



"REALISTIC SOLUTIONS FOR  
HAZARDOUS WASTE PROBLEMS"



RADIATION CONTROL PLAN  
FOR  
THORIUM AREA REMEDIATION

CLEVELAND WORKS  
THE ALUMINUM COMPANY OF AMERICA

RADIATION CONTROL PLAN  
FOR  
THORIUM AREA REMEDIATION

CLEVELAND WORKS  
THE ALUMINUM COMPANY OF AMERICA

prepared for

THE ALUMINUM COMPANY OF AMERICA  
CLEVELAND, OHIO

SEPTEMBER 30, 1991  
REVISION 2

DOCUMENT NO. 91062.063

REMCOR, INC.  
PITTSBURGH, PENNSYLVANIA

PREPARED BY

Earl H. Rothfus

9-30-91

REVIEW/APPROVAL BY:

SIGNATURE

DATE

PROJECT DIRECTOR

HEALTH AND SAFETY

RADIATION SAFETY

QUALITY ASSURANCE

ALCOA

Russell B. Bell et al

10/1/91

Charles J. Hunter

10/1/91

## TABLE OF CONTENTS

	<u>PAGE</u>
LIST OF TABLES	iv
1.0 INTRODUCTION	1-1
1.1 SCOPE AND PURPOSE	1-1
1.2 REGULATORY REFERENCES	1-2
1.3 RESPONSIBILITIES	1-2
1.4 OPERATIONAL PROCEDURES AND REVIEW REQUIREMENTS	1-3
2.0 CONTROL OF PERSONNEL EXPOSURE	2-1
2.1 RADIATION EXPOSURE LIMITS	2-1
2.1.1 Occupational Radiation Exposure Limits	2-1
2.1.2 Occupational Radiation Exposure Controls	2-2
2.1.3 Exposure to Minors	2-3
2.1.4 Exposure to Unborn Child	2-4
2.1.5 Emergency Exposures	2-5
2.1.6 Exposure to Personnel While Off Site	2-6
2.1.7 Access Control for Visitors	2-6
2.1.8 Nonoccupational Exposure Limits	2-7
3.0 PERSONNEL MONITORING	3-1
3.1 PERSONAL DOSIMETRY	3-1
3.1.1 Dosimetry for Workers	3-1
3.1.2 Dosimetry for Visitors	3-2

**TABLE OF CONTENTS**  
(Continued)

	<u>PAGE</u>
3.1.3 Extremity Thermoluminescent Detectors	3-2
3.2 LOSS OR DAMAGE OF THERMOLUMINESCENT DETECTORS	3-3
3.3 ESTIMATION OF DOSE	3-3
3.4 WEARING THERMOLUMINESCENT DETECTORS	3-4
3.5 TRACKING RADIATION EXPOSURE	3-4
4.0 INTERNAL RADIOLOGICAL MONITORING	4-1
4.1 BIOASSAY	4-1
4.2 SPECIAL INTERNAL DOSIMETRY EVALUATION	4-1
4.3 DOSE COMMITMENT	4-2
4.4 WORK RESTRICTION	4-2
5.0 PERSONNEL RECORDS AND REPORTS	5-1
5.1 EXPOSURE RECORDS	5-1
6.0 IDENTIFICATION AND MONITORING OF CONTROLLED AREAS	6-1
6.1 CONTROLLED AREAS	6-1
6.2 IDENTIFYING CONTROLLED AREAS	6-2
6.3 CONTROLLING RADIATION EXPOSURE DURING WORK	6-3
7.0 RADIOLOGICAL SURVEYS	7-1
7.1 SURVEY TECHNIQUES	7-1
7.2 SURVEY FREQUENCIES	7-1
7.3 SAFETY PRECAUTIONS	7-1

TABLE OF CONTENTS  
(Cont.)

	<u>PAGE</u>
7.4 CALIBRATION AND MAINTENANCE OF SURVEY INSTRUMENTS	7-4

TABLE



## LIST OF TABLES

<u>TABLE NO.</u>	<u>TITLE</u>
1	Radiation Worker Occupational Exposure Limits and Controls

## 1.0 INTRODUCTION

### 1.1 SCOPE AND PURPOSE

This manual presents the radiation protection standards and controls to be in effect for remediation of the thorium area in the Permanent Mold Division of the Cleveland Works of the Aluminum Company of America (Alcoa). Adherence to these controls is the responsibility of each individual as well as of Contractor and subcontractor management. All personnel responsible for operations in a radiation environment involving handling or processing of radioactive materials must be knowledgeable of the contents of this manual and must have a good understanding of the sections which apply to his/her job assignment. Any deviation from this manual requires the written approval of the Radiological Control Supervisor (RCS).

These radiological safety requirements have been developed based on the recommendations and requirements of the National Council on Radiation Protection and Measurements, the U.S. Department of Energy, the International Commission on Radiological Protection, and on standards which have been reviewed and accepted by the Public Health Service, the U.S. Nuclear Regulatory Commission (NRC), the U.S. Department of Labor, and the U.S. Environmental Protection Agency.

It is necessary that all personnel associated with the handling of radioactive material or who are in radiation areas understand that a knowledge of standard radiation protection rules and practices is a part of their job. It is not independent of, or in addition to, their routine duties but an integral part of their duties and responsibilities.

Each person should understand that it is his/her responsibility to minimize his/her own exposure to radiation. Also, each person associated with the handling of radioactive material shall receive periodic instruction in the general and specific radiological aspects which he/she may encounter and shall also be made aware of his/her responsibility to the company, the public, and coworkers for safe handling of radioactive materials.

The major purpose of this manual is to establish the basic practices to be implemented throughout the entire cleanup project by the Contractor to ensure satisfactory control of radioactive materials and radiation exposures to personnel. The basic philosophy is to maintain radiation exposures as low as reasonably achievable and to keep radioactive material contained at all times in the smallest practical volume.

## 1.2 REGULATORY REFERENCES

This Radiation Control Plan is intended to comply with all applicable rules, regulations, and standards of the NRC. The following regulations have been used in preparing this plan:

- Title 10, Code of Federal Regulations, Part 19 (10 CFR 19), "Notices, Instructions, and Reports to Workers, Inspections"
- 10 CFR 20, "Standards for Protection Against Radiation."

## 1.3 RESPONSIBILITIES

The Contractor operating field management is responsible for the implementation of the radiological control and safety programs. The RCS and Radiological Control Technicians (RCTs), therefore, have the authority to cease operations in the event that operating

conditions are not in compliance with operational safety controls or approved operating procedures. The RCS and RCTs further have the authority to remove from the list of employees authorized to receive occupational radiation exposure those individuals who approach the established administrative radiation exposure limits or who have not demonstrated their continuing understanding of, or the need for, compliance with radiological safety-related operating procedures.

RCTs are responsible for identifying safety hazards and assuring that the job is not allowed to proceed without abatement or control of these hazards. To implement this responsibility, RCTs have the authority to stop work which violates the applicable work procedures or which, in their opinion, presents an imminent danger of:

- Excessive radiation exposure to personnel
- Contamination of personnel or the environment
- Personnel injury or equipment damage from an identified industrial safety hazard.

When it becomes necessary to stop a job due to a safety hazard, conditions should be stabilized immediately so that stopping the job does not in itself present an additional hazard.

Unless precluded by the urgency of the situation, cessation of operations will be implemented through the Project Manager, who is responsible for the overall conduct of the job.

#### 1.4 OPERATIONAL PROCEDURES AND REVIEW REQUIREMENTS

Detailed procedures incorporating radiological and other safety considerations are required for operations involving the handling of radioactive materials. Preparation of such procedures by operating organizations minimizes the problems encountered by requiring explicit

planning in advance of actually performing the work. The written procedure becomes a step-by-step guide for the personnel performing the operation. Prior to being issued for use, the procedure must be reviewed and approved by Alcoa.

## 2.0 CONTROL OF PERSONNEL EXPOSURE

### 2.1 RADIATION EXPOSURE LIMITS

#### 2.1.1 Occupational Radiation Exposure Limits

Radiation exposure limits are used for controlling personnel exposure to radiation (excluding medical and dental exposures) to levels which are believed to cause no ill effects even if the employee was exposed to these levels throughout his/her entire working life. These limits are based on those promulgated by 10 CFR 20. Personnel should endeavor to maintain their own exposures as low as reasonably achievable and below these limits. The occupational exposure limits are presented in Table 1. Normal operations shall be controlled such that no employee exceeds any 10 CFR 20 occupational exposure limit and the total of all employees' exposures is the lowest level reasonably achievable.

Controlling employee exposures includes setting exposure goals for an individual project. The exposure goals for this remediation project are the administrative limits listed in Table 1. These administrative limits shall not be exceeded in this project. Radiological control inspections are incorporated into work procedures to control and monitor employee exposures. Such inspections shall be required in work procedures in which omission or incorrect accomplishment of a procedural step could result in any one of the following:

- Personnel whole body radiation exposure greater than the limits set forth below
- Release to the environment of airborne radioactivity greater than the concentration limit of 10 CFR 20, Appendix B, Table II

- Release to surrounding water of radioactive liquids greater than 10 CFR 20, Appendix B, Table II
- Surface contamination greater than  $1 \times 10^6$  pCi/100 square centimeters ( $\text{pCi}/100 \text{ cm}^2$ ) (beta-gamma) or 1,000  $\text{pCi}/100 \text{ cm}^2$  (alpha) within a radiologically controlled area (not including contamination containment)
- Exceeding the following limits:
  - 5,000 disintegrations per minute (dpm) alpha, beta, gamma/ $100 \text{ cm}^2$  averaged over 1 square meter ( $\text{m}^2$ ) or the total object if the object is less than  $1 \text{ m}^2$
  - 15,000 dpm alpha, beta, gamma/ $100 \text{ cm}^2$  maximum, for an area less than or equal to  $100 \text{ cm}^2$ , on any one object or within any  $1 \text{ m}^2$
  - 1,000 dpm alpha, beta, gamma/ $100 \text{ cm}^2$  removable; determined by wiping the area with dry filter paper and testing the filter paper with an appropriate survey meter
- The limits are applied and tested independently for alpha and for beta, gamma.

Inspections of work procedure steps as required by this criteria shall be conducted and documented by radiological control personnel prior to proceeding to the next step in the procedure. Also, no employee shall be exposed to further radiation of any kind whatsoever which may produce a lifetime exposure to the individual greater than 5 rems per year effective whole body dose as specified in 10 CFR 20 as published in the Federal Register for May 21, 1991.

#### 2.1.2 Occupational Radiation Exposure Controls

The three most important methods to minimize exposures in fulfillment of as low as reasonably achievable objectives are the proper use of time, distance, and shielding. Each of these items is discussed below:

- Time - The less time you spend in radiation areas, the less exposure to radiation you will receive. To fully utilize the time that is spent in radiation areas, all jobs should be preplanned. Such preplanning should include:
  - Making sure you have all the tools and equipment required for the job prior to entering the area
  - Being familiar with the equipment either through job mock-up training or referring to a repair manual or plans prior to entering the area
  - Knowing the radiation levels, as well as component location, prior to entering the area and having standby personnel wait in low dose rate areas until needed.
- Distance - Your exposure to radiation can be significantly reduced by keeping as much distance as possible between you and the source.
- Shielding - The third method of controlling/minimizing radiation exposure is by means of shielding. Since incorrect installation, unauthorized movement, or removal of temporary shielding can result in large changes in work area radiation levels, control of temporary shielding is essential:
  - Temporary shielding installation and removal shall be controlled by written procedures. These procedures shall specify locations and amounts of temporary shielding
  - After installation, temporary shielding shall be inspected to ensure it is properly located.
  - Periodic radiation surveys conducted in accordance with Chapter 7.0 herein shall be reviewed to ensure that shielding maintains its effectiveness in reducing radiation exposure.
  - Formal written approval for changing location or amount of temporary shielding shall be established. This written approval shall specify location and amount of shielding changed. Instructions implementing this requirement shall designate persons authorized to approve such changes.

### 2.1.3 Exposure to Minors

Individuals under the age of 18 are not permitted to enter any controlled radiation area.

#### 2.1.4 Exposure to Unborn Child

The National Council on Radiation Protection and Measurements recommends:

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

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

Instructions concerning prenatal exposure to the unborn child shall be given during initial and reverification training.

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

"The recommendation of the National Council on Radiation Protection and Measurements to limit radiation exposure to the unborn child to the very lowest practical level, not to exceed 0.5 rem during the entire period of pregnancy, has been explained to me."

Signature \_\_\_\_\_

Typed or printed name \_\_\_\_\_

Date \_\_\_\_\_

The signed statements shall be kept with the training records. Statements signed by visitors shall be retained until the end of the job and turned over to Alcoa.

#### 2.1.5 Emergency Exposures

In an emergency situation, it may be necessary for emergency personnel to exceed the exposure limits in order to save lives. In such situations, the probable effect of high exposure to the rescuer must be weighed against the expected benefits. All emergency exposure or rescue action that may involve substantial personal risk shall be performed by volunteers, and each volunteer shall be advised of the known or estimated extent of such risk by the RCS or his delegate prior to participation:

- In emergency situations which require search and recovery for injured personnel or in operations undertaken to prevent conditions that would injure numbers of people, the planned dose to the whole body shall not exceed 100 rem per individual.
- In situations where it is desirable to enter a hazardous area to protect facilities, eliminate further escape of effluents, or to control fires, the planned whole body dose shall not exceed 25 rem per individual.
- The allowed exposure from an emergency situation shall be determined by the RCS. Each individual's planned exposure shall not exceed the above limits, and the total exposure allowed should be consistent with the potential risk from the situation.
- Volunteers or other personnel in an emergency situation who may have received exposures exceeding the limits will, on an individual basis, have their exposure evaluated and appropriate action taken to limit future occupational exposure.
- Persons exposed to whole body radiation greater than 25 rem in a single exposure shall be placed under medical observation. A qualified physician will determine whether hospitalization is required. If an individual exceeds quarterly or yearly limits of Sections 2.1.2, 2.1.3, and 2.1.4 herein as a result of emergency exposure, he shall subsequently be removed from duties involving occupational exposure to ionizing radiation.

### 2.1.6 Exposure to Personnel While Off Site

Personnel will not be allowed to receive occupational radiation exposure off site.

### 2.1.7 Access Control for Visitors

The Contractor shall control the exposure of visitors to the work site to levels as low as is reasonably achievable. For exposure control purposes, a "visitor" is defined as any person not qualified as a radiation worker and who requires access to controlled areas.

If the visitor will not enter any controlled areas, he will be instructed such that he can recognize how these areas are marked and further instructed not to enter any area so marked.

Entry by a visitor to a controlled area shall require the following:

- Assignment of a temporary thermoluminescent detector (TLD) badge
- Escort by a qualified radiation worker at all times while in the controlled area.

Visitors shall not be allowed access to any area where there is a significant risk of internal deposition of radioactive material.

If repeated entries to controlled areas are required by a visitor, over periods exceeding two weeks, a temporary TLD can be issued if the visitor meets appropriate requirements as a radiation worker.

### 2.1.8 No Occupational Exposure Limits

The Contractor shall control the radioactive material and radiation-generating equipment in its possession so that exposure to members of the general public is limited to the lowest practical levels not to exceed 0.1 rem per year as specified in 10 CFR 20 as published in the Federal Register for May 21, 1991.

### 3.0 PERSONNEL MONITORING

#### 3.1 PERSONAL DOSIMETRY

##### 3.1.1 Dosimetry for Workers

The Contractor shall use TLD badges to measure personnel radiation exposure for permanent record purposes. TLD badges measure ionizing radiation by emitting a measurable amount of visible light which is directly proportional to the amount of incident radiation. The TLD measure both beta and gamma exposure. The results of the TLD badge measurements are the basis of the legal record of an employee's exposure. Therefore, any deliberate action by an employee which invalidates the TLD measurements is cause for disciplinary action.

Those personnel who have qualified as radiation workers and who have a need to enter a controlled area shall be issued a permanent TLD.

An individual's permanent TLD normally shall be worn on the front of the body between the waist and neck, facing away from the body. In some specific work situations where the source of radiation is oriented relative to the individual in an unusual manner (for example, some part of the head or trunk will receive a substantially higher dose than other parts of the body), assignment of additional TLDs will be required. These TLDs shall be worn at the point(s) of highest dose rate or as directed by an RCT.

TLD processing frequency shall be monthly for radiation workers. Nonroutine processing may be required by the RCS.

### 3.1.2 Dosimetry for Visitors

Self-reading pocket dosimeters (SRPDs) may be issued to visitors who enter controlled areas. These dosimeters, if used, shall be utilized as required and shall be returned to the RCT for processing. SRPDs shall be charged (zeroed), read out, and recorded daily or as specified by an RCT. Visitors will be escorted at all times while inside the control zone.

### 3.1.3 Extremity Thermoluminescent Detectors

When exposure to extremities (hands, feet, wrists, ankles) or forearms is expected to exceed 25 percent of the limits of Section 2.1 herein, additional TLDs shall be worn on the exposed extremity or forearm. Personnel wearing extremity or forearm dosimetry (TLD and SRPD) will be prohibited from receiving additional extremity/forearm exposure until their extremity/forearm TLDs have been processed.

The highest SRPD measurement for extremities and forearms will be recorded by the RCS on the Daily Personnel Exposure Report until the TLDs have been processed. The vendor-supplied TLD Occupational Radiation Exposure Report will be the official and permanent record of personnel extremity exposure.

The RCS will update personnel exposure monthly, when the TLD results have been received from the vendor.

Extremity TLDs will be made available if the need arises. Extremity TLDs will be TLD finger rings or TLDs oriented toward the source of radiation as much as practical without causing damage to the devices during use.

### 3.2 LOSS OR DAMAGE OF THERMOLUMINESCENT DETECTORS

Each instance of a lost or damaged personnel TLD shall be reported promptly to radiological control personnel.

Individuals who lose or damage their TLD while in a controlled area shall immediately exit the area and report the condition to the RCT. The individual shall be restricted from entering controlled areas until an exposure estimate has been completed and a new TLD issued.

### 3.3 ESTIMATION OF DOSE

Off-scale or higher than expected readings on an SRPD shall be promptly reported to the RCT for investigation of the circumstances resulting in the exposure. Processing of the wearer's TLD badge may be required as part of the investigation. The individual involved will be restricted from controlled area entry until his dose has been evaluated.

All exposures indicated by the TLD shall be considered to have been received by the individual unless it can be clearly demonstrated to be erroneous.

If an exposure measurement result from a TLD is lost or proven erroneous, an estimate of the dose received by the individual during the period in question shall be established by the RCS and documented as a part of the employee's Exposure Record.

Estimates of dose received shall consider at least the following:

- Dose rates in the individual's work area.
- Actions taken by the individual during the time for which dose information is desired. This review should include consideration of work position, time in controlled areas, etc.
- Doses received by other personnel doing similar work in the area.
- Exposures recorded by other dosimetry devices worn (e.g., SRPDs).

#### 3.4 WEARING THERMOLUMINESCENT DETECTORS

The wearing of TLDs will be strictly enforced.

#### 3.5 TRACKING RADIATION EXPOSURE

Prior to personnel performing work at the facility, NRC Form-4, "Occupational External Radiation Exposure History," will be completed to determine personnel lifetime exposure. NRC Form-5, "Current Occupational External Radiation Exposure," will be completed to determine personnel exposure for the current year and quarter. The yearly and quarterly exposures received will be used to determine available exposure for work at the facility. Copies of completed NRC Form-4 and Form-5 shall be provided to the owner's engineer. Copies of these forms for each individual contractor employee shall be provided to that employee upon his/her request.

## 4.0 INTERNAL RADIOLOGICAL MONITORING

### 4.1 BIOASSAY

In vitro sampling (urinalysis) will be performed at least twice during the course of work at the facility. The first sample will be collected prior to the actual start of work. The second sample will be collected upon work completion or personnel termination. Bioassay samples will also be collected in emergency situations.

### 4.2 SPECIAL INTERNAL DOSIMETRY EVALUATION

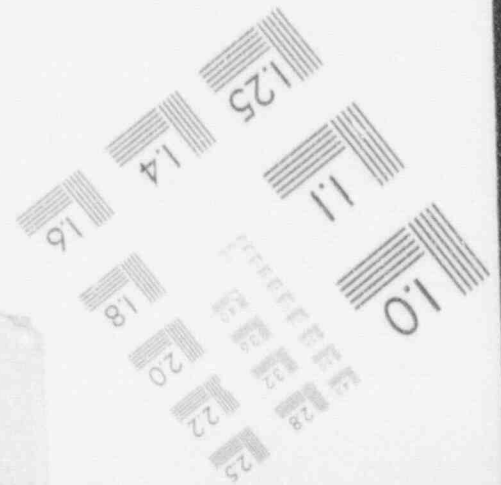
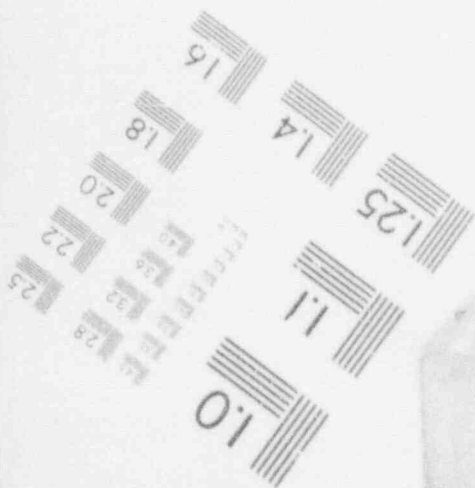
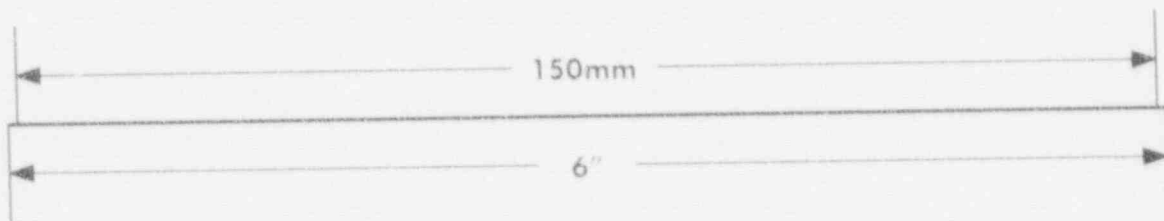
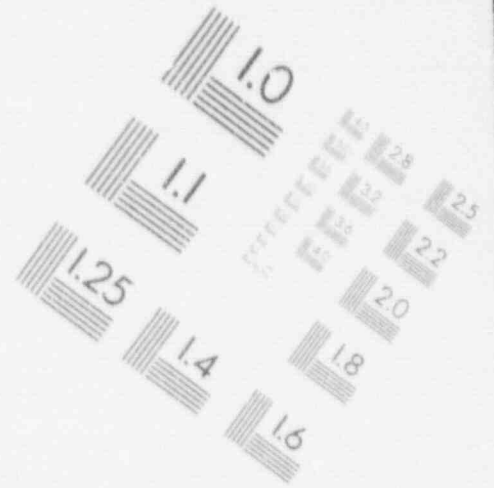
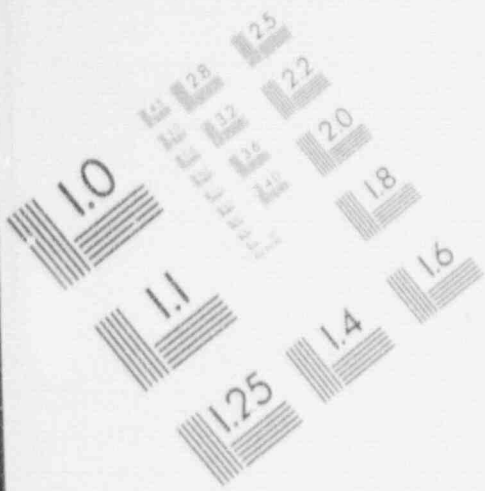
Personnel who are involved in radiological work will have internal dosimetry evaluations when internal contamination is confirmed or suspected, in accordance with the following criteria:

- A urinalysis or chest count will be required in the following circumstances:
  - Whenever personnel are exposed to high airborne radioactivity above limits in 10 CFR 20, Appendix B
  - Whenever personnel are exposed to high airborne concentrations exceeding protection provided by respiratory equipment being worn
  - Whenever nasal swabs or personnel frisking indicates detectable counts of alpha or beta-gamma activity above specified limits
  - Whenever the RCS feels that internal monitoring is needed.

When in vivo examinations are required as a result of internal contamination, the involved personnel shall be transported directly to the whole body counter facility as soon as practicable after the incident. Additionally, in vitro fecal sampling may be required, if the urinalysis or in vivo examination indicates internal contamination.

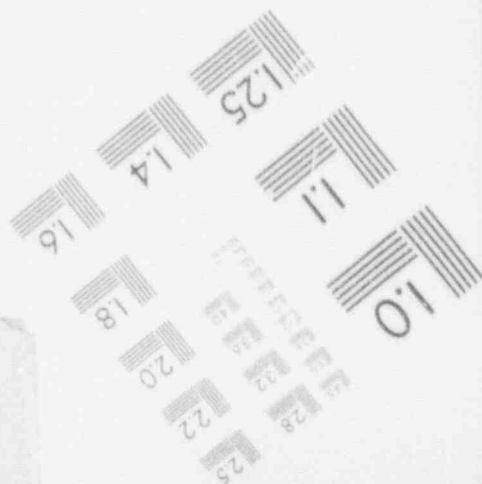
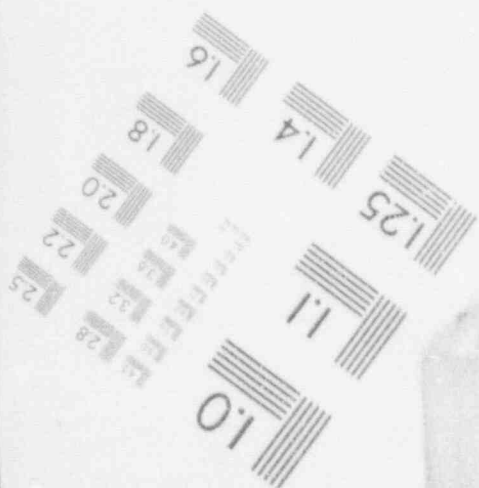
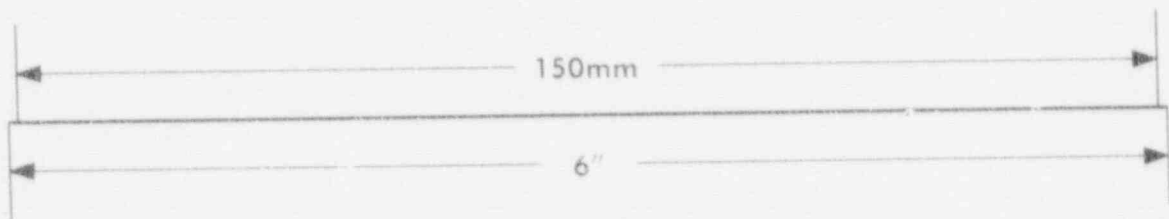
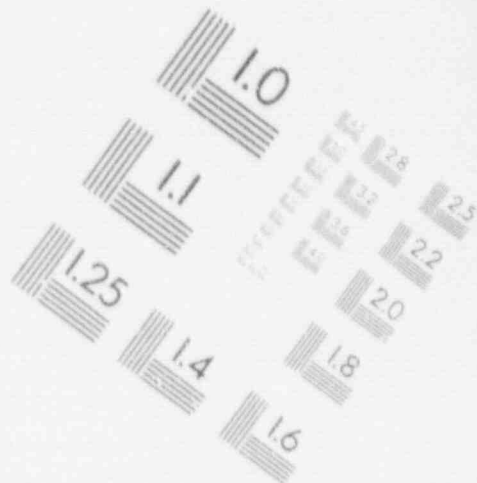
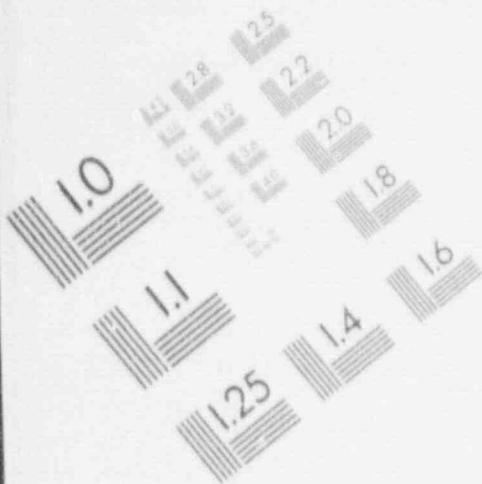
# 1

## IMAGE EVALUATION TEST TARGET (MT-3)



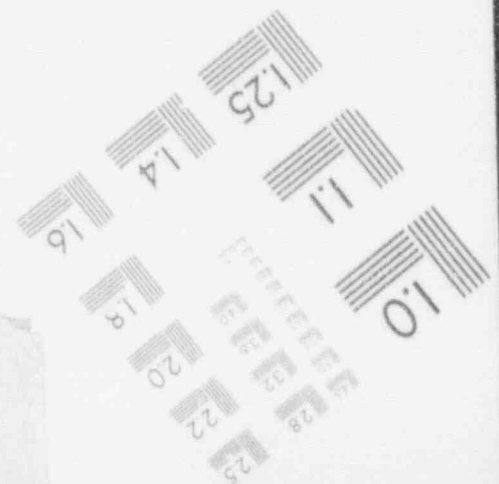
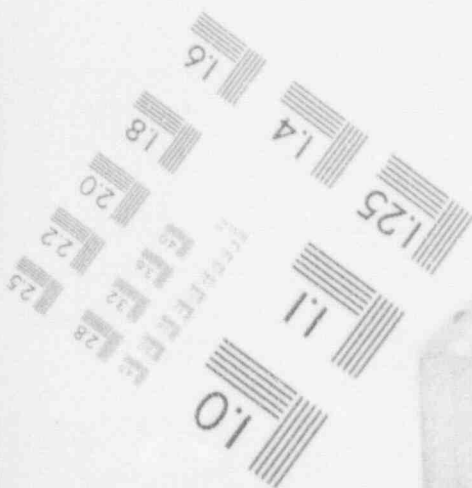
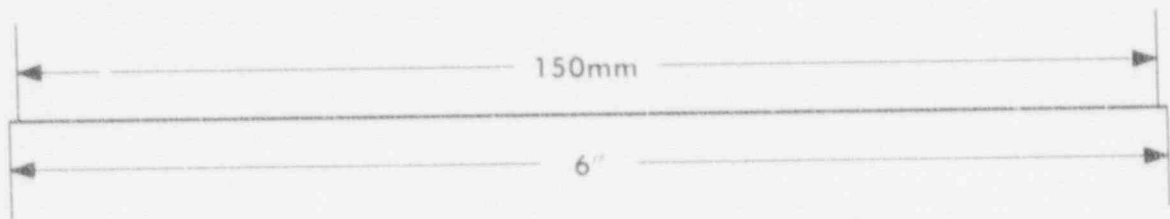
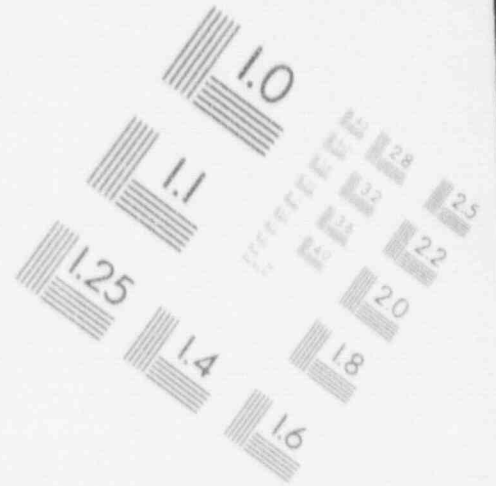
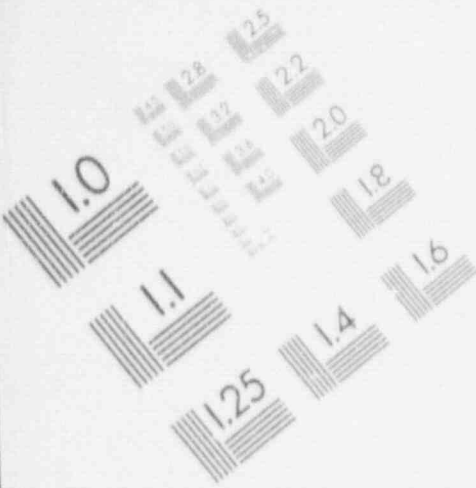
# 1

## IMAGE EVALUATION TEST TARGET (MT-3)



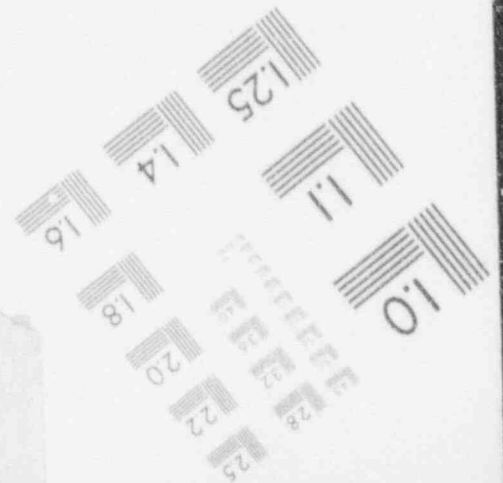
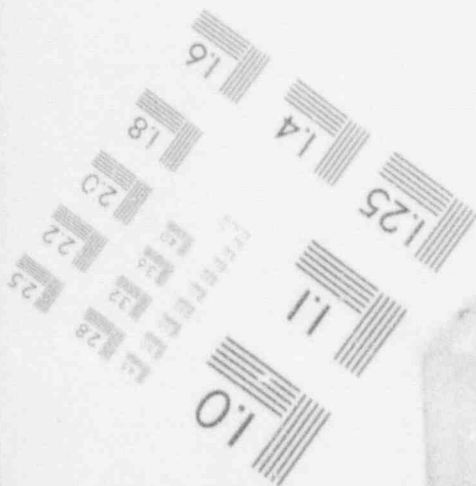
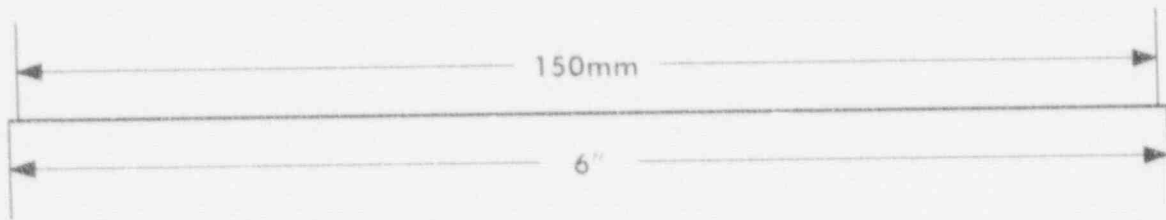
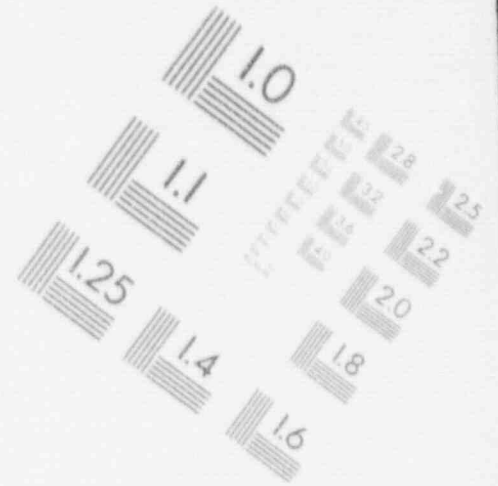
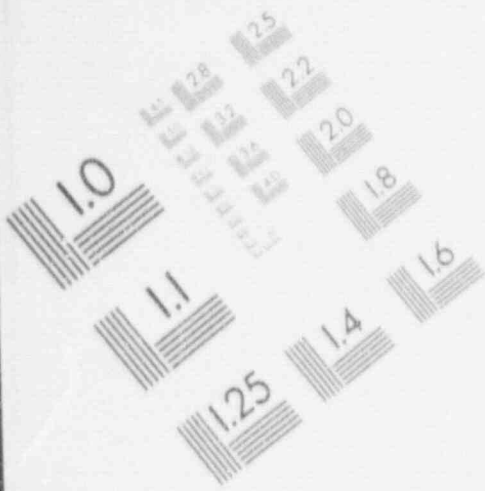
# 1

## IMAGE EVALUATION TEST TARGET (MT-3)



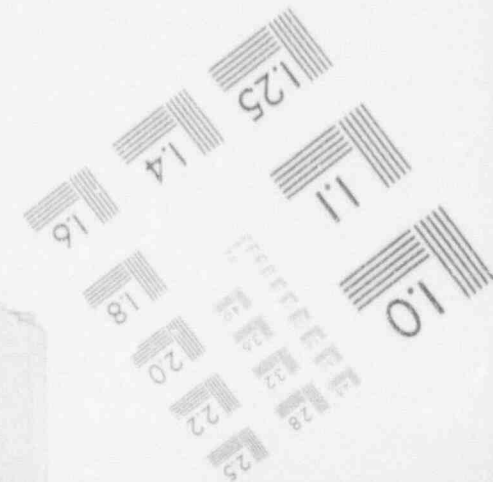
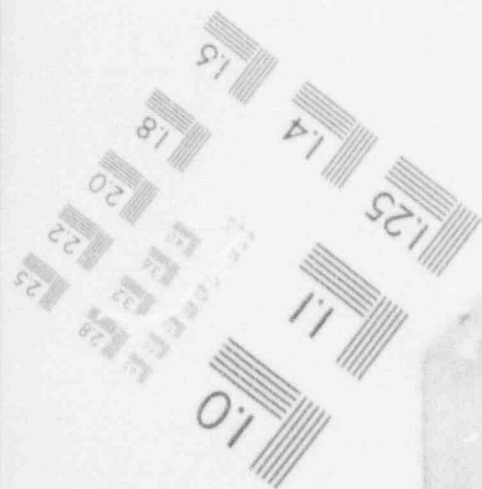
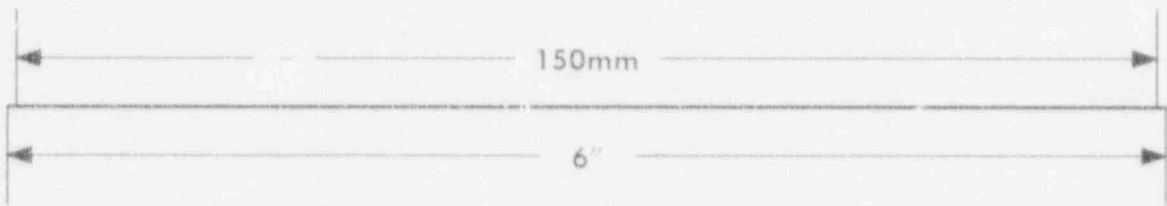
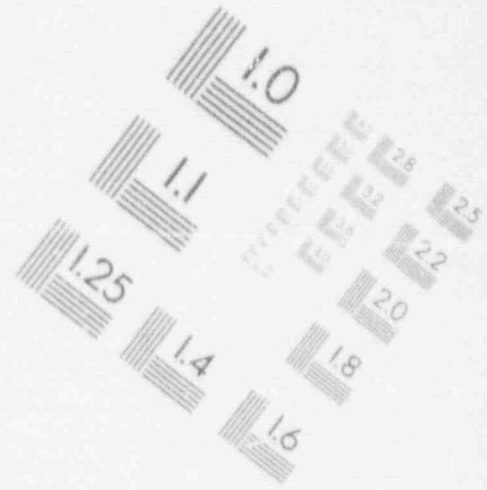
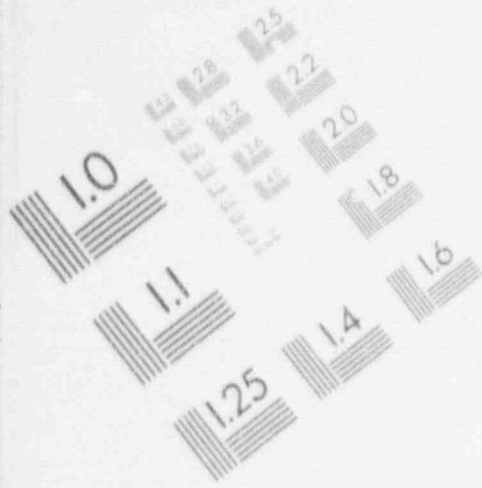
1

IMAGE EVALUATION  
TEST TARGET (MT-3)



# 1

## IMAGE EVALUATION TEST TARGET (MT-3)



#### 4.3 DOSE COMMITMENT

When an internal deposition is detected, the employee's dose commitment(s) shall be estimated by methods consistent with Reports 26 and 30 of the International Commission on Radiological Protection. The dose commitment shall be reported to the employee and shall become a part of his exposure history file. The dose commitment is defined as the dose equivalent (rem) received by specific organs during a period of one calendar year that was the result of uptakes (single or multiple) of radionuclides.

#### 4.4 WORK RESTRICTION

An employee may have his radiation work activities altered or limited as a result of:

- Approaching the control levels of Section 2.1 herein
- Unknown exposure status
- Increased potential for internal deposition such as an open skin break
- Repeated violations of safety requirements.

The RCS is responsible for implementing work restrictions when necessary. The employee's supervisor shall be notified in writing that a work restriction has been imposed within hours of determining the need for a restriction. Copies of work restrictions will be maintained in the employee's dosimetry record.

No person shall exceed the administrative control levels of Section 2.1 without prior written approval of the RCS.

An employee whose exposure status is unknown (e.g., lost dosimeter) shall not enter a controlled area until his current exposure status is determined by the RCS.

When an employee has an internal deposition of a radioisotope induced for medical diagnostic purposes, he shall be restricted from wearing a TLD until the medical isotope is eliminated from the body. This is done to avoid including exposure from the medical isotope to that exposure received from this contact with radioactive material.

Employees who work with radioactive materials shall report any skin breaks which they may have to their immediate supervisor and radiological controls personnel. Skin breaks include unhealed wounds; open cracks from chapping; and injuries such as lacerations, abrasions, punctures, and blisters or burns. A qualified local physician shall approve the person in question before entering a controlled area. The RCS shall ensure the protection afforded the skin break is adequate for the nature of the work location. A clearly open wound shall be sufficient reason to prohibit entry to a controlled area, irrespective of protective clothing or medical dressings.

Safeguards shall be maintained by supervision to minimize the likelihood of accidental introduction of radioactive materials beneath the skin. If the skin is broken while working with radioactive materials, the employee shall immediately report to his immediate supervisor who will have the skin break surveyed by an RCT. The RCS will determine if additional follow-up action is required.

Contaminated personnel shall be decontaminated in accordance with approved procedures.

## 5.0 PERSONNEL RECORDS AND REPORTS

### 5.1 EXPOSURE RECORDS

The RCS shall assure that records are maintained to permit a ready accounting of an employee's accumulated radiation exposure. This occupational exposure record shall include:

- Any known prior employment occupational exposure history
- External and internal exposure received occupationally, including that received at other installations
- Special dose evaluations and work restrictions
- Reports of unusual exposure such as overexposure or incidents with potential for internal deposition.

Each employee shall be informed of the results of all record dosimetry evaluations. Non-record exposure control information shall be preserved for two years to enable exposure re-evaluation, if it should become necessary. Employee exposure records shall be retained by the Contractor indefinitely.

## 6.0 IDENTIFICATION AND MONITORING OF CONTROLLED AREAS

### 6.1 CONTROLLED AREAS

A radiological controlled area applies to controlled surface contamination areas and to an area which contains one or more controlled surface contamination areas.

There are five area posting classifications, as defined below:

- Radiation Area - A Radiation Area is an accessible area where a major portion of the body could receive a dose from 1 mr to 100 mr in 1 hour. Entrance to radiation areas shall be conspicuously posted with "DOSIMETRY REQUIRED" signs.
- Controlled Surface Contamination Area (CSCA) - A CSCA is an area accessible to personnel in which the limits for surface contamination below are exceeded. These values are taken as detectable above background:
  1. 1,000 dpm alpha, beta-gamma/100 cm<sup>2</sup> averaged over 1 m<sup>2</sup> or the total object if the object is less than 1 m<sup>2</sup>
  2. 5,000 dpm alpha, beta-gamma/100 cm<sup>2</sup> maximum, for an area less than or equal to 100 cm<sup>2</sup>, on any one object or within any 1 m<sup>2</sup>
  3. 200 dpm alpha, beta-gamma/100 cm<sup>2</sup> removable; determined by wiping the area with dry filter paper and testing the filter paper with an appropriate survey meter
  4. 200 dpm alpha, beta-gamma/100 cm<sup>2</sup> removable for external surfaces of radioactive material container being shipped off site in accordance with 49 CFR regulation; determined as in 3 above.

Entrances to CSCAs shall be posted conspicuously with signs stating "CAUTION - CONTROLLED SURFACE CONTAMINATION AREA." These signs shall contain the conventional three-bladed radiation symbol on yellow background. Access restrictions, requirements for anticontamination clothing and respiratory equipment, and levels of loose contamination shall be posted on or alongside these signs. "DOSIMETRY REQUIRED" signs shall be posted in accordance with the Radiation Area.

- Airborne Radioactivity Area - Areas accessible to personnel will be posted as "AIRBORNE RADIOACTIVITY AREAS" if airborne radioactivity exists or is

likely to exist in concentrations exceeding those specified in 10 CFR 20, Appendix B, Table II. Each Airborne Radioactivity Area must be posted with signs meeting applicable standards, including the radiation symbol and the words "CAUTION - AIRBORNE RADIOACTIVITY AREA."

- High Radiation Area - A High Radiation Area is an accessible area where a major portion of the body could receive a dose in excess of 100 mr in 1 hour. Such areas shall be posted as "High Radiation Areas" and locked or guarded. Positive controls shall be established for each entry into the area in such a way that no individual is prevented from leaving a High Radiation Area. Prior to locking the area, a search will be performed to ensure that all personnel exited. Signs shall be posted containing the conventional magenta three-bladed symbol on yellow background and the words "CAUTION - HIGH RADIATION AREA."
- Radioactive Materials Area - A Radioactive Materials Area is an area in which work with and/or storage of packaged radioactive materials is permitted. Each Radioactive Materials Area must be posted with signs meeting applicable standards, including the radiation symbol and the words "CAUTION - RADIOACTIVE MATERIALS."

Note: Adequate protection from freezing for Radioactive Materials Areas is required.

## 6.2 IDENTIFYING CONTROLLED AREAS

The boundaries of controlled areas, if not a permanent wall or fence, shall be clearly indicated by rope or chain. Radiation warning signs printed in the standard yellow and magenta colors shall be posted to identify to personnel the actual or potential presence of radiation or contamination and to notify personnel of radiological conditions. In addition, requirements for entry into controlled areas shall be posted. The posting must be current, accurate, and credible in appearance.

The radiation symbol used on radiological signs and tags shall conform with the American National Standards Institute Standard N2.1-1969. The radiation symbol in the standard

colors (yellow and magenta) shall not be used for any purpose other than radiological controls.

All radiological posting shall be performed by or at the direction of radiological control personnel. Movement or removal of posted radiation warning signs, tags, or boundary markers by personnel other than radiological control personnel or without their approval may be cause for disciplinary action.

Controlled areas shall be posted with the appropriate signs such that posting is readily identifiable from all ordinary avenues of approach.

### 6.3 CONTROLLING RADIATION EXPOSURE DURING WORK

- The Contractor shall maintain personnel radiation exposure as low as practicable
- Use of supervisory and radiological control personnel to ensure that personnel are not waiting unnecessarily in radiation areas and inspection of radiological work to ensure that work procedures and controls are being adhered to.

## 7.0 RADIOLOGICAL SURVEYS

Radiation surveys are performed as necessary to ensure that personnel do not exceed limits of Section 2.1 and do not receive unnecessary exposure to radiation. The primary concern is to minimize personnel exposure as low as reasonably achievable by providing information to radiation workers on the radiation levels in the work area, hot spots, low radiation areas in the work area, etc., so work will be completed efficiently.

### 7.1 SURVEY TECHNIQUES

- Radiation surveys are conducted with appropriate instruments.
- General area levels are performed by scanning slowly from side to side, with the detector held at approximately waist level and occasionally held above the head and below the waist, noting the highest reading obtained. If the reading is significantly higher than at waist level reading, record this on the survey map, noting the location of the highest reading. Unless noted as such, general area surveys are normally recorded as waist level, with window closed.
- Contact Surveys are performed by moving the detector within 1/2 inch of the source. Gamma readings and locations will be recorded on an appropriate survey map of the area. Beta readings will be taken with open and closed window, the difference multiplied by the correction factor for the instrument, and recorded with the location on the survey map.

### 7.2 SURVEY FREQUENCIES

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

- Facilities Containing Radioactive Material

- Radiation surveys shall be performed to control radiation exposure whenever operations are performed that might be expected to change existing radiation levels. Examples of such operations include accumulation of waste, movement or removal of temporary shielding, and relocation of highly radioactive materials.
- Temporary boundaries (e.g., rope boundaries) of radiation areas shall be surveyed daily to ensure radiation areas do not extend beyond posted boundaries.
- Gamma surveys shall be performed at least weekly in occupied posted radiation areas and high radiation areas, in all occupied areas of radiological facilities, and in radioactive material short-term storage areas. Long-term storage areas shall be surveyed at least monthly.
- Beta-gamma surveys of ventilation filters shall be performed whenever work is performed on these filters.
- Other surveys shall be performed as necessary to control personnel exposure to alpha, beta, and gamma, radiation. Such surveys shall include:
  - A gamma survey during initial entry into an area containing potentially radioactive piping (e.g., radioactive waste tunnels)
  - Gamma surveys in spaces where significant radiation levels might exist from an adjacent facility
  - Beta as well as gamma (use of open window G-M detectors is acceptable) measurements where personnel might come in contact with contaminated surfaces
- Surveys shall be conducted when performing operations which could result in personnel being exposed to small intense beams of radiation. These operations include removing shielding and opening shipping/storage containers or radioactive equipment. When surveying areas of equipment where intense small beams of radiation could be present, the instrument shall be used with an audible response. An audible response is necessary since the visible meter response is usually considerably slower. The detector shall be moved slowly enough so that the instrument has a change to give an audible response for a large radiation level increase. If an audible response increase is noted, the detector shall be moved to the location producing maximum response and the meter read. If general dose rates are high such that a change in audible response is not detectable, slower surveys must be performed so that beams will be detectable by observing the meter. The speed of moving the detector is determined by considering the size of the detector, the instrument response time, the possible intensity of the

beam, and the general dose rates in the area. Particular attention shall be given to thoroughly scanning suspected areas such as portable shield sections and areas which are or are likely to be occupied. Small intense beams have occurred in places such as outside shields surrounding sources containing many Curies. For equipment with complex shield design, surveyors shall be briefed on the equipment designs so that areas most likely to have small beams can be given special attention.

- Potentially contaminated ducts, piping, and hoses outside radiological facilities shall be surveyed at least monthly for gamma radiation when in use or at least annually when not in use (e.g., deactivated systems).
- Surveys outside of posted areas shall be performed when 50 percent of the on-site work is complete and 1 week prior to termination of on-site work.
- During Casualties
  - Radiation surveys shall be performed as necessary to assess the extent and magnitude of a radiation condition in the event of an accident which might cause abnormal radiation levels.
- Records
  - Records of radiation surveys shall be retained until the end of the job and submitted to Alcoa. The survey information shall be recorded on a standard form, if specified, or on locally prepared forms which contain at least the following information:
    - Date and time of survey
    - Reason for survey and type of radiation measures (e.g., weekly gamma)
    - Type and identifying number of instruments used
    - Instrument calibration due dates
    - Location (shall be shown on a survey map or listed in a table)
    - Radiation level measures
    - Remarks
    - Signature of surveyor
    - Signature of persons reviewing results (e.g., RCS).

### 7.3 SAFETY PRECAUTIONS

The following safety precautions shall be observed by personnel using portable radiation monitoring equipment:

- Only personnel trained in the use of portable radiation monitoring equipment shall be allowed to use this equipment. As a minimum, training shall consist of a lecture on the use of the instrument and the meaning of its measurements, a demonstration of its proper handling, and a period of supervised use.
- Damage to or loss of radioactive source can result in spreading, inhaling, or ingesting contamination. Therefore, radioactive sources require careful handling and accountability control. To minimize the possibility of inadvertent mishandling or loss of small calibration or response check sources, these sources shall be attached to encumbering devices in such a manner that the device does not interfere with use of the source. Large rings, mounting boards, or storage boxes may be used as encumbering devices. Encumbering devices are not required for sources in planchets provided for use with counter scalers. If a source is lost, immediate steps shall be taken to recover the source and minimize radiation exposure to or contamination of personnel as a result of the lost source.
- In order to prevent sources from being inadvertently lost, the Contractor shall have procedures which shall require that all sources, except for sources which are permanently attached to monitoring instruments, be held under signature custody. These procedures are in addition to and do not supersede the accountability requirements for sources controlled under NRC or Agreement State licenses.
- Except for sources which are permanently attached to monitoring instruments, check sources which are not in use shall be kept in a locked cabinet. The number of keys shall be kept at a minimum. Combination locks are permitted and, when used, the number of personnel having the combination shall be kept to a minimum.

#### 7.4 CALIBRATION AND MAINTENANCE OF SURVEY INSTRUMENTS

Radiological control supervisory personnel shall ensure that the appropriate survey instruments are available, functional, and calibrated using accepted standards for performing radiation surveys.

TABLE 1  
RADIATION WORKER OCCUPATIONAL EXPOSURE  
LIMITS AND CONTROLS

TYPE OF EXPOSURE	10 CFR <sup>(1)</sup> 20 LIMITS (rem)		ADMINISTRATIVE CONTROLS (rem)	
	ANNUAL	QUARTER	ANNUAL	QUARTER
Whole body, head, and trunk, gonads, lens of eye, red bone marrow, active blood forming organs	5	3.0	3	1.25 <sup>(2)</sup>
Unlimited areas of the skin (except hands, feet, ankles, and forearms)	30	7.5	15	3.75 <sup>(2)</sup>
Forearms	75	8.75	15	3.75 <sup>(3)</sup>
Extremities	75	18.75	15	3.75 <sup>(3)</sup>
Minors (less than 18 years)	10 percent of above levels		No exposure allowed	

<sup>(1)</sup>"CFR" indicates Code of Federal Regulations.

<sup>(2)</sup>As measured by the "open window" of thermoluminescent detector card.

<sup>(3)</sup>As measured by appropriate supplemental dosimetry.



**"REALISTIC SOLUTIONS FOR  
HAZARDOUS WASTE PROBLEMS"**

REMCOR, Inc.  
701 Alpha Drive • P.O. Box 38310  
Pittsburgh, PA 15238  
412-963-1106