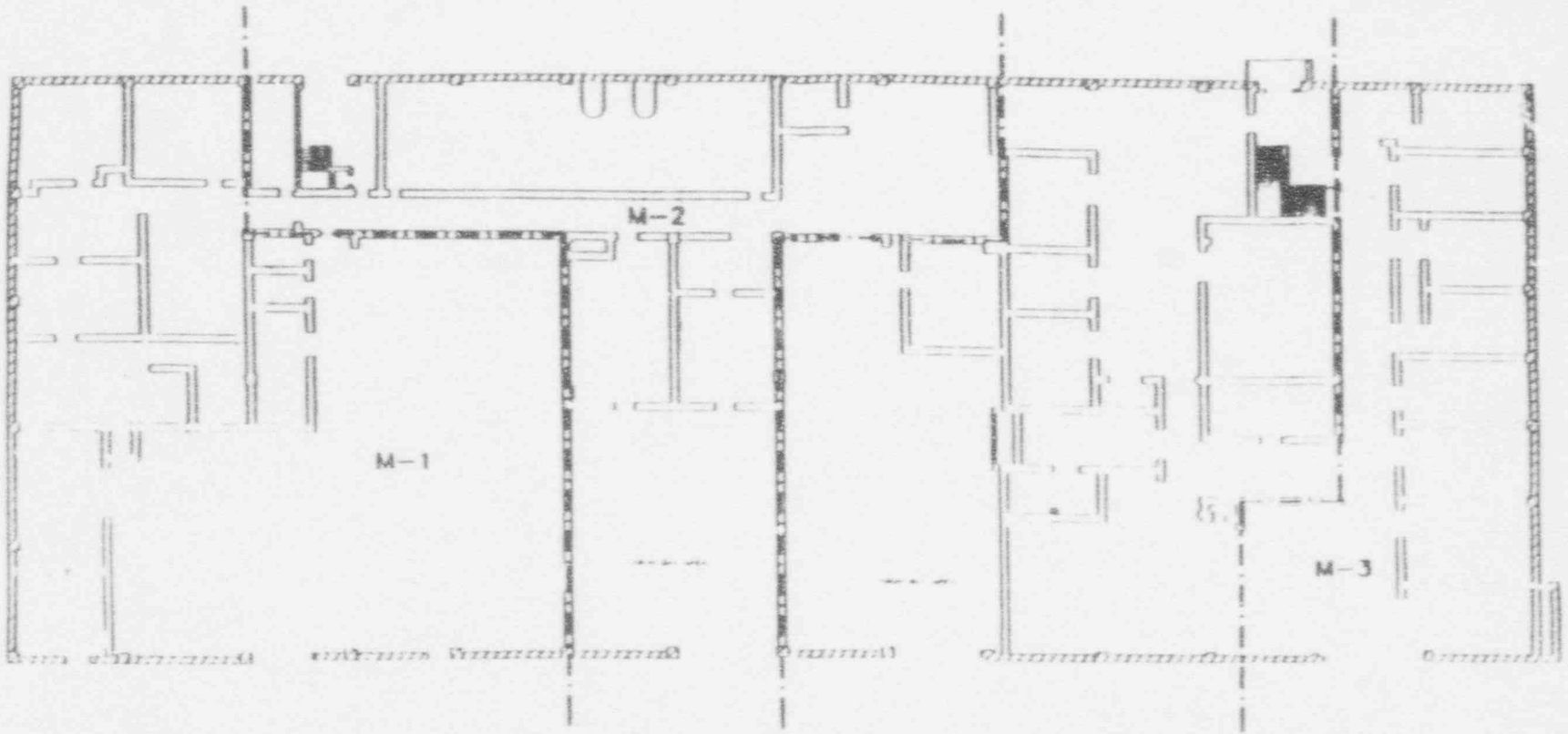
ALCOA CLEVELAND WO

Bld 65 2nd Floor

REFERENCE

ALCOA DRAWING NO 1105-SK-65-2
NOT DATED

ies



ALCOA CLEVELAND WO

Bld 65 1st Floor

REFERENCE

ALCOA DRAWING NO MJS-SK-65-2,
DATED

ies

EXHIBIT B

RADIATION WORK PERMIT

LOCATION			RWP NO
EQUIPMENT NAME/NUMBER	INITIATED BY	ESTIMATED PERSON HOURS	DATE IN FORCE
JOB DESCRIPTION (BE SPECIFIC)			DATE EXPIRES
			EST PERSON-REM
			TOTAL EXPOSURE-REM

RADIOLOGICAL CONDITIONS

GEN CONTAMINATION LEVEL pCi/100 cm2	MAX CONTAMINATION LEVEL pCi/100 cm2	GEN AREA RADIATION LEVEL MREM/hr	HOT SPOT RADIATION LEVEL REM/hr
AIRBORNE PARTICULATE ACT uCi/ml	GASEOUS ACTIVITY uCi/ml	RADIOIODINE ACTIVITY uCi/ml	TOTAL NO of M P C s

SURVEYED BY _____ DATE _____

RADIOLOGICAL PROTECTION SUPPORT

☐ INITIAL ☐ ON CALL ☐ INTERMITTENT ☐ CONTINUOUS

PROTECTIVE CLOTHING					
LAB COAT			COTTON GLOVES		
COVERALLS	1 pr ☐	2 pr ☐	RUBBER GLOVES - 1 pr ☐	2 pr ☐	
PLASTIC SUIT TOP			SURGICAL GLOVES		
PLASTIC SUIT BOTTOM					
PAPER COVERALLS			RESPIRATORY GEAR		
HOOD			FULL MASK FILTER		
FACE SHIELD			SUPPLIED AIR MASK		
RUBBER OVERSHOES			SUPPLIED AIR HOOD		
PLASTIC SHOE COVERS	HIGH		PAPER		
	LOW		SCBA		

NON-PROTECTIVE CLOTHING			
COTTON LINERS		SURGEON CAP	

DOSIMETRY	
FILM BADGE	
LOW RANGE DOSIMETER	
HIGH RANGE DOSIMETER	
DOSE RATE METER	
TLD BADGE	
NEUTRON METER	
NEUTRON BADGE	
MULTI-BADGE	
EXTREMITY	
TLD/RING - Left Hand	
TLD/RING - Right Hand	
FILM BADGE/TLD - Left Foot	
FILM BADGE/TLD - Right Foot	

SPECIAL INSTRUCTIONS

- ☐ TAPE GLOVES AND FOOTWEAR TO COVERALLS
- ☐ WEAR DOSIMETER ON INNER COVERALLS
- ☐ SET UP LOCAL CONTROL ZONE (Radiation or Contamination)
- ☐ WEAR DOSIMETRY ON HEAD
- ☐ AIRBORNE SAMPLE TO BE TAKEN AS SPECIFIED
- ☐ FIRE WATCH REQUIRED
- ☐ CONFINED SPACE ENTRY CONTROLS
- ☐ HARD HATS REQUIRED
- ☐ INDUSTRIAL HAZARD MITIGATION (SPECIFY)
- ☐ HEARING PROTECTION REQUIRED
- ☐ EYE PROTECTION REQUIRED
- ☐ FILTERED EXHAUST VENTILATION REQUIRED
- ☐ JOB PLAN MEETING
- ☐ ENCLOSED CONTAINMENT REQUIRED
- ☐ OUTER PERSONAL CLOTHING NOT TO BE WORN
- ☐ EVALUATE LOCATION OF WHOLE BODY DOSIMETRY
- ☐ RADIOLOGICAL OR HAZARDOUS CONDITIONS TO BE RE-EVALUATED AFTER WORK COMMENCES
- ☐ CHEMICAL HAZARD
- ☐ SCAFFOLDING SAFETY

RWP APPROVED DATE RCS	RWP APPROVED DATE SS	RWP CLOSE DATE RCS

1 DEACTIVATION ☐	2 ROUTINE MAINTENANCE ☐	3 SPECIAL MAINTENANCE ☐	4 WASTE - PROCESSING ☐	5 REFUELING INSPECTION ☐	6 INSERVICE INSPECTION ☐

RADIOLOGICAL WORK PERMIT PERSONNEL ENTRY

Sheet ____ of ____

Rev. ____

Date ____

Rwp. No. ____

Work Location	Badge Number	IN		OUT		Dose (mR)	IN		OUT		Dose (mR)
		Time	Dosimeter (mR) / Stay Time	Time	Dosimeter (mR)		Time	Dosimeter (mR) / Stay Time	Time	Dosimeter (mR)	
Name											
Name											
Name											
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Name											

EXHIBIT C

IRRITANT SMOKE OR BANANA OIL TEST

EXHIBIT C

IRRITANT SMOKE OR BANANA OIL TEST

This test is to be administered by a Health Physics Technician or Site Supervisor in a well ventilated area. The Isoamyl Acetate (banana oil) test requires organic vapor cartridges to be installed on the mask.

1. Instruct the individual to take shallow breaths at first and keep his eyes closed.

2. Direct smoke from the tube or swab dipped in banana oil toward the sealing surfaces of the mask starting at approximately one foot from the seal.

3. If no odor or irritation is detected, move the smoke tube or swab to within two inches from the facepiece. Ensure all sealing areas and points of possible leakage are tested.

!!!! CAUTION !!!!

The smoke (stannic chloride) is highly irritating. If the subject shows any indication of irritation, stop the test immediately.

4. If the test is used in lieu of a quantitative fit test, continue as follows:

   a. Instruct the wearer to breath deeply.

   b. Continue to direct smoke or the swab toward the facepiece while the wearer performs the following: repeated deep breathing; turning head side to side/up and down; frowning; talking; and running in place.

   c. Recheck the seal at normal breathing rate.

5. If the wearer detects an odor or irritation, readjust the facepiece and repeat the process.

6. If no leakage is detected by the wearer, the fit is acceptable.

EXHIBIT D

NEGATIVE PRESSURE TEST FOR TIGHT FITTING FACEPIECE

EXHIBIT D

NEGATIVE PRESSURE TEST FOR TIGHT FITTING FACEPIECE

This test is to be performed by the wearer for each issue of a tight fitting facepiece respirator prior to use.

1. Inspect the mask and don as required by the use procedure for that device.

2. Ensure that the mask is worn such that it affords maximum comfort. Straps adjusted too tight can cause headaches or irritation when worn for extended periods.

3. When the mask is in place and adjusted for wearer comfort, perform the negative pressure test as follows:

   a. Place the palms on the canisters or breathing inhalation ports.

   b. Inhale gently so that the mask collapses inward toward the face. If any leakage is detected around the facepiece, readjust the mask and repeat.

   c. If no leakage is detected during inhalation, hold your breath for 10 seconds checking for leakage. If there is still no detectable leakage, the test is acceptable.

   d. Remove palm(s) from the inhalation ports of the cartridge or inlets.

4. If after approximately three attempts a fit cannot be obtained, notify the Health Physics Technician or the Site Supervisor for assistance and/or get another respirator.

EXHIBIT E

COUNTING PROCEDURES

FINAL SURVEY PROCEDURE

Project Application	Copy No	Assigned To

APPROVALS

REV NO	PREPARED BY	Dept.Manager			
0					
1	Eric W. Abelquist		9/27/02		
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

NES

REVISION LOG

NUCLEAR ENERGY SERVICES, INC.

DOCUMENT NO. 82A8021

REV NO.	DATE	PAGE NO	DESCRIPTION	APPROVAL
1	9/24/92	4,5,6	See CRA 8462 - incorporated UCLA comments	
		8,9,10		
		Attach.		
		5		

TABLE OF CONTENTS

1. PURPOSE

The object of this procedure is to outline the required actions to be taken by Nuclear Energy Services (NES) in performing the final radiological survey. This procedure will ensure that standardized survey techniques are employed and ensures the comparability of data.

2. RESPONSIBILITIES

2.1 SITE MANAGER

It is the responsibility of the Site Manager to ensure overall implementation of the final survey and this procedure.

2.2 RADIOLOGICAL CONTROLS SUPERVISOR (RCS)

It is the responsibility of the Radiological Controls Supervisor to review all documented survey data resulting from the final survey. The RCS shall ensure that all documentation is complete and properly filed. He shall also ensure that the methods for data collection used during the survey are correct for the type of measurement or sampling being performed.

2.3 RADIOLOGICAL CONTROLS TECHNICIAN

It is the responsibility of the Radiological Controls Technician performing the final survey to do so in accordance with this procedure and related procedures as referenced herein.

3. PROCEDURE

3.1 GENERAL

3.1.1 This procedure outlines the survey methodology to be used by NES in performing the final radiological survey.

3.1.2 The survey techniques discussed herein are those used to satisfy the requirements of NUREG/CR-2082 for license termination surveys. The survey techniques are necessary to ensure that our decontamination efforts have been sufficient to remove residual contamination in excess of the criteria in Table 1 (Ref. 5.2). A 100% scan survey (Section 3.5) will significantly reduce the probability of missing contamination levels above the release criteria. ⚠1

3.2 PREREQUISITES

3.2.1 As a rule of thumb, general area background for a pancake GM probe should not exceed 60 cpm. 1

3.2.2 Daily source check determinations will be made for beta-gamma and alpha probes. Efficiencies and the minimum detectable activities (MDAs) will be calculated daily for instrumentation used in the final release survey. 1

3.2.3 Instrument calibrations must be current for all equipment used in the final survey.

3.2.4 Areas to be surveyed will be divided into a predetermined grid pattern, typically measuring 1m on a side. The grids will be clearly marked using a standard surveyor's alphanumeric system for easy identification. A 100% surface scan will be performed for ceilings and wall surfaces above 2m. 1

3.2.5 Surveys will be performed by ANSI/ANS-3.1 (Ref. 5.5) qualified Radiological Controls Technicians.

3.3 EQUIPMENT

3.3.1 Survey Meters

* Eberline ESP-1
* Ludlum Model 2220/2221
* Ludlum Model 3
* Ludlum Model 19 Micro-R meter
* Bicron Micro-Rem meter

3.3.2 Probes

* Ludlum 44-40 shielded pancake GM probe
* Ludlum 44-9 pancake GM probe
* Eberline AC3 alpha probe

3.3.3 Counting Equipment

* Ludlum Model 2929 alpha and beta-gamma counter
* Packard 2500 TR liquid scintillation counter

3.4 DETERMINATION OF BACKGROUND RADIATION

An accurate determination of the background radiation level must be determined prior to the final release survey. The background sampling areas shall be selected so that they closely resemble the facility, yet are not affected by radioactive material used at the facility.

The determination of the background radiation level is based on the assumption that the natural logarithms of sufficient background measurements fit a normal distribution. The background radiation level, B, in μRem/h is estimated from the following expression (Ref. 5.4):

$$B = \exp\left[\left(\overline{\log x} + 1.28\,\frac{n-1}{n}\,s\right)\right],$$

Where:

$$\overline{\log x} = \left(\sum_{k=1}^{n} \log x_k\right)/n \qquad \text{(Sample Mean)},$$

x_k = Background measurement (μrem/h), and

n = Number of measurements.

The sample standard deviation, s, is given by:

$$s = \frac{\left[\sum_{i=1}^{n} \left(\overline{\log x} - \log x_i\right)^2\right]^{1/2}}{n-1}.$$

The Bicron Micro-Rem meter or equivalent, will be used to obtain the background radiation level measurements.

3.5 SURFACE SCAN SURVEY TECHNIQUE

3.5.1 Using a pancake GM or a gas proportional floor monitor, the detector will be moved slowly across the surface. The speed of probe movement is typically 5-7 cm per second. The probe should come within 1/2" of the surface being surveyed.

3.5.2 Increases in count rate will be noted as indicated by the audible meter output and by observing the scale. Typically, count rates 2–4 times the background are indicative of contamination or radionuclide concentrations exceeding allowable levels. If using a large area probe (hand held or floor monitor), the pancake probe will be used to isolate the location of a hot spot. Check hot spots with ZnS detector for presence of alpha contamination.

3.5.3 Areas of increased count rate will be marked using chalk, tape or grease pencil for easy identification.

3.5.4 The locations and levels of elevated radiation shall be recorded on the appropriate survey form (Attachment 1).

3.5.5 Gross smears will be field counted for alpha and beta–gamma using available portable survey instruments.

3.5.6 Hot spots will be decontaminated and resurveyed.

3.6 FIXED CONTAMINATION SURVEY TECHNIQUE

3.6.1 Fixed contamination levels will be measured for alpha and beta–gamma.

3.6.2 Five, uniformly spaced, 30 second counts will be taken, as shown in Attachment 2, to determine the average beta–gamma contamination levels. These measurements will be documented on the survey form (Attachment 3). Direct alpha contamination measurements will be taken at the same locations if warranted by the scan survey and past operating history.

3.6.3 If a hot spot (area of increased count rate) is found during the surface scan, the location of the hot spot will be used as one of the five measurements.

3.6.4 Fixed beta–gamma measurements will be made using a Ludlum 2221 (or equivalent) in the scaler mode with a pancake probe. The pancake probe will be placed on the survey spot and counted for 30 seconds.

3.6.5 Alpha fixed contamination measurements will be made in the same way utilizing the ESP–1 or equivalent in the scaler mode.

3.7 REMOVABLE CONTAMINATION SURVEY TECHNIQUES

3.7.1 A removable contamination survey will be performed. The number of smears to be taken will depend on the size of the areas being released.

3.7.2 100 cm^2 smears will be taken at the location of the highest beta-gamma direct reading within each grid, as well as at two of the remaining four direct reading locations.

3.7.3 Smears will be marked and taken to the count lab as soon as possible for alpha and beta-gamma analysis.

3.7.4 A liquid scintillation counter will be used to count one of the smears from each grid for low energy beta emitters. ⚠1

3.7.5 The results of the field count and/or the laboratory analysis will be entered onto the survey form (Attachment 4).

3.8 EXPOSURE RATE MEASUREMENT TECHNIQUES

3.8.1 Exposure rate measurements will be made using a Bicron Micro-Rem meter, or equivalent.

3.8.2 Two exposure rate measurements will be made for each of the floor grids. The measurements are usually made at the center of each survey block.

3.8.3 The exposure rate measurements will be taken at approximately one centimeter and one meter above the surface. ⚠1

3.8.4 Exposure rate will be recorded on the survey sheet in microrem per hour (Attachment 5).

NOTE: In small areas such as closets, lavatories, etc., only one exposure rate measurement is necessary.

3.9 DOCUMENTATION

3.9.1 All field data will be logged directly onto the appropriate survey form.

3.9.2 Large objects remaining within the facility will be surveyed individually, and documented on the appropriate survey forms.

3.9.3 Field measurements in counts per minute (cpm) shall be converted to disintegration per minute (dpm) to satisfy the release criteria.

The formula:

$$\text{dpm}/100\text{cm}^2 = \frac{\text{gross cpm} - \text{background cpm}}{\text{efficiency} \times \text{probe area}/100\ \text{cm}^2}$$

is used to convert counts per minute for a specified probe area to disintegrations per minute per 100cm². The probe area divided by 100 cm² is a normalizing factor used to convert direct readings to dpm/100cm². 1

3.9.4 The minimum detectable activity (MDA) will be calculated for each instrument (e.g., L2221, L2929) used in the final release survey. The MDA is based on a 5% probability of non-detection. That is, a 5% probability exists of concluding that there is no activity, when activity really exists. The equation for MDA is given by (Ref. 5.6):

$$MDA = \frac{2.71/T_s + 3.29\sqrt{R_B/T_B + R_B/T_s}}{\text{efficiency}},$$

Where:

R_B = background counting rate (cpm)

T_B = background count time (min)

T_s = sample count time (min)

If the background and sample count times are equal and neglecting the first term ($2.71/T_s$), the equation becomes:

$$MDA = \frac{4.65\sqrt{R_B/T_B}}{\text{efficiency}}.$$

4. RECORDS

4.1 All original survey forms will be reviewed and retained by the Radiological Controls Supervisor in the NES office, until job completion when they will be turned over to the client.

4.2 A folder will be maintained for each area surveyed. A survey map convention will be provided with each folder to facilitate grid identification.

4.3 A copy of all survey data will be kept at the job site and retained by NES.

5. REFERENCES

5.1 NUREG/CR-2082, "Monitoring For Compliance with Decommissioning Termination Survey Criteria."

5.2 NRC Regulatory Guide 1.86 – Termination of Operating Licenses for Nuclear Reactors.

5.3 NES Procedure 82A8033, Surface Contamination Program.

5.4 R. W. Leggett, et. al., "A Statistical Methodology for Radiological Surveying," June 1978.

5.5 ANSI/ANS-3.1, "American National Standard for Selection, qualification and Training of Personnel for Nuclear Power Plant," 1981.

5.6 L. A. Currie, "Limits for Qualitative Detection and Quantitative Determination," 1968.

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[b,c]	MAXIMUM[b,d]	REMOVABLE[b,e]
U–nat, U–235, U–238, and associated decay products	5,000 dpm α/100 cm²	15,000 dpm α/100 cm²	1,000 dpm α/100 cm²
Transuranics, Ra–226, Ra–228, Th–230, Th0228, Pa–231, Ac–227, I–125, I–129	100 dpm/100 cm²	300 dpm/100 cm²	20 dpm/100 cm²
Th–nat, Th–232, Sr–90, Ra–223, Ra–224, U–232, I–126, I–131, I–133	1000 dpm/100 cm²	3000 dpm/100 cm²	200 dpm/100 cm²
Beta–gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr–90 and other noted above.	5000 dpm βγ/100 cm²	15,000 dpm βγ/100 cm²	1000 dpm βγ/100 cm²

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

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

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

[d] The maximum contamination level applies to an area of not more than 100 cm².

[e] The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of know efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

ATTACHMENT 1

ELEVATED READINGS CONTAMINATION RESULTS

DATE: _____ LOCATION: _____

INSTRUMENT: _____ PROBE: _____ EFF: _____
Model

PRE-DECONTAMINATION RESULTS			POST-DECONTAMINATION RESULTS		
GRID NUMBER	CPM	dpm/100cm ^{2}	GRID NUMBER	CPM	dpm/100cr

Average background counts per min. _____

NOTE: DPM/100 cm^2 calculated as follows:

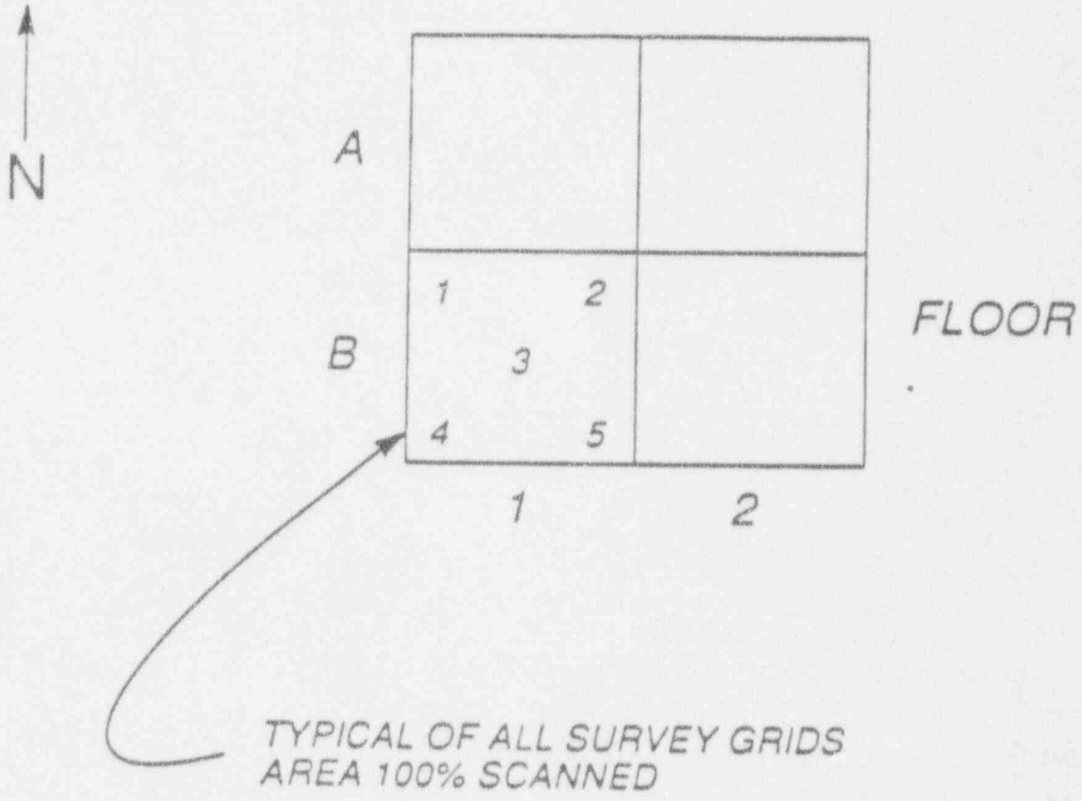
$$\frac{\text{dpm}}{100\text{cm}^2} = \frac{(\text{gross count rate}) - (\text{background count rate})}{(\text{efficiency})\ \frac{(\text{probe area})}{100\text{cm}^2}}$$

SURVEYOR _____

SUPERVISOR _____

ATTACHMENT 2

TYPICAL RELEASE SURVEY COVER SHEET



ATTACHMENT 3

AVERAGE CONTAMINATION SURVEY RESULTS

dpm/100cm^2

DATE: ______________________ LOCATION: ______________________

INSTRUMENT: ______________________ PROBE: ______________ EFF: ______________

Model Number Model

GRID NUMBER ____	GRID NUMBER ____	GRID NUMBER ____	GRID NUMBER ____
1. ____	1. ____	1. ____	1. ____
2. ____	2. ____	2. ____	2. ____
3. ____	3. ____	3. ____	3. ____
4. ____	4. ____	4. ____	4. ____
5. ____	5. ____	5. ____	5. ____
$\bar{X}$ ____	$\bar{X}$ ____	$\bar{X}$ ____	$\bar{X}$ ____

GRID NUMBER ____	GRID NUMBER ____	GRID NUMBER ____	GRID NUMBER ____
1. ____	1. ____	1. ____	1. ____
2. ____	2. ____	2. ____	2. ____
3. ____	3. ____	3. ____	3. ____
4. ____	4. ____	4. ____	4. ____
5. ____	5. ____	5. ____	5. ____
$\bar{X}$ ____	$\bar{X}$ ____	$\bar{X}$ ____	$\bar{X}$ ____

GRID NUMBER ____	GRID NUMBER ____	GRID NUMBER ____	GRID NUMBER ____
1. ____	1. ____	1. ____	1. ____
2. ____	2. ____	2. ____	2. ____
3. ____	3. ____	3. ____	3. ____
4. ____	4. ____	4. ____	4. ____
5. ____	5. ____	5. ____	5. ____
$\bar{X}$ ____	$\bar{X}$ ____	$\bar{X}$ ____	$\bar{X}$ ____

Average Background counts per minute ______________

NOTE: Results recorded in DPM/100cm^2 using the formula:

$$\frac{\text{dpm}}{100\text{cm}^2} = \frac{(\text{gross count rate}) - (\text{background count rate})}{(\text{efficiency}) \ \frac{(\text{probe area})}{100\text{cm}^2}}$$

SURVEYOR ______________________

SUPERVISOR ______________________

ATTACHMENT 4

REMOVABLE CONTAMINATION

DATE: _____ LOCATION: _____

COUNTER: _____ EFFICIENCY: _____

Model Number Alpha Beta/Gamma

SMEAR#	DPM/100cm² βγ	α	SMEAR#	DPM/100cm² βγ	α	SMEAR#	DPM/100cm βγ	α

PHA BKG COUNT RATE: _____

BETA/GAMMA BKG COUNT RATE: _____

SURVEYOR _____

SUPERVISOR _____

ATTACHMENT 5

EXPOSURE RATE SURVEY RESULTS

DATE: _____ LOCATION: _____

INSTRUMENT: _____

GRID NUMBER	EXPOSURE RATE µrem/h		GRID NUMBER	EXPOSURE RATE µrem/h	
	1cm	1m		1cm	1m

MEASUREMENTS TAKEN AT 1cm and 1m ABOVE THE FLOOR.

SURVEYOR _____

SUPERVISOR _____

AIRBORNE RADIOACTIVITY PROGRAM

UNCONTROLLED COPY

Project Application	Copy No.	Assigned To
GENERIC		

APPROVALS

TITLE / DEPT. - SIGNATURE - DATE

REV NO	PREPARED BY	REVIEWED BY PROJ. MGR.	APPROVED BY DEPT. MGR.		
0					
1	Eric Abelquist				
2	Eric Abelquist 4/24/92		4/24/92		
3					
4					
5					
6					
7					
8					
9					
10					
11					

NES

REVISION LOG

NUCLEAR ENERGY SERVICES, INC.

DOCUMENT NO. 82A8037

REV NO.	DATE	PAGE NO.	DESCRIPTION	APPROVAL
1	8/21/92	-	Pages are marked with triangle blocks per CRA 8427	
2	10/16/92	6	CRA 8486 - incorporated Field Change 001 into the procedure.	

TABLE OF CONTENTS

1. INTRODUCTION

1.1 SCOPE

This procedure specifies the methods to be employed for maintaining concentrations of airborne radioactivity below established limits. This procedure shall be employed by Nuclear Energy Services (NES).

1.2 GENERAL BACKGROUND INFORMATION

Airborne radioactivity is the presence of radioactive particles or gases in the air. Control of airborne radioactivity is necessary to limit the internal radiation exposure that can result from the inhalation of radioactive material.

The respiratory protection program is the responsibility of the Radiological Controls Supervisor. The Radiological Controls Technicians implement the program. Although airborne radioactivity is not expected to exceed the concentrations permitted by 10CFR20, Appendix B, Table II, respiratory protection requirements and use is discussed.

Airborne radioactivity concentrations shall be minimized to the extent practicable by the use of engineered controls (containment, ventilation, etc.). When establishing radiological controls for work involving potential airborne radioactivity, the first consideration should be to use techniques which will prevent airborne radioactivity and maintain loose surface contamination in controlled areas to as low as reasonably achievable levels.

1.3 REFERENCES

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

2. NES, "Surface Contamination Program.

3. L.A. Currie, "Limits for Qualitative Detection and Quantitative Determination," 1968.

2. LIMITS FOR AIRBORNE RADIOACTIVITY

2.1 FEDERAL LIMITS

Radionuclide concentrations in air are the limited by the Code of Federal Regulations, Title 10, Part 20 (10 CFR 20), for work in controlled areas. Exposure for 40 hours per week throughout the year to any of these concentrations will be approximately equivalent to 5 rem per year of whole body radiation exposure.

3. MONITORING FOR AIRBORNE RADIOACTIVITY

3.1 ROUTINE AIR SAMPLING

3.1.1 Sampling Techniques

Routine air samples shall be collected with a both low and high volume portable air samplers with appropriate filter papers. High volume air samplers will be run for a minimum of 5 minutes and low volume air samples for a minimum of 10 minutes for adequate collection, as determined by the Radiological Controls Supervisor.

Personnel (lapel) air samplers will be used, as required, when deemed necessary by the Radiological Controls Supervisor.

The sampler head shall be placed as close to the work area as possible and within the breathing zone of the workers in order to best collect a sample that is representative of the air that the workers are breathing. The location for air samples shall be based on the type of work being performed (e.g., grining) and the containment enclosure arrangement used. The radiological controls supervisor will ensure that the air sample is collected from the proper location.

Care should be taken to avoid contamination of the air sampler or filter while in use. Such contamination would be falsely interpreted as airborne contamination.

3.1.2 Sampling Frequencies

The frequency for air sampling will conform to the following:

1. At least every four hours in occupied spaces, if the air particle detector in that space is required to be operative but is inoperative.

2. At least every four hours in (1) radiological facilities when radioactive work is performed, (2) during radioactive work which has been known to cause or is expected to cause airborne radioactivity, and (3) in occupied areas where surface contamination exceeds the limits of Reference 3. These portable samples are not required if continuous monitoring is performed. Continuous monitoring shall be performed according to an approved procedure. If the installed continuous air particle detector for a ventilation exhaust is inoperative and radioactive work is being performed, portable sampling every four hours is required.

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

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

5. Whenever airborne radioactive levels above the limit of Section 2 are suspected .

3.1.3 Counting Air Samples

2

The air samples will be counted on the smear counter (e.g., Ludlum 2929 or equivalent) to determine gross alpha and beta/gamma airborne radioactivity levels. Air sample results will be entered onto the Air Sample Log Sheet (Figure 2) and the Gross Alpha/Beta Analysis of Air Particulates Analysis Data Sheet (Figure 3).

The minimum detectable count rate (MDCR) is the smallest count rate that has a 95% probability of being detected. The minimum detectable concentration (MDC) is the MDCR corrected by the factors needed to convert sample counts per minute (cpm) to concentration units. Both the MDCR and MDC will be calculated as illustrated in Figure 1 and recorded on the data sheet in Figure 3.

The quantity of self-absorption by the air sample filter depends on the type of radiation involved, the type of filter used, and the quality of the air being sampled. The conversion factor on the Analysis Data Sheet in Figure 3 assumes an alpha self-absorption factor of 1.5. That is, the measured activity concentration is

increased by a factor of 1.5 due to the expected absorption of alpha particles within the air sample filter. No significant self–absorption is assumed to occur for beta/gamma emitters.

3.2 ENVIRONMENTAL SAMPLING

NES shall monitor and record airborne particulate radioactivity by using a portable air sampler. The frequency of air sampling shall be as necessary.

NES shall use a regulated air sampler (e.g., Eberline RAS–1,), or equivalent, with 47mm glass fiber filter paper for environmental monitoring.

NES shall count the sample filters using a low background gas proportional counter, or gamma spectrometry system, depending on the type of analysis needed.

3.3 RECORDS AND REPORTS

All records of airborne radioactivity surveys required by the Airborne Radioactivity Program shall be maintained neatly, retained by NES and turned over to the client at the end of the job. In addition, copies of all records will be provided to the client's representative, as appropriate. These records shall include at least the following information:

A. Date and time of measurement.

B. Location

C. Reason for measurement.

D. Instrument used or equivalent

E. Results of most recent response check and background radiation level when survey meters are used for measuring portable samples

F. Airborne radioactivity in µCi/ml.

G. Remarks.

H. Signature of surveyor.

I. Signatures of persons reviewing records

A report of any incident involving high airborne radioactivity other than fallout or natural background in areas occupied by personnel not wearing respiratory equipment shall be sent

to the client within ten days. The incident will be investigated as to the cause of the high airborne, immediate actions taken, methods to prevent a future occurrence, and results of internal monitoring of personnel involved.

An incident report shall also be conducted in cases where workers are exposed to concentrations of airborne radioactivity which exceed the protection provided by respiratory protection equipment being worn.

3.4 CALIBRATION

The calibration of the air sampling equipment will be done in accordance with the appropriate operation and maintenance manual, or an approved procedure.

The calibration/re-calibration of the air sampling equipment will be done annually and after instrument repair by a RCT.

NES will maintain calibration certificates as part of the permanent project file.

4. CONTROLLING AIRBORNE RADIOACTIVITY

4.1 PERSONNEL EXPOSURE

Personnel exposure to airborne radioactivity is controlled using contamination containments, ventilation systems, and respiratory equipment. When working in areas with high levels of surface contamination (e.g., 22,000 dpm/100 cm^2 beta/gamma or 1100 dpm/100 cm^2 alpha) respiratory equipment will be used because of the likelihood that this surface contamination could become airborne. This requirement may be waived depending on the radiological conditions by agreement of the Radiological Controls Technician and Radiological Controls Supervisor.

Contamination containments shall be used to the maximum extent practicable to prevent personnel from being exposed to airborne radioactivity above the limits of Section 2.1. These containments are required during radioactive work which has been known to cause or is expected to cause airborne radioactivity.

Personnel shall wear respiratory equipment in accordance with Section 4.2 in areas where airborne radioactivity exceeds the applicable limit of Section 2.1.

Signs shall be posted at entrances to areas where respiratory equipment is required. This requirement to wear respiratory equipment also shall be included on a sign with the anti-contamination clothing requirements.

When personnel not wearing respiratory equipment are likely to be exposed to airborne radioactivity above a limit in Section 2.1, a ventilation system shall be operated which will remove airborne particulate radioactivity to a controlled ventilation system or other system with a high efficiency filter. For example, during such operations as machining contaminated surfaces, vacuum cleaners fitted with high efficiency filters, portable exhaust blowers fitted with high efficiency filters, or flexible ducts connected to a filtered ventilation exhaust shall take suction from within about one foot of the work. Experience has shown that some operations within containments, such as grinding on highly contaminated components, require exhausting the containment through a ventilation system with an installed high efficiency filter, such as by using a vacuum cleaner, to prevent high airborne radioactivity outside the containment.

High efficiency particulate air (HEPA) filters shall be installed in the ventilation exhaust from radiological facilities in which work which could cause airborne radioactivity is in progress to prevent discharge of airborne radioactivity to the environment.

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

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

HEPA ventilation exhaust filters are not required if all radioactive work that could cause airborne radioactivity greater than a limit of Section 2.1 is performed within a contamination containment enclosure.

Monitoring for airborne radioactivity shall be performed in accordance with Section 3.1.

As shown in Table 1 (Ref. 2), full–face filtered air respirators will be worn by personnel when the alpha airborne concentration is greater than 1E-11 µCi/ml or when the beta/gamma airborne concentration is greater than 1E-10 µCi/ml.

Full–face supplied air respirators or hoods will be worn by personnel when the alpha airborne concentration is greater than 5E-10 µCi/ml or when the beta/gamma airborne concentration is greater than 5E-9 µCi/ml.

Personnel will not be allowed to enter into areas when the alpha airborne concentration is greater than 2E-6 µCi/ml or when the beta/gamma airborne concentration is greater than 2E-7 µCi/ml.

If personnel entry is required to these areas, containment or filtered ventilation will be used to reduce airborne radioactivity levels to below 1,000 times the limit of Section 2.1.

4.2 RESPIRATORY PROTECTION

4.2.1 General

NES management personnel who have subordinate personnel working in controlled areas are responsible for maintaining concentrations of airborne radioactivity below the established limits in Section 2. The RCT will provide technical direction in placement and type of continuous and periodic air sampling equipment required to detect and evaluate the levels of airborne radioactivity in work areas.

The respiratory protection program is the responsibility of the Radiological Controls Supervisor (RCS). The RCS' responsibility is to implement the program. Respiratory protection equipment requirements will be specified.

Airborne radioactivity concentrations shall be minimized to the extent practical by the use of engineered controls (containment, ventilation, etc.). When establishing radiological controls for work involving potential airborne radioactivity, the first consideration should be to use techniques which will prevent airborne radioactivity and maintain loose surface contamination in controlled areas to as low as reasonably achievable levels.

4.2.2 Wearing Respiratory Protective Equipment

When airborne radioactivity concentrations exceed the limits in Section 2.1, respiratory equipment must be used to protect personnel. The protection factor for a full–face filtered air respirator is 50. As shown in Table 1, full–face filtered air respirators will not be worn in airborne concentrations greater than 50 times the alpha or beta–gamma limit.

In situations where airborne concentrations of radioactive material exceeds the stated concentration guides for filtered air respirators in Table 1, the supplied air respirator will be used. An air supply system will be used by NES to provide breathing air. As shown in Table 1, supplied air respirators will not be worn in airborne concentrations greater than 2,000 times the alpha or beta–gamma limit. The protection factor for particulates, gases, and vapors afforded by a continuous flow or pressure demand, full–face supplied air respirator is 2,000.

As shown in Table 1, no other respiratory equipment will be used at airborne concentrations 2,000 times the limit of of Section 2.1.

All respirators will meet NIOSH/MSA approval.

4.2.3 Respiratory Protection Maintenance Program

All respirators will be maintained in accordance with the manufacturer's recommendations for repairs, cleaning, and disinfection.

All respirators and auxiliary equipment will be surveyed after cleaning by a RCT prior to packaging for issue. All respirators will be decontaminated by an RCT prior to packaging.

Prior to packaging a respirator, the RCT will inspect the respirator for damage and will seal it in a plastic bag for personnel issue.

The RCS will issue respirators only to respirator qualified personnel.

The air supply system will be inspected by the RCT prior to use.

4.2.4 Respiratory Protection Training Program

Training is provided to all respirator users and individuals who direct the work of users in respirators. The training is conducted by NES.

The individual conducting the respiratory protection program training is a qualified and experienced instructor with a thorough knowledge of the application and use of respiratory protective equipment and the hazards associated with radioactive airborne contaminants and experience in selection and use of respirators.

The training is provided annually at appropriate times to maintain a high degree of proficiency. Training and fitting records will be maintained by Radiological Controls personnel.

4.3 USE OF HIGH EFFICIENCY PARTICULATE AIR FILTER

Systems containing high efficiency particulate air (HEPA) filters shall be at least 99.95% efficient for filtration of 0.3 micron dioctylphthalate (DOP) particulates.

HEPA filters shall be 99.97% efficient.

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

A. HEPA filters shall be purchased to specifications at least equivalent to Military Specification MIL-F-51068 series, "Filter Particulate, High Efficiency, Fire Resistant".

B. The HEPA filters are fragile. Any penetration of the media is a direct opening from one side of the filter to the other. Therefore, HEPA filters shall be handled carefully.

C. Great care shall be used in installing HEPA filters to ensure the filter material separators are in the vertical position, tight seals are made around the edges of the filters, and that filters are not damaged during installation.

D. Because slight damage can greatly reduce their efficiency, HEPA filters shall be inspected before installation by careful visual examination. After installation, the filter system shall be tested and be equal to or greater than 99.95% efficient for 0.3 micron particles.

E. Installed HEPA filters in use shall be DOP tested annually. If a filter installation does not pass the DOP test satisfactorily, the cause of leakage shall be determined and corrected prior to further system operation.

F. A HEPA filter shall be replaced when: (1) the pressure drop across it exceeds the limit specified for the filter, (2) the flow of air from the system it services is reduced so as to ineffectively exhaust an area, (3) the external gamma radiation level from the filter exceeds allowable radiation levels in the area in which the filter is located, or (4) the filter is damaged.

FIGURE 1

1

MDC/MDCR CALCULATIONS

A. MDCR CALCULATION[2] –

$$MDCR = \frac{2.71}{T_S} + 3.29 \left(\frac{R_B}{T_B} + \frac{R_B}{T_S} \right)^{1/2}$$

where:

MDCR	=	minimum detectable count rate (cpm)
R_B	=	background count rate (cpm)
T_B	=	background count time (min)
T_S	=	sample count time (min)

NOTE: These equations ensure that MDCR is calculated at the 95% confidence level.

B. MDC CALCULATION –

$$MDC = \frac{MDCR}{(V)(E_C)(2.22E6)}$$

where:

MDC	=	minimum detectable concentration (μCi/ml)
V	=	air sample volume in ml
E_C	=	counter efficiency (decimal form)
2.22E6	=	conversion from dpm to μCi

NOTE: If the sample net count rate is less than MDCR and the volume is at least 1.0E6 ml, enter "< MDC" in the log book. If the sample net count rate is less than MDCR and the sample volume is less than 1.0E6 ml, recalculate MDC using the actual sample volume.

[2] Based on statistical concepts presented by L.A. Currie in Ref. 3.

FIGURE 2

AIR SAMPLE LOG SHEET

DATE	SAMPLE	TIME	LOCATION	ACTIVITY		DATE/TIME	RECOUNT ACTIVITY	
				ALPHA	BETA		ALPHA	BETA

FORM #NES 205 7/90

FIGURE 3
GROSS ALPHA/BETA ANALYSIS OF AIR PARTICULATES
ANALYSIS DATA SHEET

SAMPLING DATA _____ SAMPLE NO.: _____

Location: _____ Reason: _____

Collected By: _____ Sampler ID: _____

Date/Time On: _____ Flow Rate (CFM) On: _____

Date/Time Off: _____ Flow Rate (CFM) Off: _____

COUNTING DATA	ALPHA			BETA		
Counting System						
Serial Number						
Counting Date/Time						
Gross Counts						
Sample Count Time (Min)						
Gross Counts (cpm)						
Background counts						
Bkg Count Time (Min)						
Bkg Counts (cpm)						
Net Counts (cpm)						
Counter Efficiency						
Conversion Factor	6.76 E-7	6.76 E-7	5.76 E-7	4.5 E-7	4.5 E-7	4.5 E-7
Volume (ml)						
Activity (µCi/ml)						
MDCR (cpm)						
MDC (µCi/ml)						

Comments: _____

Technician: _____ Date: _____

Reviewed by: _____ Date: _____

NOTE: $(ft^3)(2.83E4) = ml$

Activity (µCi/*ml*) = (Net cpm) (Conv. Factor)/(Counter Eff) (Vol *ml*)

TABLE 1 [1]

REQUIRED RESPIRATORY PROTECTIVE DEVICES

Type of Radioactivity	Concentration Guide Limit [1] in µCi/cc	Type of Device
Alpha Emitters	a. 0 to 1 x 10^{-11}	a. None required
	b. >1x10^{-11} to 5 x 10^{-10}	b. Full-face filtered air respirator (protection factor of 50)
	c. >5 x 10^{-10} to 2 x 10^{-8}	c. Full-face supplied air respirator (protection factor of 2000)
	d. >2 x 10^{-8}	d. None allowed – no entry
Beta/Gamma Emitters	a. 0 to 1 x 10^{-10}	a. None required
	b. > 1 x 10^{-10} to 5 x 10^{-9}	b. Full-face filtered air respirator (protection factor of 50)
	c. >5 x 10^{-9} to 2 x 10^{-7}	c. Full-face supplied air respirator (protection factor of 2000)
	d. >2 x 10^{-7}	d. None allowed – no entry

[1] Based on 10 CFR 20, Appendix B limits and the protection factors of 10 CFR 20.

APPENDIX A

AIRBORNE SAFETY ASSURANCE PROGRAM

1. SCOPE

The Airborne Safety Assurance Program has been established to provide protection against airborne hazards and to provide the basis of all training and record keeping necessary to ensure that safety.

2. GENERAL

The following program is excerpted from the corporate Occupational Health Manual, Section 17. This program is in compliance with the requirements of the federal Occupational Safety and Health Administration (OSHA) and incorporates the guidelines of the American Nuclear Standards Institute ANSI–Z88.2. Exposures of workers to airborne radioactive materials in restricted areas shall follow the guidelines of Regulatory Guide 8.15.

3. RESPIRATORY PROTECTION PROGRAM

3.1 RESPIRATORY PROTECTION REQUIREMENTS

The Occupational Safety and Health Administration has set maximum exposure standards for many airborne toxic materials. If employee exposure to these substances exceeds the standard, federal law requires that feasible engineering controls and/or administrative controls be installed or instituted to reduce employee exposure to acceptable levels. If these controls do not prove feasible, or while they are being installed/instituted, NES shall provide appropriate respiratory protection for employees.

Respiratory protection is also necessary for routine but infrequent operations, non–routine operations in which the employee is exposed briefly to high concentrations of a hazardous substance, e.g., during maintenance or repair activities, or during emergency conditions.

3.2 RESPIRATORY PROTECTION PROGRAM

Providing respiratory protective equipment to the employee, however, is only one aspect of NES' responsibility pertaining to the use of respiratory protective equipment as a control measure. A respiratory protection program must be implemented.

3.3 RESPIRATORY PROTECTIVE EQUIPMENT SELECTION

Respirator selection is critical to an effective program. The proper selection of respiratory protective equipment involves three basic steps:

1. The identification of the hazard.
2. The evaluation of the hazard.
3. The selection of the appropriate approved respiratory equipment based on the first two considerations.

3.4 IDENTIFICATION AND EVALUATION OF THE HAZARD

Identification and evaluation of the hazard forms the basis for a decision on the need for the respiratory program. If a survey of operations and work environments indicates that no employees are being exposed to containment concentrations exceeding established limits (OSHA standards) then a respirator program is not required. In–house evaluation with an industrial hygiene survey may have indicated the need for respiratory protection equipment. This applies to both radiological and non–radiological hazards.

A walk–through survey of the worksite to identify processes, or worker environments where respirators may be required, is the next step in the respirator selection process.

3.5 APPROVED RESPIRATORY PROTECTIVE EQUIPMENT

When purchasing respiratory protective equipment, be sure to purchase approved equipment for the particular containment. An approved respirator is one that has been tested and found to meet minimum performance standards by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH).

A NIOSH approved respirator contains the following:

1. An assigned identification number placed on each unit, e.g., TC–21C–101.
2. A label identifying the type of hazard the respirator is approved to protect against.
3. Additional information on the label which indicates limitations and identifies the component parts for use with the basic unit.

3.6 ISSUANCE OF RESPIRATORY PROTECTIVE EQUIPMENT

Where practical, the user should be given respiratory protective equipment for his/her exclusive use. A record of issuance shall be maintained. Any respirator permanently assigned to an individual shall be permanently marked to indicate to whom it was assigned.

3.7 FITTING OF RESPIRATORY PROTECTIVE EQUIPMENT

It is essential that respiratory protective equipment be properly fitted to the employee when it is issued. For that reason, NES shall provide several respirators from which to choose.

There are two types of fitting tests – qualitative and quantitative tests. Qualitative tests are fast, usually simple, but not as accurate an indicator of improper fit as the quantitative test. The quantitative test requires testing equipment, setup and a specially trained operator.

Two qualitative fit tests, the positive pressure fit test and the negative pressure fit test, can be used as a quick check of the fit of the respirator facepiece before beginning or during work in the hazardous atmosphere. These tests would apply only to air–purifying respirators.

Facial hair lying between the sealing surface of a respirator facepiece and the wearer's skin will prevent a good seal. Beards and sideburns can prevent satisfactory sealing and shall be removed prior to respirator use. The negative pressure developed in the facepiece of non–powered air–purifying respirators during inhalation can lead to leakage of contaminants into the facepiece when there is a poor seal. Individuals who have stubble – even a few days' growth may permit excessive leakage of containment, – a moustache, sideburns, or a beard that passes between the skin and the sealing surface shall not wear a respirator.

Industrial safety glasses may cause a fitting problem, if they interfere with the seal .

Contact lenses shall not be worn while wearing a respirator. A properly fitted respirator (primarily a full facepiece respirator) may stretch the skin around the eyes, thus increasing the possibility that the contact lens will fall out. Contaminants also penetrate the respirator clouding soft lenses and may cause severe discomfort.

3.8 MAINTENANCE OF RESPIRATORY PROTECTIVE EQUIPMENT

On–going maintenance of respiratory protective equipment is an important part of the program. Wearing poorly maintained or malfunctioning equipment may be as dangerous as not wearing a respirator.

While OSHA places a strong emphasis on the importance of an adequate maintenance program, it does permit the tailoring of the maintenance program to the type of plant and hazards involved. All maintenance programs should follow manufacturer's instructions and should include provisions for:

Cleaning and disinfecting of equipment

Storage

Inspection for defects

Repair

Cleaning and disinfecting –

When respirators are used daily for several hours, they should be cleaned and disinfected daily. When they are used occasionally, periodic cleaning and disinfecting is appropriate. Individual workers who maintain their own respirator should be trained in the cleaning of respirators.

Respirators should be washed in a detergent containing a bactericide. To prevent dermatitis, the respirators should be rinsed thoroughly in clean water. Dry on an open rack.

Storage –

After cleaning and drying the respirator, it should be placed in a resealable plastic bag. A wall–mounted cabinet or an employee's locker shelf is appropriate for storing when not in use.

Repair –

Replacement of parts and repair of air–purifying respirators should, in most cases, present little problem. Replacement parts must be those of the manufacturer of the equipment and repairs made by qualified individuals.

NOTE: REGULATIONS REQUIRE SELF–CONTAINED BREATHING APPARATUS EQUIPMENT BE RETURNED TO THE MANUFACTURER FOR ADJUSTMENT OR REPAIR.

Inspection –

An important part of a respirator maintenance program is the inspection of the devices. If performed carefully, inspections will identify damaged or malfunctioning repairs.

All respiratory protective equipment must be inspected –

before and after each use; and

during cleaning.

Equipment designated for emergency use must be inspected –

after each use

during cleaning; and

at least monthly.

3.9 RECORD KEEPING–INSPECTION

A record must be kept of inspection dates and findings for respirators maintained for emergency use.

Listed below are some of the primary defects to look for in inspection of the components of the respirator. When appropriate, information within the parentheses are suggested actions to be taken.

1. Disposable respirator–check for:

   - holes in the air filter (obtain new disposable respirator).
   - straps for elasticity and deterioration (obtain new disposable respirator).

2. Air–purifying respirators

   Rubber facepiece–check for:

   - excessive dirt (clean all dirt from facepiece)
   - cracks, tears or holes (obtain new facepiece)
   - distortion (allow facepiece to "sit", free from any constraints and see if distortion disappears; if not, obtain new facepiece)

Headstraps–check for:

- breaks or tears (replace headstraps)
- loss of elasticity (replace headstraps)
- broken or malfunctioning buckles or attachments (obtain new parts)

Inhalation valve, exhalation valve–check for:

- detergent residue, dust particles, or dirt on valve (clean residue with soap and water)
- missing, damaged or defective valve cover (obtain valve cover from manufacturer)

Filter element(s)–check for:

- proper filter for the hazard
- approval designation
- missing or worn gaskets (order replacement)
- worn threads (replace filter or facepiece, whichever is applicable)
- cracks or dents in filter housing (replace filter)

4. RESPIRATORY PROTECTION EVALUATION

Two important aspects of the respirator program are the periodic surveillance of the work areas requiring usage of respirators, and an evaluation of the overall respirator program for effectiveness.

Many things such as changes in operation or process, implementation of engineering controls, temperature, and air movement can affect the concentration of the substance(s) which originally required the use of respirators. To determine the continued necessity of respiratory protection or need for additional protection, measurements of the contaminant concentration should be made whenever the above changes are made or detected. A record of these measurements shall be kept.

The following are questions to be answered by the Radiological Controls Supervisor (RCS) when the program is evaluated, at least annually – or when changes are made in its implementation.

1. Is program responsibility vested in one individual who is knowledgeable and who can coordinate all aspects of the program?

2. What is the present status of the implementation of engineering controls, if feasible, to alleviate the need of respirators?

3. Are there written procedures covering the various aspects of the respirator program?

4. Are work area conditions and employee exposures properly surveyed?

5. Are respirators selected on the basis of hazards to which the employee is exposed?

6. Are selections made by individuals knowledgeable of selection procedures?

7. Are only approved respirators purchased and used and do they provide adequate protection for the specific hazard and concentration of the contaminant?

8. Has a medical evaluation of the prospective user been made to determine ability to wear respiratory protective equipment?

9. Have respirators been issued to the users for their exclusive use, and are there records covering issuance?

10. Is the best fitting respirator issued?

11. Is the fit tested at frequent intervals?

12. Are those users who require corrective glasses properly fitted?

13. Are users prohibited from wearing contact lenses when using respirators?

14. Are respirators cleaned and disinfected after each use or as frequently as needed?

15. Are proper methods of cleaning and disinfecting utilized?

16. Are respirators stored properly?

17. Are respirators inspected before and after each use and during cleaning?

18. Are qualified individuals/users instructed in inspection techniques?

19. Is replacement or repair only done by experienced persons with parts designed for the respirator?

20. Are workers trained in proper respirators usage and care?

4.1 MEDICAL PROGRAM FOR RESPIRATOR USER

So that the examining physician can render a qualified opinion regarding respirator usage by an employee, the physician, initially, should be given the following information:

- Type of equipment to be used .
- Tasks that the employee will perform while wearing the respirator.
- Length of time the user will wear the equipment.
- Substance to which the employee will be exposed.

The following medical tests should be considered by the examining physician in the evaluation:

- Pulmonary function test.
- Eye test.
- General physical examination.
- Electrocardiogram.

4.2 MEDICAL FACTORS

4.3 Medical factors to be considered by the examining physician in determining the prospective user's ability to wear a respirator are:

- Emphysema.
- Asthma.
- Chronic bronchitis.
- Heart disease.
- Deep facial scars.
- Poor eyesight or hearing.
- Lack of use of fingers or hands.
- Claustrophobia.
- Lack of teeth or dentures.

4.4 THE FITTING OF RESPIRATORS

For safe use of any respiratory protective device, it is essential that the user be properly instructed in its use. Supervisors as well as workers must be so instructed by competent persons.

OSHA requires that all employees be trained in the proper use of the device assigned to them.

Each respirator wearer should be given training which would include:

a. an explanation of the respiratory hazard and what happens if the respirator is not used properly.

b. a discussion of what engineering and administrative controls are being used and why respirators still are needed for protection.

c. an explanation of why a particular type of respirator has been selected.

d. a discussion of the function, capabilities, and limitations of the selected respirator.

e. instruction in how to don the respirator and to check its fit and operation, instruction in the proper wearing of the respirator.

g. instruction in respirator maintenance.

h. instruction in recognizing and handling emergency situations.

Supervisory personnel should periodically monitor the use of respirators to insure that they are worn and maintained properly.

The employee using the respirator tests it for fit each time it is put on. The respirator fit can be checked by one of the following methods:

– Positive Pressure Test:

Close the exhalation valve and gently exhale into the facepiece. The facepiece fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators, this method of leak testing requires that the wearer first remove the exhalation valve cover and then carefully replace it after the test.

- Negative Pressure Test:

Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the seal(s). Inhale gently so that the facepiece remains in its slightly collapsed condition and if no inward leakage of air is detected, the fit of the respirator is considered satisfactory.

- Stannic Chloride Smoke Test:

The most frequently used qualitative fit test is the irritant smoke test. An irritant smoke tube (glass tube 12cm long by 1cm diameter, filled with stannic chloride–impregnated pumice) is used to produce a very irritating smoke when air is blown through the tube. The smoke is directed at the facepiece seal and leakage is indicated by irritation of the throat and lungs. If the respirator does not fit properly, the irritating "smoke" will be inhaled and the wearer will cough or sneeze involuntarily. The fact that the fit test is measured by an involuntary reaction on the part of the wearer makes this test more acceptable.

To carry out this test in a "controlled" condition a large plastic bag can be hung from the ceiling and the wearer can step under it. The respirator wearer should close his eyes during the fit test. Light puffs of smoke can be introduced into the top and side of the plastic bag away from the wearer's face. If there is no evidence of leakage, the smoke tube should be held closer to the wearer's face and smoke density increased. Any time leakage is detected, the tester should stop and the wearer should adjust the facepiece and head straps of the respirator. NOTE: Only 3 or 4 puffs of "smoke" are required. CHARCOAL FILTERS must be used on the respirator for this test.

ALPHA COUNTING PROCEDURE

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Project Application	Copy No.	Assigned To
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APPROVALS

TITLE / DEPT. – SIGNATURE – DATE

REV NO	PREPARED BY	REVIEWED BY PROJECT MGR.	APPROVED BY DEPT. MGR.		
0					
1					
2					
3	Eric Abelquist 4/24/98		[signature] 4/24/98		
4					
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NES

REVISION LOG

NUCLEAR ENERGY SERVICES, INC.

DOCUMENT NO. 82A[redacted]

REV NO.	DATE	PAGE NO.	DESCRIPTION	APPROVAL
1	1/26/90	5,6,8	Clarification of Information (See CRA 7528)	
2	8/21/92	-	All pages noted with triangle blocks per	
			CRA 8431	
3	10/16/92	6	CRA 8483 - incorporated Field Change 001	
			into the procedure	

FORM # NES 206 3/90

TABLE OF CONTENTS

1

1. PURPOSE

This procedure specifies the method for counting alpha radioactivity on filter media from air samples and smears as well as from evaporated crystaline liquid samples .

2. RESPONSIBILITIES

Implementation of this alpha counting procedure is the responsibility of the Radiological Controls Supervisor (RCS). The site Health and Safety Office (HSO) is responsible for ensuring procedural compliance.

3. PROCEDURE

3.1 BACKGROUND COUNTS

Daily, a background count will be made with the alpha counting instrumentation (e.g., Ludlum 2929). The empty sample slide (planchet holder) will be inserted and the instrument's alpha background will be counted.

A 30 minute background count will be made and the results written into the laboratory log book and/or survey form.

3.2 SOURCE CHECKS

3.2.1 Determination of Source Check Range

An alpha check source will be counted ten times; each count will be one minute in duration. The mean (C_{AVE}) standard deviation(s) of the counts will be calculated as follows:

$$C_{AVE} = \frac{\sum_{i=1}^{n} C_i}{n} \qquad \text{(Sample Mean)},$$

Where:

C_i = Gross source counts,

n = Number of measurements.

$$s = \sqrt{\frac{\sum_{i=1}^{n} C_i \ (C_{AVE} - C_i)^2}{n-1}}$$ (Sample Standard Deviation).

The acceptable range (95% confidence interval) of the source counts is calculated by:

Range = $(C_{AVE} - 1.96\ S)$ to $C_{AVE} + 1.96\ S$.

The range will be documented in the log book.

3.2.2 Daily Source Check

Daily, the alpha check source will be counted twice for a 1 minute counting interval. The number of gross counts obtained will be recorded in the log book. The Radiological Controls Supervisor will be notified if the source check counts fall outside of the range.

3.3 EFFICIENCY DETERMINATION

3.3.1 A plutonium–239 (Pu–239) calibration source is placed, active side up, into the sample slide (planchet holder) and slid into place within the counter.

3.3.2 The gross count rate will be determined by counting the calibration source ten times. Each count will be one minute in duration.

3.3.3 The average of the ten counts will be calculated for the Pu–239 source. The net count rate will be determined by subtracting the background count rate from the gross count rate. The average net "counts per minute" value will be divided by the known source activity to determine the daily counter efficiency.

$$eff = \frac{C\ net}{C_s}$$

where:

C net = average of ten counts ($C_1 + C_2 + C_3 + \cdots C_{10}$)/10 in counts per minute (cpm) corrected to net cpm by subtracting out the background count rate.

C_s = source activity in alpha disintegrations per minute (dpm).

3.3.4 The results calculated for efficiency will be written into the log book. The client's representative will be notified if the efficiency deviates more than ±10%.

3.4 SMEAR COUNTING

3.4.1 NES uses either filter paper or cloth smears for surveys. The smears shall be placed into clean planchets for counting.

3.4.2 The planchet is then placed into the sample slide and moved into place beneath the detector.

3.4.3 Smears will be counted for 30 seconds, or as determined by the RCS.

3.4.4 Smear results will be transmitted to the responsible technician for logging onto survey maps.

3.4.5 Smears with counts greater than the release criteria of Table 1 will be saved for 24 hours pending further analysis at the discretion of Radiological Controls supervision. (3)

3.5 AIR SAMPLE FILTER COUNTING

3.5.1 Air sample filters will be placed into clean planchets, fuzzy side up to minimize amount of self-absorption of filter paper. The planchet will be placed into the sample slide and moved into place beneath the detector.

3.5.2 Air sample filters will be counted for 5 minutes.

3.5.3 Air sample results will be entered onto Figure 1, Air Particulate Analysis Data Sheet.

3.5.4 Air sample filters will be recounted after two hours minimum, to allow for decay of naturally-occurring, short-lived radon daughter products.

3.5.5 Air sample filters will be saved, for the duration of the project and attached to the calculation sheet (Figure 1).

3.6 FIXED ALPHA CONTAMINATION COUNTING

2

Direct alpha contamination measurements will be taken by placing the alpha probe (i.e., ZnS) in direct contact with the surface to be measured. A 30 second count will be obtained at the desired location with an ESP-1 or equivalent in the scaler mode. The RCS may require a longer count time depending on site conditions (e.g., alpha background, release criteria).

The measurements will be documented on the appropriate survey form.

3.7 LIQUID COUNTING

3.7.1 A minimum 10cc aliquot will be drawn from all samples of liquid collected for radiological analysis and dried in preparation for gross alpha analysis. Samples will be prepared in accordance with NES 82A8023.

4. REFERENCES

4.1 Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-product, Source or Special Nuclear Material. (Table 1)

4.2 NES Procedure 82A8023, Liquid Sample Preparation and Analysis.

4.3 Ludlum Model 2929, Technical Manual.

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[b,c]	MAXIMUM[b,d]	REMOVABLE[b,e]
U–nat, U–235, U–238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra–226, Ra–228, Th–230, Th0228, Pa–231, Ac–227, I–125, I–129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th–nat, Th–232, Sr–90, Ra–223, Ra–224, U–232, I–126, I–131, I–133	1000 dpm/100 cm^2	3000 dpm/100 cm^2	200 dpm/100 cm^2
Beta–gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr–90 and other noted above.	5000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1000 dpm $\beta\gamma$/100 cm^2

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

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

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

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

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

FIGURE 1

GROSS ALPHA/BETA ANALYSIS OF AIR PARTICULATES

ANALYSIS DATA SHEET

SAMPLING DATA _____ SAMPLE NO.: _____

Location: _____ Reason: _____

Collected By: _____ Sampler ID: _____

Date/Time On: _____ Flow Rate (CFM) On: _____

Date/Time Off: _____ Flow Rate (CFM) Off: _____

COUNTING DATA	ALPHA			BETA		
Counting System						
Serial Number						
Counting Date/Time						
Gross Counts						
Sample Count Time (Min)						
Gross Counts (cpm)						
Background counts						
Bkg Count Time (Min)						
Bkg Counts (cpm)						
Net Counts (cpm)						
Counter Efficiency						
Conversion Factor	6.76 E-7	6.76 E-7	6.76 E-7	4.5 E-7	4.5 E-7	4.5 E-7
Volume (ml)						
Activity (µCi/ml)						
MDCR (cpm)						
MDC (µCi/ml)						

Comments: _____

Technician: _____ Date: _____

Reviewed by: _____ Date: _____

NOTE: $(ft^3)(2.83E4) = ml$

Activity (µCi/*ml*) = (Net cpm) (Conv. Factor)/(Counter Eff) (Vol *ml*)

BETA–GAMMA COUNTING PROCEDURE

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Project Application	Copy No.	Assigned To
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APPROVALS

TITLE / DEPT. – SIGNATURE – DATE

REV NO	PREPARED BY	REVIEWED BY PROJECT MGR.	APPROVED BY DEPT. MGR.		
0					
1	Eric Abelquist				
2	Eric Abelquist 10/24/02				
3					
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NES

REVISION LOG

NUCLEAR ENERGY SERVICES, INC.

DOCUMENT NO. 82A8022

REV NO.	DATE	PAGE NO	DESCRIPTION	APPROVAL
1	8/21/92	-	Pages marked with triangle blocks per	
			CRA 8424	
2	10/16/92	6	CRA 8484 - Incorporated Field Change 001	
			into procedure.	

TABLE OF CONTENTS

1 PURPOSE

This procedure specifies the method for counting beta–gamma radioactivity on filter media from air samples and smears as well as from evaporated crystalline liquid samples .

2 RESPONSIBILITIES

Implementation of this beta–gamma counting procedure is the responsibility of the Radiological Controls Supervisor (RCS). The site Health and Safety Officer (HSO) is responsible for ensuring procedural compliance. 1

3 PROCEDURE

3.1 BACKGROUND COUNTS

Daily background counts will be made using beta/gamma counting instrumentation (e.g., Ludlum Model 2929 with phoswich detector). The empty planchet holder will be inserted and the instrument's beta/gamma background will be counted.

A 30 minute background count will be obtained and the results recorded in the log book and/or survey form.

3.2 SOURCE CHECKS

3.2.1 Determination of Source Check Range

A beta/gamma check source will be counted ten times; each count will be one minute in duration. The mean (C_{ave}) and standard deviation (S) of the counts will be calculated as follows:

$$C_{ave} = \sum_{i=1}^{n} Ci/n \quad \text{(sample mean)},$$

where:

Ci = Gross source counts,

n = Number of measurements

$$S = \sqrt{\frac{\sum_{i=1}^{n} (C_{ave} - C_i)^2}{n-1}}$$ (sample standard deviation).

The acceptable range (95% confidence interval)of the source counts is calculated by:

$$\text{Range} = (C_{ave} - 1.96S) \text{ to } (C_{ave} + 1.96S)$$

The range will be documented in the logbook.

3.2.2 Daily Source Check

Daily, the beta/gamma source will be counted twice for a 1 minute counting interval. The number of gross counts obtained will be recorded in the logbook. The RCS will be notified if the source check counts fall outside of the range.

3.3 EFFICIENCY DETERMINATION

3.3.1 A Tc–99 calibration source is placed, active side up, into the sample slide (planchet holder) and slid into place within the counter.

3.3.2 The gross count rate will be determined by counting the calibration source ten times. Each count will be one minute in duration.

3.3.3 The average of the ten counts will be calculated for the Tc–99 source. The net count rate will be determined by subtracting the background count rate from the gross count rate. The average net "counts per minute" value will be divided by the known source activity to determine the counter efficiency.

$$\text{eff} = \frac{\text{Cnet}}{C_s}$$

where:

Cnet. = average of ten counts $(C_1 + C_2 + C_3 + \cdots C_{10})/10$ in counts per minute (cpm) corrected to net cpm by subtracting out the background count rate.

C_s = source activity in disintegrations per minute (dpm).

3.3.4 The results calculated for efficiency will be written into the log book and/or survey form. The client's representative will be notified if the efficiency deviates ±10% from the previous calculated efficiency.

3.4 SMEAR COUNTING

3.4.1 NES uses either filter paper or cloth smears for surveys. The smears shall be placed into clean planchets for counting.

3.4.2 The planchet is then placed into the sample slide and moved into place beneath the detector.

3.4.3 Smears will be counted for 30 seconds, or as determined by the RCS.

3.4.4 A liquid scintillation counter will be used to count smears for low energy beta emitters.

3.4.5 Smear results will be transmitted to the responsible technician for logging onto survey maps.

3.4.6 Smears with counts greater than the release criteria of Table 1 will be saved for 24 hours pending further analysis at the discretion of Radiological Controls supervision.

3.5 AIR SAMPLE FILTER COUNTING

3.5.1 Air sample filters will be placed into clean planchets, fuzzy side up. The planchet will be placed into the sample slide and moved into place beneath the detector.

3.5.2 Air sample filters will be counted for 5 minutes.

3.5.3 Air sample results will be entered onto Figure 1, Air Particulate Analysis Data Sheet.

3.5.4 Air sample filters will be saved for the duration of the project and attached to the calculation sheet (Figure 1).

3.5.5 A liquid scintillation counter will be used to count air sample filters for low energy beta emitters.

3.6 LIQUID COUNTING

Direct beta/gamma contamination measurements will be taken by placing the GM pancake probe or equivalent beta/gamma detector directly on the surface.

A 30 second count will be obtained at the desired survey location. The RCS may require a longer count time depending on site conditions (e.g., beta/gamma background, release criteria).

The measurements will be documented on the appropriate survey form.

3.6.1 A minimum 10cc aliquot will be drawn from all samples of liquid collected for radiological analysis and dried in preparation for gross alpha analysis. Samples will be prepared in accordance with NES 82A8023.

4 REFERENCES

4.1 Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By–product Source or Special Nuclear Material. (Table 1)

4.2 NES Procedure 82A8023, Liquid Sample Preparation and Analysis.

4.3 Ludlum Model 2929, Technical Manual.

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[b c]	MAXIMUM[b d]	REMOVABLE[b e]
U–nat, U–235, U–238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra–226, Ra–228, Th–230, Th–228, Pa–231, Ac–227, I–125, I–129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th–nat, Th–232, Sr–90, Ra–223, Ra–224, U–232, I–126, I–131, I–133	1000 dpm/100 cm^2	3000 dpm/100 cm^2	200 dpm/100 cm^2
Beta–gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr–90 and other noted above.	5000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1000 dpm $\beta\gamma$/100 cm^2

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

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

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

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

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

FIGURE 1

GROSS ALPHA/BETA ANALYSIS OF AIR PARTICULATES

ANALYSIS DATA SHEET

SAMPLING DATA_____ SAMPLE NO.:_____

Location:_____ Reason:_____

Collected By:_____ Sampler ID:_____

Date/Time On:_____ Flow Rate (CFM) On:_____

Date/Time Off:_____ Flow Rate (CFM) Off:_____

COUNTING DATA	ALPHA			BETA		
Counting System						
Serial Number						
Counting Date/Time						
Gross Counts						
Sample Count Time (Min)						
Gross Counts (cpm)						
Background counts						
Bkg Count Time (Min)						
Bkg Counts (cpm)						
Net Counts (cpm)						
Counter Efficiency						
Conversion Factor	6.76 E-7	6.76 E-7	6.76 E-7	4.5 E-7	4.5 E-7	4.5 E-7
Volume (ml)						
Activity (µCi/ml)						
MDCR (cpm)						
MDC (µCi/ml)						

Comments:_____

Technician:_____ Date:_____

Reviewed by:_____ Date:_____

NOTE: $(ft^3)(2.83E4) = ml$

Activity ($\mu Ci/ml$) = (Net cpm) (Conv. Factor)/Counter Eff) Vol ml)