

**The Dow Chemical Company**

**Thorad Project**

**RADIOLOGICAL HEALTH AND SAFETY PLAN**

Prepared for:

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June 2000

Project Number 007133-8210

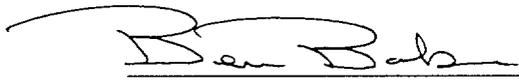
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## 1.0 Approvals

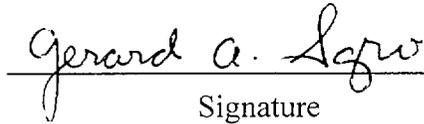
By their signature the undersigned key project team members acknowledge their assignments to the named positions and certify that: (1) This revised Radiological Health & Safety Plan (RHSP) will be utilized by all team members at The Dow Chemical Company's Bay City, Michigan site; and (2) All project activities associated with sampling, remediation radiological control, and radiation measurements will be conducted in accordance with 10CFR19 and 10CFR20 (NRC, 1997).

Ben Baker  
Dow Project Manager

  
\_\_\_\_\_  
Signature

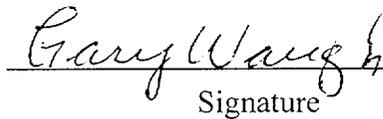
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Date

Gerard A. Sgro  
Field Services Manager

  
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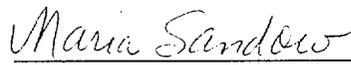
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Gary Waugh  
Field Services Superintendent

  
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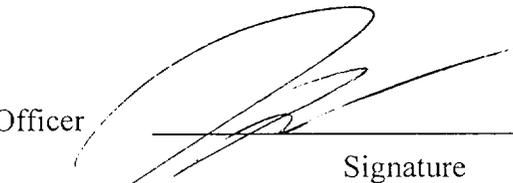
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Maria Sandow  
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Ricardo V. Burke  
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8/14/2000  
Date

Charlene Loar  
2<sup>nd</sup> Assistant Radiation Safety Officer

  
\_\_\_\_\_  
Signature

8/14/2000  
Date

## DISCLAIMER

The Dow Chemical Company does not guarantee the health or safety of any person entering this site. Due to the nature of the site and the activity occurring thereon, it is not possible to discover, evaluate, and provide protection for all potential hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury at this site. The health and safety guidelines in this plan were prepared specifically for this site and should not be used on any other site without prior review by trained health and safety specialists.



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## **2.0 Applicability**

This revised Radiological Health and Safety Plan (RHSP) will be implemented to establish safety criteria procedures for workers involved in the removal of material from The Dow Chemical Company's (Dow) Bay City, Michigan storage site.

This RHSP establishes:

- ALARA Program;
- Health and Safety organization and responsibilities;
- Site Access Control Procedures;
- Worker Training and Indoctrination;
- Environmental Monitoring Program;
- Program requirements, occupational monitoring, and personnel protection methods;
- Sample control, handling, packaging, and shipping procedures; and
- Emergency and Contingency Procedures for site emergencies (during handling and transport).

Applicable health and safety standards and responsibilities in carrying out this plan are delineated. The Project Radiation Safety Officer (RSO) will have prime responsibility for carrying out the plan and will thus be responsible for on-site worker radiation health and safety, and for insuring that environmental releases do not adversely affect public health. The RSO and supporting staff will perform the combined health physics and industrial hygiene functions at the Bay City storage site. Guidance on program requirements, hazard control, and monitoring is included. The standards and procedures delineated in this plan must be understood and observed by all Dow personnel and contractors.



### **3.0 Site Safety Management and Organization**

The following describes the health and organizational responsibilities and safety designations that will be employed during field activities at the site. Resumes of the designated staff are provided in Appendix A.

#### **3.1 Organization**

Figure 3-1 is a schematic outline of the Project Organization. As shown, lines of authority for health and safety management will be independent of those for operational management to ensure that site health and safety functions are not overridden by operational concerns. The QA/QC field and laboratory functions will also be independent of the Project Organization.

The RSO will report to the Dow Project Manager. A radiological support services staff that will perform the day-to-day monitoring of radiological on-site health and safety aspects of the Project will support the RSO.

#### **3.2 Personnel Responsibilities**

##### **3.2.1 Project Manager**

The Dow Project Manager has the overall responsibilities of implementing the health and safety procedures outlined in this RHSP and to ensure that all site work is executed in a safe manner. He is responsible for providing adequate resources to the site personnel to enable proper implementation of the provisions of this RHSP. He has the authority to sign contracts, commit project funds, and make license commitments for radiological health and safety for the project.

##### **3.2.2 Health and Safety Officer**

The Health and Safety Officer (HSO) establishes environmental health and safety policies, provides technical assistance to the RSO as required, and assures that all personnel designated to work on the site are medically qualified. The HSO is responsible for authorizing the appropriate monitoring, and safety equipment and other resources necessary to implement this RHSP.



### **3.2.3 Radiation Safety Officer/Radiological Support Services**

The Radiation Safety Officer (RSO) will be responsible for the radiological health and safety of all workers and for ensuring that airborne and liquid effluents are below the limits in 10CFR20 Appendix B, Table 2. This individual shall be provided with properly trained staff and adequate equipment as needed to ensure that all work is done safely.

The RSO has the responsibility to assist project management personnel in implementing this RHSP in accordance with the Dow Corporate Environmental, Health and Safety Standards and consistent with the health and safety requirements of the Nuclear Regulatory Commission (NRC).

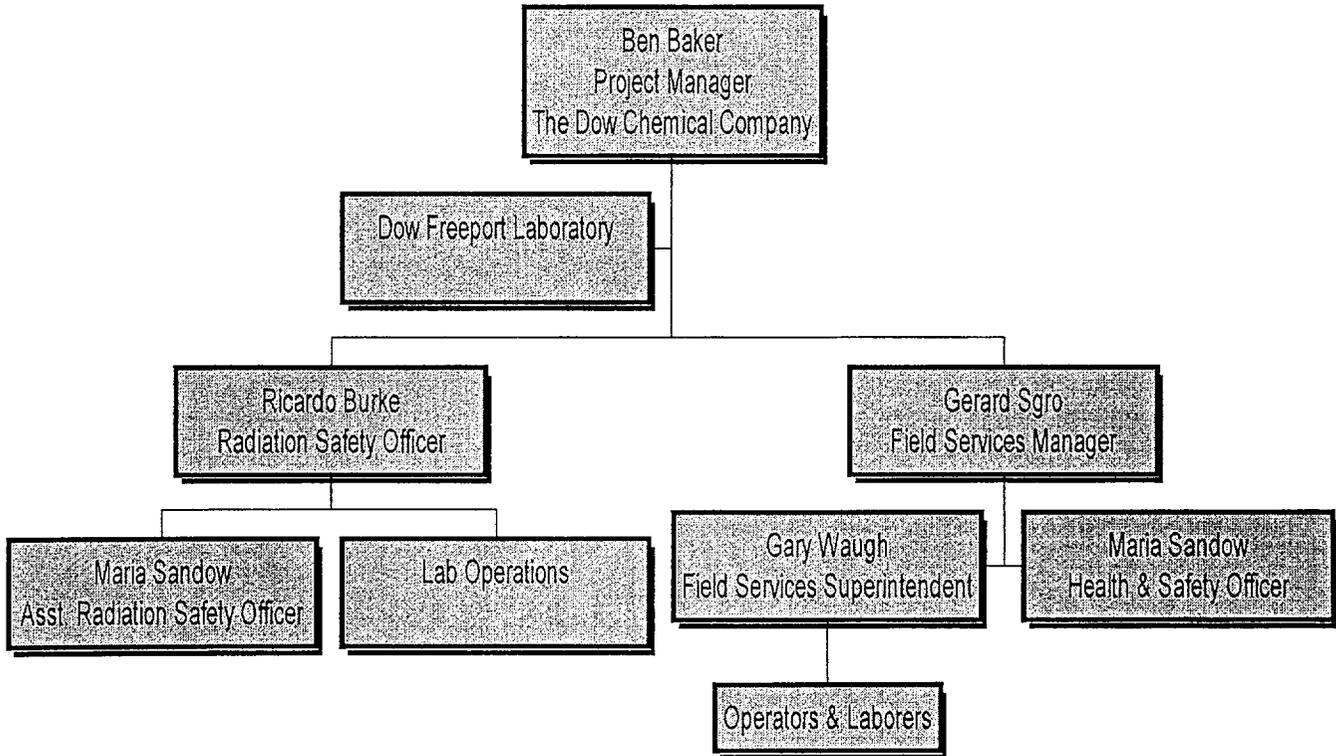
The RSO will execute appropriate monitoring techniques to ensure adequate protection for site personnel and conduct on-site inspections to identify potential safety and health hazards. The RSO, with the assistance of the HSO, will investigate all accidents and incidents occurring on this site and will conduct safety briefings and site-specific training for all on-site personnel. The RSO together with appropriate Dow personnel will accompany all government agency representatives visiting the site in response to health and safety issues.

The RSO has stop-work authorization if an imminent hazard or potentially dangerous situation exists during the course of on going site activities. Authorization to again proceed with work will be verified by the HSO.

No work will be performed inside the Controlled Area without the on-site presence of the Radiation Safety Officer or one of the Assistant Radiation Safety Officers.



THORAD Project Organizational Chart





#### **4.1 Reviews and Revisions of Administrative Changes**

If a change or revision to the RHSP, a RWP or a SOP is required, the change is presented to the RSO for initial approval. It is then presented to the ALARA committee for approval and implementation. The ALARA committee meets on a monthly basis during operation. If a change is needed before the regularly scheduled meeting, a special meeting will be called. Documentation of approval will be in the minutes of the ALARA meeting.



### **3.2.4 Assistant Radiation Safety Officers**

The Assistant Radiation Safety Officers (ARSOs) will be responsible for implementing the health and safety procedures outlined in this RHSP with assistance from the RSO. In the event of an emergency, the ARSO will also implement site evacuation procedures, including the shutting down of appropriate equipment, removing equipment and coordinating emergency services on-site.

### **3.2.5 Site Personnel**

It is the responsibility of all site personnel to report unsafe or potentially hazardous conditions to their supervisor. They should maintain knowledge of the information, instructions, and emergency response actions contained in this RHSP and will be required to read and acknowledge the requirements of this RHSP by signature. They shall also comply with rules, regulations and procedures set forth in this RHSP and revisions, which are instituted and prevent admittance of unauthorized personnel to the site.



## **4.0 ALARA**

Dow's policy is to limit radiation exposures of workers and the general public to as low as reasonably achievable (ALARA). In all cases, the radiation exposure shall not exceed the regulatory limits specified in 10 CFR Part 20.

The ALARA policy will be implemented in the site health and safety program through site safety training, planning, meetings, Standard Operating Procedures (SOPs), radiation exposure control measures, establishing administrative control limits, issuing Radiation Work Permits (RWPs), and personal protective equipment. Implementation of this policy also requires the active participation of every member of the on-site staff and anyone entering the control area.

Personnel will be trained in radiation safety procedures and ALARA philosophies to a level commensurate with their assigned tasks. Engineering controls will be the preferred means of reducing exposures, although administrative controls or personal protective clothing and equipment may also be used. The equipment necessary to implement the ALARA policy will be dependent on the specific tasks involved. In some instances, the work will be planned so special protective equipment will not be necessary to limit exposures.

The RSO (and ARSOs) shall have sufficient delegated authority to enforce regulations and administrative practices concerning any aspect of the radiological safety program.

A management review will be performed periodically to assess the effectiveness of the ALARA program. In particular, work area and perimeter air sampling and other data results will be evaluated to ensure that personnel exposures are maintained as low as practicable.

The programs to implement these principles are described in the sections of this plan. In addition, standard safe work practices and physical hazard control constraints, which will be enforced to help assure ALARA work conditions, are summarized in Section 11.0.



#### **4.1 Reviews and Revisions of Administrative Changes**

If a change or revision to the RHSP, a RWP or a SOP is required, the change is presented to the RSO for initial approval. It is then presented to the ALARA committee for approval and implementation. The ALARA committee meets on a monthly basis during operation. If a change is needed before the regularly scheduled meeting, a special meeting will be called. Documentation of approval will be in the minutes of the ALARA meeting.



## 5.0 Background Information

### 5.1 Material

The radioactive material at the Bay City site consists primarily of foundry slag containing low-levels of thorium. This material was produced in the period from 1940 to 1970 as the residual from the production of magnesium-thorium alloy. This lightweight alloy was used for defense purposes, including aircraft engines and aeronautical structural components. The slag was originally stored, with plans for reclamation, on the two Dow properties. Some other thorium-contaminated material from a decommissioned third site was added to the Bay City pile in 1985.

A single license (STB-527) was originally granted by the NRC in 1973 for the Bay City and Midland sites to store up to 200,000 pounds of thorium as slag. This license expired in 1978, but has remained in effect under timely renewal. The Midland site has been verified clean and released from this license by the NRC.

The material slated for removal consists of magnesium with up to two-percent thorium. In its present state, portions of the process slag have been mixed with soil or limited amounts of construction debris (about 1% of the total volume); in addition, there has been some emplacement of the material outside the boundaries of the Bay City site. As a result of this mixing, the thorium concentrations, as determined by Dow soil sampling, vary from 2 - 7,000 pCi/g at the Bay City site. The estimated total activity of 9.7 Ci of Th-232 is distributed through approximately 60,000 cubic yards of slag, soil and construction debris.

Dow has contracted URS (formerly Radian International) to remove the thoriated material from the site

### 5.2 Bay City Storage Area Parameters

The Bay City site is located on property owned by Dow near the town of Bay City, Michigan about one-mile south of Saginaw Bay. Figure 5-1 shows the affected area, as defined by NUREG/CR-5849. As shown, the affected area encompasses a region beyond the original thorium pile.

The thoriated material at Bay City is located adjacent to and north of an inlet canal,

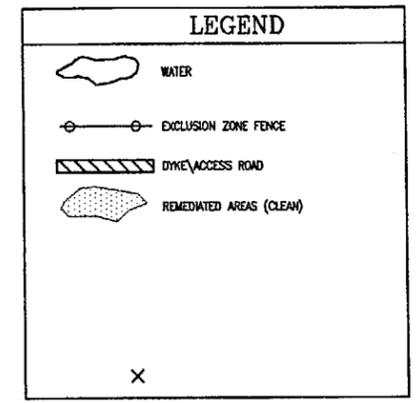
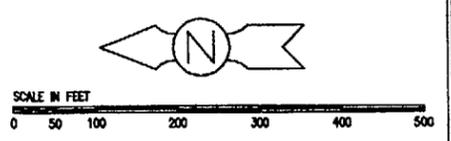
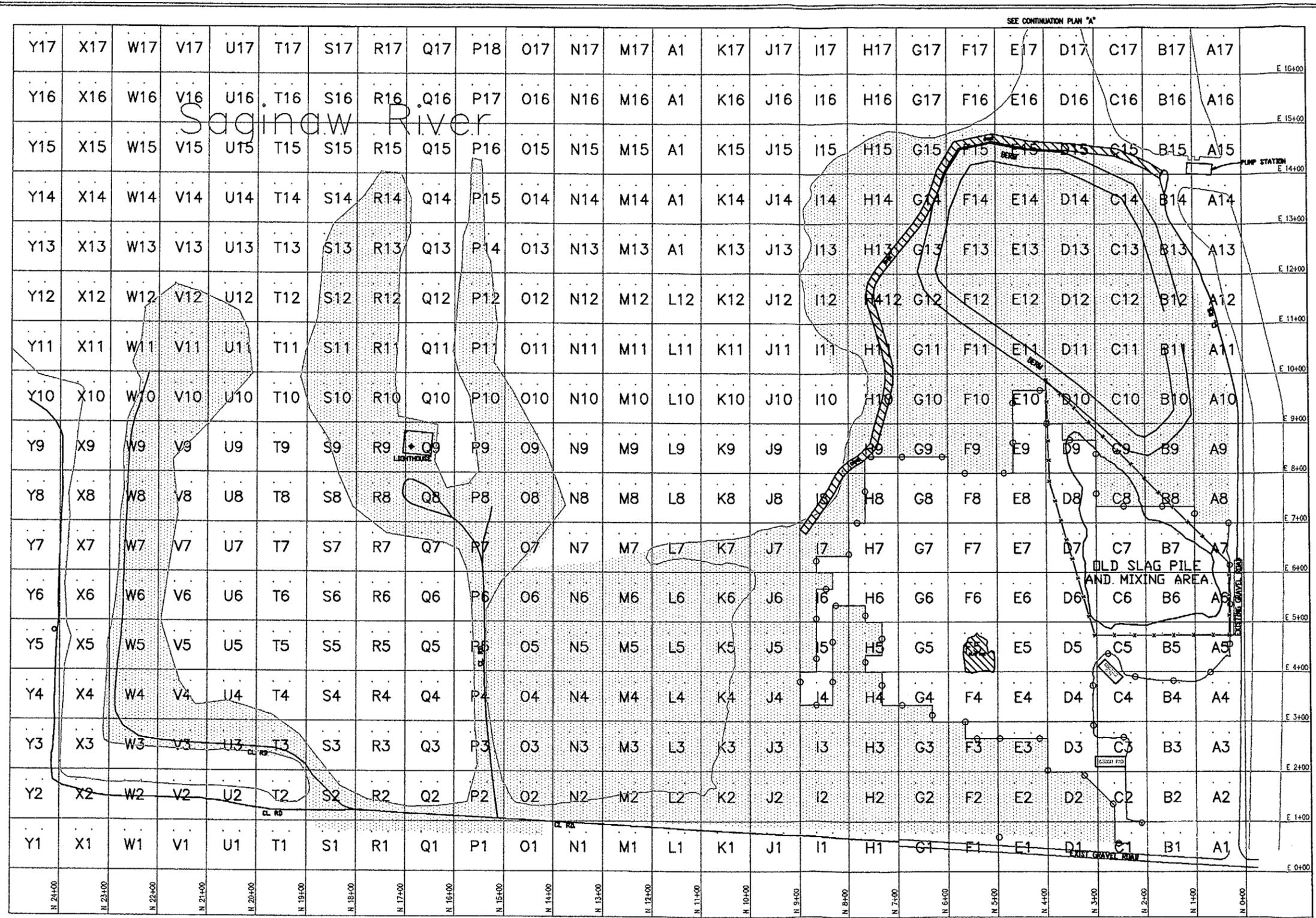


which enters the Saginaw River to the east. The Saginaw River as shown on Figure 5-1 is located to the north and east of the material.

The area surrounding the material is relatively level, with some marshy areas and ponds. Typically the material sits approximately 5 to 10 feet above the water level in the inlet canal.

The highest concentration Bay City material was partially covered with an asphaltic sealant and fenced. However, this material has since been excavated and shipped to Envirocare of Utah for disposal.

The affected area includes all areas that have potential radioactive contamination (based on operating history) or known radioactive contamination (based on radiological surveillance). Areas immediately surrounding the Bay City pile storage area are included in this classification because of the potential for inadvertent spread of contamination. The unaffected areas are not expected to contain residual radioactivity based on knowledge of site history and existing survey information. Figure 5-1 depicts the previously surveyed area.



NOTES:  
1. COORDINATE GRID SHOWN IS A LOCAL SITE GRID.

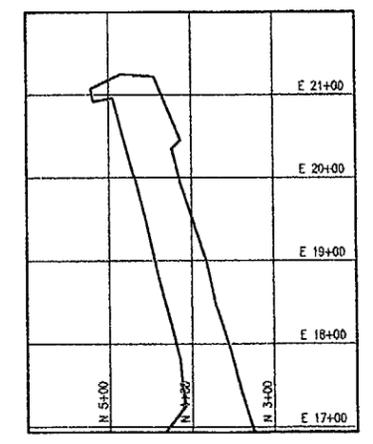


Figure 5-1: THORAD SITE BASE MAP

DRAWN BY: JLB	DATE: 6/30/00	SCALE: AS SHOWN
CLIENT: DOW CHEMICAL CO.	JOB NO.: 007133	
DWG. NO.: 0300	REV.:	1



## **6.0 Site Access Control**

Access to the Bay City storage site for personnel, vehicles, and equipment is restricted by fences and locked gates. All personnel requiring access to a site will be admitted by a designated safety officer at a specified gate, sign the site access control register, and, as necessary, be issued a personal dosimeter. A copy of the register will be maintained at the site. Access control procedures and a copy of the access control roster are contained in SOP 1.1 Access Control Procedures, focused in Appendix B.

The contaminated areas are posted with signs at points of potential access bearing the radiation caution symbol and the words "Caution Radioactive Materials". Such postings will be maintained during remedial operations.



## **7.0 Worker Training and Medical Requirements**

### **7.1 Worker Training**

A formal 4 -hour training program will be provided by the RSO or their designee to workers before they begin on-site work in potentially contaminated areas. The training will be commensurate with the work hazard and will include discussions of the remediation project, industrial and radiological safety procedures (to include "Stop Work Authority"), emergency and contingency procedures. The potential for encountering hazardous materials on the sites, and emergency telephone numbers, first aid, and location of first-aid stations and hospitals will also be discussed.

The training will also include the highlights of this RHSP, detailed description of decontamination procedures, and respirator use and fit testing pursuant to 29 CFR 1910.134. Practical demonstrations will be given in self-monitoring for contamination on workers. Adequate information regarding known radioactive and physical hazards that may be encountered on-site will be provided.

A written test is given upon completion of the initial training. The new employee is assigned to work with an experienced employee until it is judged that the new employee is proficient at the task.

Annual Radiation Refresher training will be provided by the HSO, RSO or designee. It consists of a review of the topics listed in Table 7.1

The RHSP and SOPs are reviewed by the RSO annually for any changes in procedures that may be required. If a change has occurred, each employee is trained on the new procedure. That training is documented by signing the training attendance provided at the sessions. The employee is observed until it is judged that they are proficient at the new method or procedure.

Visitors will receive training on the specific hazards they may encounter. Documentation of the training of each employee will be retained. A representative site-specific training outline is provided in Table 7.1.



Prior to beginning work at a new location or when working conditions change, the RSO or designee will provide a briefing to workers stating the nature of hazards and the extent of contamination to be encountered that day, and an explanation of safety equipment to be used.

The RSO shall identify those individuals requiring First Aid and CPR training in order to ensure that emergency medical treatment is available during field activities. It is expected that at least two members of the field team will have First Aid and CPR training. The training will be consistent with the requirements of the American Red Cross Association.



Table 7.1  
Site Radiation Safety Training Outline

1.0	Site-General History
2.0	Fundamentals of Radiological Health Protection 2.1 Background Radiation - Sources 2.2 Alpha Particle Radiation 2.3 Beta Particle Radiation 2.4 Gamma Radiation 2.5 Half-Life 2.6 Exposure Pathways 2.7 Instruction Concerning Prenatal Radiation Exposure 2.8 Risk 2.9 ALARA
3.0	Site Radiation Health and Safety Practices and Worker Responsibilities 3.1 General 3.2 Control Area and Potentially Contaminated Areas 3.3 Clean Areas 3.4 Postings
4.0	Personnel Hygiene Practices 4.1 Protective Clothing 4.2 Respiratory Protection 4.3 Worker Hygiene 4.4 Decontamination
5.0	Control Measures Dust Suppression 5.1 Engineering Controls 5.2 Procedural Controls
6.0	Radiological Monitoring 6.1 Airborne Particulate Monitoring - Lapel and General Area Sampling 6.2 Gamma Exposure Rate Surveys 6.3 Gamma Count Rate Surveys 6.4 Gamma Spectrometry 6.5 Bioassay 6.6 Whole Body Counting - Invivo 6.7 Personnel and Equipment Contamination Release Surveys 6.8 Personal Dosimetry - TLD
7.0	Emergency Procedures
8.0	Regulatory Authority 8.1 U.S. Nuclear Regulatory Commission (NRC) 8.2 Occupational Safety and Health Administration (OSHA)

ALARA - as low as reasonably achievable

TLD - thermoluminescent dosimeter



All personnel authorized to wear personal radiation exposure monitoring devices, thermoluminescent detectors (TLD), shall submit prior occupational radiation exposure records (USNRC Form 4 or equivalent) prior to TLD issue. The RSO or designee shall review all exposure history records prior to TLD use.

All contractor personnel will comply with the site Radiological Health and Safety Plan and be responsible to the RSO or designee.

A worker under age 18 shall neither be employed in, nor be allowed to enter, controlled areas.

Visitors to the sites shall be required to comply with all health and safety restrictions provided in this document. A trained site worker will accompany visitors at all times. Visitors must sign into the access log to gain access to the sites.

#### **7.1.1 Hazard Communication Training**

Hazard Communication training covering 29 CFR 1910.1200 will be conducted as part of the site-specific training and on an as needed basis during the life of the project. The training will include the following:

- Requirements of the standard;
- Operations involving hazardous chemicals;
- Location and availability of the written program, chemical list and MSDSs;
- Methods used to detect the presence or release of hazardous chemicals;
- Physical and health hazards of the chemicals; and
- Protective measures, work practices, and emergency procedures.

The OSHA and the NRC posters will be posted at the site in a conspicuous place (Appendix C and Appendix D).

#### **7.2 Medical Requirements**

An occupational physician shall clear all personnel performing work at the Bay City site for work. The occupational physician shall evaluate the physical condition of the site employees to ensure the employees are in good health to perform the work that is required of them.



Site personnel, except non-working supervisory personnel and visitors who are typically observing work from a distance, will participate in an annual medical monitoring program and a respirator fit test. The objective of the medical monitoring program is to determine the medical competency of employees who work while wearing respiratory protection and those who work under the heat and physical stress that may be encountered in the work place. Only those employees determined to be physically capable will be eligible for respiratory fit testing and training and/or assigned work involving physical stress pursuant to 29 CFR 1910.134.

Prior to initiating work, a work-related radiation exposure history shall be acquired and maintained for each employee working in a controlled area. At the discretion of the RSO, baseline bioassay measurements may be required of personnel prior to working in areas of potential airborne radioactivity.



## **8.0 Hazard Assessment**

The following sections discuss the hazards, which could potentially be encountered on-site.

### **8.1 Radiological Hazards**

The radiological constituents present in the slag and soil at the Bay City site is Thorium-232, Thorium-230, and their associated decay products. Thorium-232 is at the head of its decay series while thorium-230 is a constituent in the Uranium-238 decay series.

The radiation from the radiological constituents present at the sites could pose both external and internal radiation hazards during remedial activities. Some of the radionuclides in these two series, during decay, emit gamma radiation which is a potential external hazard to the body.

Thorium-230 and 232 and their daughters also emit alpha radiation. Inhalation of airborne alpha activity is the primary internal exposure pathway, which could occur from breathing contaminated dust. A secondary internal pathway is ingestion of alpha contamination transferred from a worker's hands or clothing.

Monitoring programs to be conducted during remedial activities to detect elevated levels of radioactivity in the environment and contamination on surfaces are discussed in Sections 10.0 and 12.0 along with relevant action levels.

### **8.2 Physical Hazards**

A variety of physical hazards may be present during site activities. The most common hazards are slips, trips, falls, cold and heat stress and noise effects. The weather related stress and noise effects are often not obvious, and are therefore discussed below. Other physical hazards are due to the use of hand and power tools and handling and storage of solvents and fuels.

These hazards are not unique and are generally familiar to decontamination workers. Additional specific hazards may be covered during safety briefings at the project site.



## **8.2.1 Heat-Related Illnesses**

If site activities are conducted in the summer, there is a potential for personnel suffering from heat related illnesses. Additionally, the use of personal protective equipment increases the potential even further. Heat Stress is a significant potential hazard, associated with the use of protective equipment in hot weather environments. The following sections briefly discuss the heat-related illnesses and emergency response actions.

### **8.2.1.1 Heat Cramps**

Heat cramps are brought about by long exposure to heat. As an individual perspires, water and salt is lost by the body resulting in painful muscle cramps. The signs and symptoms of heat cramps are as follows:

- Severe muscle cramps, usually in the legs and abdomen;
- Exhaustion often to the point of collapse; and
- Dizziness or periods of faintness.

First aid treatment consists of providing shade, rest and fluid replacement. Normally, the individual should recover within 30 minutes. If the individual does not recover within 30 minutes, the individual should be transported to a hospital for medical attention.

### **8.2.1.2 Heat Exhaustion**

Heat Exhaustion usually occurs in an individual who has been exposed to excessive heat while working or exercising. The circulatory system of the individual begins to fail as blood collects near the skin in an effort to relieve the body of excess heat. The signs and symptoms of heat exhaustion are as follows:

- Rapid and shallow breathing;
- Weak pulse;
- Cold and clammy skin with heavy perspiration;
- Pale skin;
- Fatigue and weakness;
- Dizziness; and
- Elevated body temperature.



First aid treatment consists of cooling the victim, elevating the feet and replacing fluids. If the individual has not recovered within 30 minutes, the individual should be transported to a hospital for medical attention.

### **8.2.1.3 Heat Stroke**

Heat stroke occurs when an individual is exposed to excessive heat and stops sweating. This condition is classified as a **medical emergency**, requiring immediate cooling of the patient and transport to a hospital. The signs and symptoms of heat stroke are as follows:

- Dry hot red skin;
- Body temperature approaching or above 105°F;
- Large (dilated) pupils; and
- Loss of consciousness - the individual will go into a coma.

First aid treatment consists of cooling the patient and transport to a hospital immediately.

Working with personal protective equipment in hot weather may produce circumstances, which will require restricted work schedules in order to protect employees. Should work remediation activities proceed into the summer, a Wet Bulb Globe Temperature (WBGT) Index will be used to establish a work/rest cycle during hot climate.

If the measured WBGT exceeds 86°F (76°F when workers are wearing semi-impermeable or impermeable clothing), the work/rest cycle given in Table 8.1 will serve as a guideline. The use of work/rest cycle and training on signs and symptoms of heat related illnesses should prevent them from occurring.



**Table 8.1**  
**Permissible Heat Exposure Threshold Limit Values**  
(Values are given in °F WBGT)

Work/Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous Work	86	80	77
75% work - 25% rest, each hour	87	82	78
50% work - 50% rest, each hour	89	85	82
25% work - 75% rest, each hour	90	88	86

- When workers are wearing semi-impermeable or impermeable clothing, subtract 10°F from the WBGT value in the above table.
- Rest means minimal physical activity. Rest should be accomplished in the shade. Any activity requiring only minimal physical activity can be performed during rest periods.

### 8.2.2 Cold Stress

If work continues during winter months, then workers may be exposed to the hazards of working in cold environments. Potential hazards in cold environments include hypothermia and frostbite, physical conditions which gradually result over time of exposure and which result often in personnel employing poor judgment and taking short cuts, as well as involving the physical hazards of slips, trips and falls on icy surfaces.

Progressive clinical symptoms of hypothermia include:

<u>Core Temperature (°F)</u>	<u>Symptoms</u>
98.6	Normal rectal temperature
96.8	Metabolic rate increases
95.0	Maximum shivering
93.2	Victim conscious and responsive
91.4	Severe hypothermia



89.6 - 87.8

Consciousness clouded, blood pressure difficult to obtain, pupils dilated but react to light, shivering ceases

Core Temperature (°F)

Symptoms

86.0 - 84.2

Progressive loss of consciousness, muscular rigidity increases, pulse and blood pressure difficult to get, respiratory rate decreases

78.8

Victim seldom conscious

64.4

Lowest accidental hypothermia victim to recover

In order to minimize the risk of the hazards of working in cold environments, workers will be trained and periodically reinforced in the recognition of the physiologic responses of the body to cold stress. In addition, the use of insulated work clothing, warm shelters and work/warm regimens may be used to minimize the potential hazards of cold stress. Also, special attention will be paid to equipment warm-up time and freeze protection for vessels, piping, equipment, tools and walking/working surfaces.

### 8.2.3 Noise

During site activities, equipment will be used which may require the use of ear protection due to elevated noise levels. Disposable earplugs or other hearing protection will be required when working with or around this equipment.

## 8.3 Biological Hazards

During the course of the project, there is potential to come into contact with certain biological hazards including insects and plants while on-site.

### 8.3.1 Insects

Insects such as mosquitoes, ticks, bees and wasps may be present at the site during certain times of the year. Workers will be trained during site-specific training and as part of a daily safety briefing to recognize and to minimize contact with these insects.

Workers will be encouraged to use insect repellent when working in areas where insects may be present. If insects present a potential problem, efforts will be made to further protect workers and/or remove them.



Any worker that is allergic to bee/wasp or other insect stings must inform the RSO of the medical condition prior to starting work. The medical staff at the hospital will be informed of the condition and steps taken to prepare for this type of medical emergency.

Ticks can transmit microorganisms that can cause several diseases, including Lyme Disease and Rocky Mountain Spotted Fever. Ticks adhere tenaciously to the skin or scalp. There is some evidence that the longer an infected tick remains attached, the greater the chance it will transmit the disease.

It is recommended that personnel check themselves when in areas that could harbor deer ticks, wear light color clothing and visually check themselves and their buddy when coming from wooded or vegetated areas. If a tick is found biting an individual, the RSO or designee should be contacted immediately. If personnel feel sick or have signs similar to those above, they should likewise notify the RSO or designee immediately.

### **8.3.2 Plants**

Plants such as poison ivy, poison oak and stinging nettles may be present at the site during certain times of the year. Workers will be trained during site-specific training and as part of a daily safety briefing with periodic reinforcement to recognize these plants and to minimize contact with them.

## **8.4 Control Measures for Physical Hazards**

Control measures for the physical hazards identified in Section 8.2 are described below.

### **8.4.1 Drill Rig Operations**

- Conduct pre-work inspections of all parts of the equipment;
- Use in accordance with the Operator's Manual/Manufacturer's Specifications;
- Remove/replace broken/damaged parts;
- Use the designated personal protective equipment for the task; and
- Ensure minimum of 10 feet of clearance from overhead power lines.



#### 8.4.2 Hand and Power Tools

- Conduct pre-work inspections of all parts of the equipment;
- Use in accordance with the Manufacturer's Operations and Maintenance Manual'
- Remove/replace broken/damaged parts;
- Use the designated personal protective equipment for the task;
- Use the tool for its intended purpose;
- Ensure that all electrical tools are grounded; and
- Use ground fault interrupters.

#### 8.4.3 Slips/Trips/Falls

- Pay careful attention to walking surfaces, especially when they are wet or icy;
- Clear water, ice or spills as quickly as possible off walking surfaces or in high traffic areas;
- Do not take short cuts over fences or walls;
- Do not jump over excavations;
- Any platform area higher than 4 feet will have standard guard railings and toeboard;
- Use non-slip surfaces when constructing platform, if possible; and
- Use fall protection for work higher than 6 feet of potential free-fall.

#### 8.4.4 Lifting

- Perform limbering exercises prior to lifting loads;
- Obtain help for heavy weights and bulky objects;
- Communicate with other workers;
- Face object, plant feet at shoulder length apart, use the best hand holds, keep back straight and lift with the center of strength in the legs not in the back;
- Do not twist while handling the load; and
- Use caution when manually shoveling heavy material, move small loads and follow the proper lifting procedures.

#### 8.4.5 Fire Protection

- No smoking in work areas;
- At least one fire extinguisher rated at least 1A, 10:BC will be located in each work area; and
- Inspect all fire extinguishers monthly by site personnel and annually by licensed personnel.



#### **8.4.6 Motors and Pumps**

- All electric motors will have ground fault interrupters (GFI) in place;
- All rotating parts, gears or chains will be properly guarded; and
- All pumps shall have pressure relief devices.

#### **8.4.7 Electrical Equipment**

Any work involving the installation of electrical equipment or the use of electrical apparatus or appliances shall comply with the provisions of NFPA 70, the National Electric Code which has been adopted by OSHA 29 CFR 1910 and 29 CFR 1926. Electric installations themselves shall meet the requirements of the authority having jurisdiction.

In general, electrical requirements to be adhered to at the site include but are not limited to the following:

- Use of GFI's on all electrical tools/equipment being used during decontamination activities;
- Use of multiple pronged (grounded) electrical power supply systems and appliances unless double insulated;
- Restrictions or limitations on the use of flexible (extension) cords;
- Clearance requirements for electrical service boxes;
- Grounding provisions for fixed equipment;
- Use of explosion-proof equipment for hazardous locations, as specified in articles 500-503 of the NEC; and
- Lock-out/Tag-out requirements on equipment being serviced.

#### **8.4.8 Welding/Burning/Cutting**

- Use of permit;
- Use of proper personal protective equipment (face shields, gloves, etc.)
- Fire protection; and
- Monitoring requirements.

#### **8.4.9 Drum Moving**

- Full drums will not be moved without mechanical assistance (e.g., a drum dolly);
- Inspect drum lids/seals for damage;
- Communicate with other personnel helping to move drums;
- Avoid pinch points;
- Ensure that pull drum lids are tightened prior to moving;



- Use pallets to provide easier means of movement; and
- Use leather workgloves while handling drums where possible.



## 9.0 Work Area Control

Access to the site will be controlled to protect workers from unnecessary radiation exposure and to minimize the potential for spread of contamination. These controlled areas will be conspicuously marked according to applicable posting requirements.

Each site shall be divided into the following three zones:

- Contamination (Exclusion) Zone;
- Contamination Reduction Zone; and
- Clean (Support) Zone.

### 9.1 Contamination Zone

This zone includes the actual areas of contamination (uncovered thoriated material under excavation in the designated affected area). This zone has the highest inhalation exposure potential and/or presents a high probability of skin contact. It will be clearly delineated by fencing, cones, tapes, or other means. Entry and exit point(s) to and from this zone will be strictly controlled and decontamination facilities will be set at all such points. Personnel are not allowed in this zone without a buddy, site-specific training, and wearing appropriate personal protective equipment.

All work done in this zone will be performed under a Radiation Work Permit (RWP). RWP procedures are contained in SOP 1.10, Radiation Work Permit, found in Appendix B.

The surface contamination action limits in the contamination zone are 26 dpm/100cm<sup>2</sup> removable and 129 dpm/100cm<sup>2</sup> total alpha (average) for total thorium for equipment and solid debris surfaces.

### 9.2 Contamination Reduction Zone

This zone includes the areas immediately surrounding the Contamination Zone, and includes the contamination reduction corridor, and personnel, vehicle and equipment decontamination stations. This zone will be used for general site entry and egress in addition to access for heavy equipment and emergency support services. It has the next highest inhalation hazard but does not have a high probability of skin contact.



Contamination limits within this zone will be maintained at  $<26$  dpm/100cm<sup>2</sup> removable and  $<129$  dpm/100cm<sup>2</sup> total alpha (or equivalent beta).

### **9.3 Clean (Support) Zone**

This zone covers all areas outside of the Contamination Reduction Zone. Adverse exposure in this zone is unlikely since it is an uncontaminated area. Field support for most operations including field team communications, sanitary facilities, and safety equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. As areas of the sites are decontaminated, they may be fenced and also managed as clean areas.

Access to these zones shall be controlled for people, vehicles, and equipment by fencing and posting the area or by using other methods to prevent inadvertent exposure to contaminated material.

Smoking, drinking, eating, or other activities that would enhance the transfer of radionuclides into the human body shall be prohibited within the Contamination and Contamination Reduction Zones.

All site activities will be conducted to minimize the generation of airborne dust. Dust suppression measures, including wetting the roadways and work areas, providing sprays or mists during loading operations, and instituting vehicle speed limits, will be used at all times if any visible dust is evident. In addition, respiratory protection will be employed as described in Section 10.2.



## **10.0 Radiological Monitoring**

This section provides information on the parameters of the site personnel and environmental monitoring programs, use of personnel protective equipment, administrative controls, and sample control procedures.

### **10.1 Monitoring Equipment Calibration and Maintenance**

Daily, before use, field monitoring instruments such as alpha scintillometers and Geiger-Muller counters will be efficiency-tested using a National Institute of Standards and Technology (NIST) source or sources with known levels of radioactivity. In addition, all radiation monitoring equipment will be calibrated and serviced annually unless damaged. All monitoring equipment will be recalibrated after repair. Sealed radioactive sources are used in instrument calibration and efficiency testing. All sources have been chosen such that they are exempt quantity sources and do not require licenses. The pressurized ion chamber will be calibrated at a facility licensed to perform such work.

Radioactive sources used in efficiency testing and calibration will be shipped according to relevant NRC regulations, and to Department of Transportation regulations 49 CFR 171-178 (CFR 1997).

The onsite laboratory consists of three Multi Channel Analyzers. The calibration and maintenance program for the gamma spectroscopy equipment employs a background sample, a spike sample taken from the site, and a NIST traceable multi-gamma source sample. Each day prior to use, the system is checked with each of the above samples for 15 minutes. A report is printed and the counts are converted to activity and then compared to the known activity. If the relative percent difference between the known activity and the analytical results is less than 10% for the NIST standard and less than 20% for the spike and background samples the unit is determined to be functioning properly. If the unit does not meet these criteria the sample is rerun (a maximum of 3 times) to balance statistical counting errors. If it still does not pass, the unit is recalibrated.



One hundred percent of all verification samples and ten percent of the survey samples collected & analyzed at Bay City are sent to Dow's Freeport, Texas, laboratory for quality assurance/quality control (QA/QC). Verification samples are representative dirt samples used to verify if an area is qualified for exclusion from the Controlled Area. Ten percent of all samples sent to Freeport are sent to an outside laboratory for QA/QC.

To calibrate, the NIST source and a spike are counted for one hour each. Peaks and regions of interest (ROI) are marked. Gammavision software is utilized at both laboratories, which allows the lab technicians to name each ROI and assign efficiencies for each peak (nuclide). The sources used are mentioned above. The NIST source contains seven different nuclides, which are listed in table 17.1. The NIST sources are decay corrected every quarter as determined by site policy. After the calibration, the unit is function checked as described above before being used.

Results from Freeport are compared to Bay City's results. If there is a discrepancy, the sample data and function checks are examined. If necessary, the sample is re-counted at both laboratories and the error is investigated internally. The same procedure is used for the QA/QC of the Freeport lab with the outside lab.

The Dow staff responsible for performing the soil analyses onsite have the training described in table 7.1 (page 7-2) and additional hands-on-training on the MCAs.

Dr. Keith Frank and Dr. Jaime Simon's of The Dow Chemical Company are responsible for performing the soil analyses. Their resume listing their qualifications was in the original Radiation Health and Safety Plan.

Table 17.1 Activities of NIST Source

<u>Nuclide</u>	<u>Activity (microCuries)</u>
<u>Eu-155</u>	<u>0.078</u>
<u>Co-57</u>	<u>0.092</u>
<u>Sn-113</u>	<u>0.108</u>
<u>Cs-137</u>	<u>0.049</u>
<u>Mn-54</u>	<u>0.109</u>
<u>Zn-65</u>	<u>0.139</u>
<u>K-40</u>	<u>0.087</u>



## **10.2 Personnel Monitoring and Protective Equipment**

Personnel leaving the Contamination Zone or coming into contact with potentially contaminated material will be monitored with a portable alpha detector (see Appendix B, SOP 1.2, Total Alpha Surface Contamination Measurements). A thin-window GM will also be used to measure beta contamination levels. Any contaminated clothing such as gloves, boot covers, and coveralls will be removed and cleaned or placed in a designated contaminated clothing container. For any reading above background on the actual skin, personnel will be required to wash the contaminated area and have the area re-surveyed until background levels are achieved or approved by the site RSO or his designee. Based on previous experience, skin contamination is easily removed by washing.

All personnel working with licensed material, or in an area where licensed material is present, will be monitored. On-Site workers will be issued individual thermoluminescent dosimeters (TLDs) to monitor their external exposure as appropriate (see Appendix B, SOP 1.3, External Dosimetry Procedure). The TLDs will be worn under protective clothing to prevent possible contamination. All TLDs, as well as controls, will be located in the Clean Zone when not in use. A third-party vendor will read them quarterly during periods of high activity. Otherwise, they may be read semiannually.

The air-sampling program, as described herein, will follow the guidance provided in NRC Regulatory Guide 8.25, Air Sampling in the Workplace, and 8.34, Monitoring Criteria and Methods to Calculate Occupational Radiation Doses.

Occupational general area airborne particulate sampling with RAS-1 intermediate volume air samplers, with flow rates of 60 to 80 liters per minute, will be conducted at work locations each work day according to SOP 1.6, Intermediate Volume Air Particulate Sampling. Locations of sampling stations will be determined based on the prevailing wind direction observed on-site, site activities, and source terms. Air samples will be collected at a height of 1 to 1.5 meters above ground level in locations free from unusual micrometeorological or other conditions that could result in artificially high or low concentrations. General air monitoring will be performed daily or whenever site work activities have the potential for releasing airborne radioactivity. If airborne concentrations



of radioactivity in the work area exceed 25 percent of the concentration limits for insoluble thorium 230 ( $1 \times 10^{-12}$ ) as stated in 10CFR Part 20 Appendix B Table 1, then personnel will be required to don air purifying respirators and associated Level C protective equipment. Personnel performing critical jobs such as the loader operator will also work in Level C protective equipment. Modified Level C protection consists of steel toed safety shoes, boot covers, long sleeve disposable coveralls, cloth gloves, a full face air purifying respirator, hearing protective devices (as required) and a hard hat. Any personnel not properly trained, not properly fitted, or not medically certified to use respirator equipment will be required to leave the area of elevated airborne activity. The respirator fit tests will be conducted according to SOP 1.11, Respiratory Protection Program. Under work conditions where the monitoring results indicate that the thorium action level is not exceeded, personnel will use level D protection equipment (no air purifying respirator).

In addition, a high volume (Hi Vol) air sampler maybe used to assist in assessing the airborne particulate concentrations in the work area environment (see SOP 1.18, Sampling of Airborne Particulates\_using High Volume Air Samplers).

The THORAD Project performs bioassay analysis based on routine and non-routine criteria. All individuals receiving routine and non-routine in vivo analysis (whole body count) will be directed to the Big Rock Nuclear Power Plant in Charlevoix, Michigan. The analysis will be performed in accordance with their standard operating procedures, as approved by the Nuclear Regulatory Commission (NRC).

Routine bioassay measurement is required for the following:

1. New employees assigned to the Project should receive a baseline/entrance bioassay measurement prior to receiving a TLD unless they have never entered a Radiological Controlled Area or otherwise determined by the RSO.
2. When an individual is no longer requires access to the "Controlled Area" due to termination, then an exit Whole Body Count (WBC) will be scheduled, unless otherwise determined by the RSO.



A non-routine bioassay is required when an individual is suspected of having received an unplanned intake of radioactive material.

In addition, gamma exposure rate surveys, using hand-held detectors, will be conducted in the work area (see SOP 1.4, Beta-Gamma Radiation Measurements Using a Geiger-Muller Director; SOP 1.5, Measurement of Gamma-Ray Fields Using a Sodium Iodide (NaI) Detector.

All exposures, internal and external, will be documented and maintained at the site in worker radiation exposure files. In addition, all workers will be required to provide documentation of previous exposure history prior to beginning work at the site.

Basic emergency and first aid equipment will be available at the Support Zone and/or the Contamination Reduction Zone. They will include one (1) standard industrial first air kit, one (1) fire extinguisher rated at least 1A, 10:ABC, one (1) portable emergency eyewash limit, and air hose (at least one).

### **10.3 Environmental Monitoring**

The radiological constituents present in the slag and soil at the Bay City site is thorium-232, thorium-230, and their associated decay products. These radiological constituents could pose an internal radiation hazard with inhalation of airborne alpha activity being the primary exposure pathway. The airborne thorium-232, thorium-228, and thorium-230 concentrations will be controlled by a measurement of gross alpha emissions from air particulate filters, assuming that all emissions arise from the decay of thorium-232, the most restrictive isotope. At least a 72-hour decay period will be used prior to analysis to allow time for the decay of radon-222 and radon 220. For each project at the site during which 15 or more daily air samples indicate a gross alpha air concentration greater than 10% of the insoluble thorium-232 concentration in 10CFR Part 20, Table 2, the filters will be saved for an isotopic analysis upon completion of the project.

#### **10.3.1 Perimeter Environmental Air Monitoring**

RAS-1 intermediate volume air samplers will be stationed at various locations along the site perimeter, as determined by the RSO, to assess thorium-228 and 230 concentrations and demonstrate compliance with 10 CFR Part 20. Locations of sampling stations will be



determined based on wind rose data gathered by Saginaw airport (Tri-Cities) and demographic factors. Because there are no stack emissions associated with site activities, maximum off-site concentrations from dust that may be produced are assumed to occur at ground level near the site boundary. Air samples will be collected at a height of 1 to 1.5 meters above ground level in locations free from unusual micrometeorological or other conditions that could result in artificially high or low concentrations. Locations will be selected to avoid areas where large-particle (non-respirable) fugitive dust can dominate the sample. Monitoring will be continuous for 24 hours a day. The filters are changed out weekly with isotopic analysis required for most samples or composites of samples. Background measurements will be made prior to beginning work in order to determine the area background particulate radioactivity, as well as to assess the air quality impact of site operations at the site perimeter. Sampling will decrease only if there are no anomalous results of any trends in the increase in the background concentrations. A minimum sampling rate of 60 L/min (no more than 80 L/min) will be sufficient to determine whether off-site concentrations are exceeding the general public limit for thorium-228 and 230 of  $2 \times 10^{-14}$   $\mu\text{Ci/mL}$ . Sampling will be performed in accordance with SOP 1.6.

### **10.3.2 Background Thorium-228, Radon-222, and Radon-220 Concentrations**

Natural background concentrations of thorium-228, radon-222, and radon-220 will be assessed to indicate their contribution to on-site and off-site air concentrations. The control background station will be located at a suitably chosen background location in the unaffected area. SOP 1.6 will be used to measure background concentrations of long-term gross alpha, isotopic thorium, radon-222, and radon-220. Thorium control concentrations using gross alpha results will be determined on weekly basis from continuous air sampling (24 hours a day).

### **10.4 Clean Area and Laboratory Monitoring**

Administration offices and laboratory facilities will be located within the designated clean (unaffected) area. The areas outside and within the facility not used for analytical work will be maintained as clean areas. Clean areas inside the facility will be inspected daily and monitored weekly during periods of site activity according to SOPs 1.1 and 1.7,



Sampling for Removable Alpha Contamination. The laboratory equipment used to measure removable alpha contamination (SOP 1.7) is sufficient to detect near background levels of activity. Any contractor clean areas developed at the site inside the control area will require the same inspection and monitoring frequency. All clean areas inside the control area will be posted "CLEAN AREA." Potentially contaminated clothing, tools and equipment may not be stored in clean areas.

The facilities will also include a short-term sample storage room, analytical laboratory, and general chemistry laboratory with a vented fume hood. The entryways to these areas and the fume hood will be posted "CAUTION RADIOACTIVE MATERIALS." These areas will be treated and controlled as potentially contaminated areas, but will be inspected and monitored as clean areas in order to prevent the possible spread of contamination to the clean areas inside the facility. These laboratory areas will be kept clean to minimize exposure to personnel as well as to prevent the potential spread of contamination. Smoking, drinking, chewing, and eating will be prohibited at all times in the general chemistry laboratory and sample storage room. The doors to these rooms will be kept closed during work activities.

### **10.5 Sample Control, Handling, Packaging and Shipping**

Samples are collected in the potentially contaminated (affected) area and placed in 2-liter Marinelli beakers. The exteriors of the beakers are wiped with a clean towel to remove potential exterior contamination. For samples of slag material, the exteriors are cleaned and surveyed for total contamination (SOP 1.2) to ensure that there is not detectable external contamination present. The beakers containing contaminated slag material will be labeled "CAUTION RADIOACTIVE MATERIAL." No slag sample will be removed from the affected area without this label.

The samples will be brought to the on-site laboratory for analysis. The samples may be analyzed using gamma spectroscopy without additional sample handling. These samples may be stored in the sample storage room for short periods of time. However, the quantity and storage time will be limited since the presence of the samples may affect the analytical laboratory radiological background, thereby creating analytical errors.



Samples analyzed for hazardous substances may be removed from the Marinelli beaker and tested using various techniques. Dry dispersible material will be handled in the vented fume hood within the general chemistry laboratory. All liquid wastes will be collected or discharged to the laboratory sink where they are routed to a holding tank. The holding tank contents will be tested prior to off-site release to ensure compliance with all environmental regulations. The radioactive assay will be compared with the criteria specified in 10 CFR 20. Upon completion of the laboratory work, any sediments having radionuclide concentrations above background will be disposed of as radioactive waste.

Any samples of radioactive material to be analyzed off-site (QC samples) will be shipped in accordance with relevant NRC and DOT regulations and SOP 1.8, Guide to the Handling, Packaging, and Shipping of Samples. SOP 1.9, Sample Control and Documentation, applies to all samples collected on-site.



## 11.0 General Standard Operating Procedures for Field Operations

To assure that operations associated with the remediation of the thorium contaminated storage areas are conducted at the highest level of safety and that all releases and exposures are maintained at ALARA levels, the following practices will be followed:

### 11.1 Standard Safe Work Practices

- A RSO or designee will be present on-site at all times during radiological characterization survey activities and shall provide all monitoring and health and safety support in order to ensure the adequacy of protective equipment and safety procedures.
- Knowledge of the location of safety equipment and emergency evacuation procedures will be established prior to initiation of operations. Use of designated protective clothing will be required during all activities as described in RHSP.
- The buddy system and line-of-sight shall be employed at all times when in an exclusion zone.
- If field personnel perceive an unsafe condition or situation, the RSO or their supervisor will be notified immediately.
- All field operations should be planned and discussed with personnel prior to the beginning of start-up of site activities. A Tailgate Safety Meeting shall be conducted at the beginning of each shift and whenever new personnel arrive on the job.
- Be cognizant of slip-trip hazards present due to areas of difficult terrain.
- Practice contamination prevention both on- and off-site.
- Ignition sources in the vicinity of potentially flammable materials are prohibited.
- When working in areas where flammable vapors may be present, particular care must be exercised with tools and equipment that may be sources of ignition. All tools and equipment provided must be properly bonded and/or grounded.
- Approved and appropriate safety equipment shall be worn where required.
- Smoking is restricted to designated areas. Eating, drinking, or application of cosmetics is restricted to the Clean Zone.
- All employees shall be required to wash their faces and hands with soap and water before eating, drinking, smoking, or applying cosmetics.
- Contaminated tools and hands must be kept away from the face. Do not unnecessarily touch a contaminated surface or allow clothing, tools or other equipment to do so.
- Persons with long hair and/or loose fitting clothing that could become tangled in power equipment must take adequate precaution.
- Report the presence of open wounds to the RSO prior to work in the "Exclusion Zone" (affected area). If a wound occurs which, in such an area, report immediately to RSO and attend to the wound. Apply first aid immediately to any and all cuts, scratches and abrasions.



- Horseplay is prohibited in the work area.
- Follow good "housekeeping" practices to minimize the amount of material and equipment that has to be decontaminated or disposed of as contaminated wastes.
- Contaminated protective equipment shall not be removed from the contamination reduction zone until it has been cleaned or properly packaged and labeled.
- Working under the influence of intoxicants, narcotics, or controlled substances is prohibited.
- Be alert to your own physical condition. Watch your buddy for signs of fatigue and/or exposure.
- Initiate a work/rest regimen if ambient temperatures and protective clothing create a potential heat stress situation.
- Do not proceed or continue working unless adequate lighting exists and appropriate supervision is present.
- Legible and understandable precautionary labels shall be prominently affixed to containers of raw materials, scrap, waste, debris, and contaminated clothing.
- Removal of materials from protective clothing or equipment by blowing, shaking, or any other means, which may disperse materials into the air, is prohibited.
- Portable emergency shower stations shall be strategically located throughout the controlled area.
- Change rooms and shower facilities shall be provided for the use of employees working in the controlled area.
- Showers will be available for personnel to use at their discretion before leaving the job site.
- Walking through mud puddles, kneeling on the ground, or leaning against excavation machinery should be avoided whenever possible.
- Monitoring equipment shall not be placed on potentially contaminated surfaces.
- A flagman with roadwork vest, signs, cones, and high-level warning signs shall be provided when it is necessary to control normal vehicular traffic due to vehicles entering or leaving the site.
- Wetting agents shall be used for dust abatement when the probability of airborne contamination exists.
- Wet materials shall be dewatered prior to loading onto transport trucks to reduce the possibility of contamination run-off when in transit.
- Transport trucks shall be securely tarped when filled to prevent an inadvertent release of material.
- Prompt remedial action shall be taken whenever an inadvertent release of a hazardous material occurs.
- The OSHA poster, Job Safety and Health Protection, and NRC poster, Notice to Employees (Appendix C & D) will be posted at the Bay City site in conspicuous places.



## 11.2 Hazard Control

Personnel working on the remediation of sites involving chemical and radiological substances may encounter conditions that are unsafe or potentially unsafe. In addition to the danger caused by the physical, chemical, and toxicological properties of the material present or other types of hazards, e.g., electricity, water, heavy equipment, falling objects, loss of balance, or tripping, can have an adverse effect on the health and safety of personnel. This section describes the general requirements that will be implemented to minimize these potential adverse effects.

The excavation and hauling of the thoriated material requires proper handling and control measures to ensure the safety of personnel from both aspects of radiological exposure and physical/mechanical hazards.

- All trenching and excavation work must comply with all safety regulatory agency rules.
- Before any excavation work, the existence and location of underground pipe, electrical conductors, etc., must be determined.
- The walls and sides of all excavations more than 4 feet deep, which a worker may enter, shall be guarded by shoring laid back at a 1 on 1 maximum slope or some other equivalent means.
- Daily inspections of excavations shall be made. If there is evidence of possible cave-ins or slides, all work in the excavation shall cease until the necessary safeguards have been taken.
- Excavations more than 4 feet deep, which a worker will enter, shall have ladders extending not less than 3 feet above grade located no more than 25 feet from the worker's locations.
- All excavations shall be backfilled as soon as practical after work is completed and all associated equipment removed.
- All equipment shall be kept out of traffic lanes and access-ways. Equipment shall be stored so as not to endanger personnel at any time.
- All excavations shall be completely guarded on all sides. Excavated material shall be kept a minimum of 2 feet from edges of all trenches.
- Excavation guarding shall consist of wooden or metal barricades spaced no further apart than 20 feet. Such barricades shall be not less than 36 inches high when erected.
- Protection between barricades shall consist of at least 3/4 inch wide nylon tape, yellow, or yellow and black tape. The tape shall be stretched between barricades.



## **12.0 Decontamination**

### **12.1 Personnel Decontamination**

All personnel shall be given instruction on the proper removal of anti-contamination clothing at the control point exit from the affected area. PPE clothing and equipment shall be worn and removed in such a manner to preclude the transfer of potential contamination from external surfaces to inner clothing or skin surfaces.

All personnel, after removal of PPE at the control point, shall perform or have performed a whole body survey (called frisk) for contamination using the control point 'frisker' (typically AC ratemeter with GM pancake detector). An immediate and sustained audible increase on the frisker (typically 100cpm > background) may indicate the presence of residual contamination.

In the unlikely event that contamination is found on a person's underclothing or skin, the following actions are applicable:

- Note area and resurvey;
- Complete whole body frisk to determine other areas;
- Notify RSO or fellow worker; and
- Remain at control point for response by RSO or radiological control technician.

The presence of contamination on skin or clothing does not present an immediate threat to health or safety. However, decontamination of personnel, if required, shall only be performed by the RSO/RCT and properly documented.

### **12.2 Procedures for Handling Potentially Contaminated Property and Equipment**

#### **12.2.1 Monitoring for Unrestricted Release from the Site**

Property and material to be released includes goods or equipment that have inherent value in their present physical form, such as heavy earth-moving equipment, vehicles, hand tools, piping, or any other objects that could be reused.



All heavy equipment and tools used during site remediation activities will be wiped down and/or steam cleaned or power washed (if required) prior to being scanned for residual surface contamination. The RSO and Site Manager shall select a location for this activity.

Standard Operating Procedures (SOPs) have been developed in order to meet the surface residual contamination requirements set forth in the U.S. Nuclear Regulatory Commission (NRC) the "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination Of Licenses for Byproduct, Source, or Special Nuclear Material". The procedures include the following:

1. A survey form, on which the piece of equipment or tool shall be identified, will be created and filed accordingly. The license tag number, model or serial number, or any other available unique identifier will be recorded, when possible.
2. A complete scan of potentially contaminated areas will be performed by a RCT using an alpha probe and rate meter with the results recorded on the data form. Maximum and average total alpha levels shall be recorded.
3. A minimum of one wipe test will be conducted by RCT covering 100 cm<sup>2</sup> per 1 m<sup>2</sup> of potentially exposed area. For articles with areas less than 100 cm<sup>2</sup>, the entire surface shall be wiped, and the results shall be reported based on an estimate of the area sampled. The wipe test shall be a biased sample from areas judged or measured (from scan) to have the highest potential for contamination and highest potential for removal of material.
4. Should results of the wipe test or surface scan for total alpha activity indicate activity approaching the limits, additional measurements may be required to ensure that the release criteria are met.

### **12.2.2 Monitoring of Scrap Material and Debris for On-Site Management or Disposal**

Scrap material and debris at the sites consist of building material and other material potentially containing oxidized iron and steel, aluminum, concrete, bricks, cross ties, and small pieces of magnesium. Most of this material is uncontaminated and when practical, will be buried on-site (at Bay City) rather than shipped to a radioactive waste disposal site.



Experience with the scrap material and debris at the Madison, Illinois storage site containing the same thorium material showed that only a very small percentage of the pieces had measurable surface contamination, with a few exceptions where the concentrated thorium slag was embedded in rusted drums. In addition, bricks and other debris found in the concentrated slag had measurable levels. Attempts failed at decontaminating the bricks using high-pressure water. Therefore, if these items are present, they will likely be sent to the radioactive waste disposal site. Material potentially suitable for on-site burial will be selected according to the following criteria:

- Scrap iron and steel having no visible evidence of slag contamination;
- All debris found in the clean slag areas or off-pile areas;
- All debris no likely to have come into contact with the highly concentrated thorium slag material such as that currently stored at the covered pile;
- Material that can be transported to the monitoring area without fear of release of contaminated material in the clean zone (that is, no loose slag on or in the pieces);
- Pieces that do not have the potential to act as a container for contaminated slag; and
- Objects having no value for reuse.

Trained technicians (RCTs) will scan each object to be buried, according to SOP 1.2. If only background levels are found, the object will be placed in a pile for potential burial. One hundred percent of the objects will be selected for a wipe test using SOP 1.7 to check that the removable contamination limits specified in Table 12.1 are met. If the results are background levels, the pile will be buried. If any of the samples are elevated, the pile will either be disposed of as radioactive waste or each piece will be wipe-tested to ensure that the criteria in Table 12-1 are met. For those items shown by the scan to have measurable contamination, the item will either be sent for disposal as radioactive waste or monitored using SOPs 1.2 and 1.7 to ensure compliance with the total and removable contamination limits for unrestricted release prior to burial (see Table 12.1). As a final check to ensure that no concentrated thorium-bearing material is hidden inside an object, a gamma scan will be done according to SOP 1.5. Any increase above the local gamma-ray background will be reason to send the object for radioactive waste disposal. The sensitivity of the instrumentation used in SOP 1.2 and SOP 1.7 is sufficient to measure the levels specified in Table 12.1.

The monitoring plan is based upon the following assumptions:

- The buried material will have little or no value to anyone in the future;
- It has been verified that the pieces do not contain radioactive slag material;



- All surfaces do not have any measurable total surface contamination, 100% of the pieces have been checked to ensure that there is no removable contamination; and
- If it is desirable to bury material with measurable total surface contamination, the material will be monitored to ensure that it meets the release criteria for removable surface contamination as well as total surface criteria, as presented in Table 12.1.

This plan is considered conservative, considering our extensive experience with these materials at the Madison, Illinois site. Implementation of this plan will result in compliance with the criteria in Table 12.1. All information below has been obtained utilizing the "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material".



**Table 12.1**  
**Surface Contamination Limits**

		NRC Guideline *
I	Removable Contamination: <sup>a</sup> (dpm/100cm <sup>2</sup> )	26 <sup>c</sup>
	A. Average over any surface <sup>b</sup>	
II	Total Contamination <sup>d</sup> (dpm/100 Cm <sup>2</sup> )	387
	A. Average over any surface <sup>e</sup>	
	B. Maximum on any surface <sup>f</sup>	

Reference: NRC 1987

- \* The amount of removable radioactive material per 100 cm<sup>2</sup> of surface area should be determined by wiping that area with a dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination is detected on objects with surface area less than 100 cm<sup>2</sup>, the activity per unit area should be based on the actual area and the entire surface should be wiped. These numbers are maximum amounts. <sup>b</sup>Measurements of average contamination should not be averaged over an area of more than 1 m<sup>2</sup>. For objects of less surface area, the average should be derived for each such object. The maximum contamination level applies to an area of not more than 100 cm<sup>2</sup>. <sup>d</sup>Total contamination indicates fixed plus removable. <sup>e</sup>Total contamination indicates fixed plus removable.

The values have been calculated using the average thorium-230 to thorium-232 ratio of 3 to 1, the limits for pure alpha emitting radionuclides for thorium-230, the limits for natural thorium-232 in equilibrium with its progeny for thorium-232, and the use of the formula below.

$$\sum_{I-1}^n \frac{A f_i}{g_i} - 1$$

where:

- $f_i$  = fraction of the total activity on a surface due to the  $i_{th}$  radionuclides  
 $A$  is the total activity on the surface  
 $g_i$  = the applicable guideline for the  $i_{th}$  radionuclides



- <sup>a</sup> Per the U.S. Nuclear Regulatory Commission (NRC) Guideline "The amount of removable radioactive material per 100 cm<sup>2</sup> of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped."
- <sup>b</sup> The NRC Guideline does not specify an average removable contamination level.
- <sup>c</sup> These values were determined by taking the ratios of Th-232 and Th-230 at the site and applying them to the values from NRC Guideline Table 1.
- <sup>d</sup> Total contamination indicates fixed plus removable.
- <sup>e</sup> Per the NRC Guideline, "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."
- <sup>f</sup> Per the NRC Guideline, "The maximum contamination level applies to an area of not more than 100 cm<sup>2</sup>."

### **12.2.3 Waste Disposal Procedures**

All discarded waste materials such as PPE consumables, etc., shall be handled in such a way as to exclude the potential for the spread of contamination, creating a sanitary hazard or causing litter to be left on-site. All potentially contaminated disposable wastes, e.g., boots, gloves, coveralls, will be scanned to determine if they are radiologically contaminated. If contaminated, they will be bagged and/or drummed, labeled and segregated in a designated and secured area on-site for disposal. All contaminated waste materials shall be disposed of in accordance with applicable regulations. All non-contaminated materials shall be collected and bagged for proper disposal as normal domestic waste.

All other disposable protective clothing: gloves, boot covers, contaminated coveralls, will be tightly bagged and stored appropriately on-site in drums or other adequate containers following completion of each day's work. All drums/containers used for storage of such waste will be clearly labeled as "PPE".

All non-disposable contaminated personal protective equipment that will not decontaminate adequately will also be discarded and disposed of as above and replaced with new or uncontaminated equipment as needed. Steel-toed field boots or shoes will be decontaminated thoroughly. If this procedure does not adequately remove all contaminated materials, they will also be disposed of as described above.



## **13.0 Contingency Plan**

The contingency plan outlined in this section, will be known by all field personnel involved in site activities and will be covered during the initial worker health and safety training. The contingency plan will be available for use at all times during site work.

Various individual site characteristics will determine preliminary actions taken to assure that this contingency plan is successfully implemented in the event of a site emergency. It should be noted that drills are not conducted on site. Based on the low levels of radioactive material present at the Bay City site, the Radiation Protection Management has deemed it unnecessary and impracticable.

The emergency coordinator, the Field Operations Leader, shall make contact with the Dow personnel at the site prior to beginning of work on-site. Prior to start-up of site operations, the emergency coordinator shall also contact the local emergency services regarding the nature and duration of work expected on the site and the type of contaminants and possible health or safety effects of emergencies involving these contaminants. The emergency coordinator will make necessary arrangements to be prepared for any emergencies that could occur.

The emergency coordinator will implement the emergency plan whenever conditions at the site warrant such action. The emergency coordinator will be responsible for coordination of the evacuation, emergency treatment, and emergency transport of site personnel as necessary, and notification of emergency response units and the appropriate management staff.

### **13.1 Material Release**

The potential for release of contaminated material from the site will be minimized. The primary potential release mechanism from the Bay City site is through the air. When significant quantities of material from the thorium storage pile are exposed, special precautions will be taken, including applying water or stopping work will be implemented to reduce air emissions from the site.



### **13.2 Evacuation**

In the event of an emergency situation, such as fire an air horn or other appropriate device will be sounded in 10 second intervals indicating the initiation of evaluation procedures. All personnel will evacuate and assemble at a pre-designated location. The location shall be upwind of the site where possible. For efficient and safe site evacuation and assessment of the emergency situation, the emergency coordinator will have authority to initiate action if outside services are required. Under no circumstances will incoming personnel or visitors be allowed to proceed in the area once the emergency signal has been given. The RSO or designee will see that access for emergency equipment is provided and that all equipment have been shut down and secured once the alarm has sounded. Once the safety of all personnel is established, the emergency response groups, as necessary, will be notified by telephone of the emergency.

### **13.3 Personal Injury**

If emergency life-saving first aid and/or medical treatment is required, normal decontamination procedures may need to be abbreviated or omitted; monitoring will not be performed. The site RSO or designee (health physicist) shall accompany contaminated victims to the medical facility in accordance with SOP 1.12, Emergency Procedures for Handling Services Injuries with Potential Radiological Contamination. The outer garments can be removed if they do not cause delays, interfere with treatment or aggravate the problem. Protective clothing can be cut away. If the outer contaminated garments cannot be safely removed, a plastic barrier between the individual and clean surfaces should be used to help prevent contaminating the inside of ambulances and/or medical personnel. Outer garments are then removed at the medical facility. No attempt will be made to wash or rinse the victim, unless it is known that the individual has been contaminated with an extremely toxic or corrosive material which could also cause severe injury or loss of life to emergency response personnel or the person is suffering from heat stroke. For minor medical problems or injuries, personnel will be monitored and decontaminated, if necessary, prior to administering first aid. Note that heat stroke requires prompt treatment to prevent irreversible damage or death. Protective clothing must be promptly removed. Less serious forms of heat stress also require prompt attention and removal of protective clothing immediately. Unless the victim is obviously contaminated, decontamination should be omitted or minimized and first aid begun immediately.



In an emergency situation, an ambulance shall be contacted for transportation to the hospital as necessary. Only in non-emergency situations shall an injured person be transported to the hospital by means other than an ambulance. The hospital routes are identified in Section 13.

#### **13.4 Fire/Explosion**

Fire extinguishers will be available to support local fire fighting. They will be placed in all buildings and near all construction activity and will be checked monthly or after each use. The proper use of the extinguishers will be incorporated in the site health and safety training.

In the event of a fire or explosion, immediate evacuation of the site (air horn will sound in 10 second intervals) shall be initiated by the emergency coordinator. The local fire and police department and other appropriate emergency response groups will be notified immediately if an actual fire or explosion takes place.

#### **13.5 Chemical Exposure**

In the event project personnel are exposed to toxic chemicals, the following guidelines will be followed:

*Skin Contact:* Apply copious amounts of soap and water. Wash/rinse affected area thoroughly and provide appropriate medical attention. Emergency eyewash is located in the Support or the Contamination Reduction Zone. Eyes should be rinsed for a minimum of 15 minutes upon chemical exposure.

*Inhalation:* Move to fresh air and area, if necessary, decontaminate/transport to medical facility.

*Ingestion:* Decontaminate and transport to medical facility.

*Puncture:* Decontaminate and transport to medical facility.

*Wound/Lacerations:* Decontaminate and transport to medical facility.

#### **13.6 Adverse Weather Conditions**

In the event of adverse weather conditions, the RSO or designee will determine if work can continue without compromising the health and safety of field personnel. Some of the items to be considered prior to determining if work should continue are the following:



- Potential for heat stress and heat-related illnesses;
- Potential for cold stress and cold-related illnesses;
- Treacherous weather-related working conditions; and
- Potential for an electric storm.

### 13.7 Accident/Incident Reporting

As soon as first aid and/or emergency response needs have been met, the following parties are to be contacted by the RSO or designee via telephone:

1. Maria Sandow, HSO  
(517) 638-0244 (W)  
(517) 835-8024 (H)
2. Ben Baker, Project Manager:  
(517) 636-0787 (W)  
(517) 839-0764 (H)
3. The employer of any injured worker, if not Dow employee.

Written confirmation of verbal reports are to be submitted within 24 hours by the RSO or designee. An Accident Incident Report form is to be used for this purpose. All personnel contacted by telephone are to receive a copy of this report. If the employee involved is not Dow employee, his employer will receive a copy of this report.

For reporting purposes, the term accident refers to fatalities, lost time injuries, OSHA recordable injuries, spill or exposure to hazardous materials (radioactive, toxic, explosive, flammable or corrosive), fire, explosion, damage to property, or potential occurrence of the above.

Any information released from the health care provider, which is not deemed confidential patient information, is to be attached to the appropriate form. Any medical information, which is released by patient consent, is to be filed in the individual's medical records and treated as confidential.



The Dow Chemical Company THORAD Project  
Radiological Health and Safety Plan

Emergency Resources for the Bay City Thorad Site				
Project Number 007133				
Emergency Information		Name	Telephone Number from a Dow Phone	Telephone Number from a non-Dow phone
Local Resources	Dow Chemical Project Manager	Ben Baker	Office 6-0787 Mobile Phone (9) 245-5709	636-0787 245-5709
	Dow Chemical Owner's Rep	Bob Reiss	Office 8-0297 Mobile Phone (9) 274-4576 Pager (9) 247-1100	638-0297 274-4576 247-1100
Emergency Resources	<b>Ambulance</b>	<b>Dispatch</b>	<b>(9) 9-1-1</b>	<b>9-1-1</b>
	<b>Hospital (Bay Medical)</b>	<b>Dispatch</b>	<b>(9) 9-1-1</b>	<b>9-1-1</b>
	<b>Police</b>	<b>Dispatch</b>	<b>(9) 9-1-1</b>	<b>9-1-1</b>
	<b>Fire Department</b>	<b>Dispatch</b>	<b>(9) 9-1-1</b>	<b>9-1-1</b>
	<b>Poison Control</b>		<b>(9) 800/764-7661</b>	<b>800/764-7661</b>
Non Emergency Medical Resources	WorkCare	Dr. Chan	(9) 800-455-6155	800-455-6155
	Occupational and Preventative Medicine Associates	Dr. on Call	(9) 517/790-5990	517/790-5990
Radian Resources	Field Services Manager	Gerard Sgro	8-0342	638-0342
	Field Services Superintendent	Gary Waugh	8-0341	638-0341
	Construction and Remediation Health and Safety Manager	Gary Beswick	Office - (9) 412/788-2717 Home - (9) 412/695-0980	412/788-2717 412/695-0980
	Regional Health and Safety Manager	Ken Yates	Office (9) 409/238-7490 Pager (9) 888 736-6996	409/238-7490 888 736-6996
	Midland Office	Receptionist	8-4293	638-4293
	Environmental Health & Safety Coordinator Midland Office	Maria Sandow	Office - 8-0244 Pager (9) 222-1294	638-0244 222-1294



### **13.8 Directions to the Hospitals**

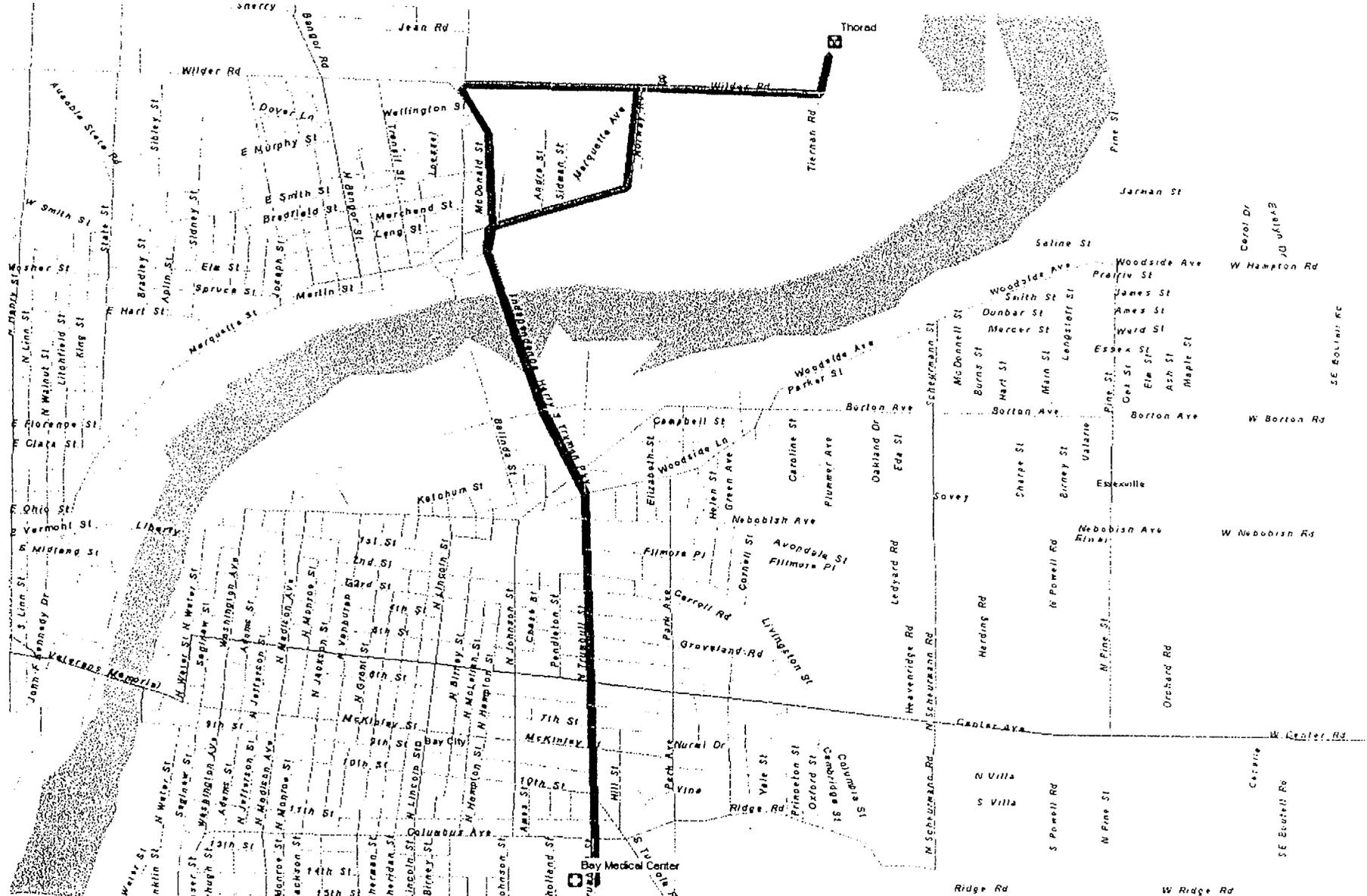
Figure 13-1 shows the route from the Dow Bay City site to the Bay Medical Center at 1900 Columbus Avenue in Bay City.



# The Dow Chemical Company THORAD Project Radiological Health and Safety Plan

## Hospital Route

- west on Wilder Rd. to Marquette Ave. (dirt road just past railroad tracks)
- take Marquette out to traffic light, turn left (South) on Trumbull Pkwy.
- Stay on Trumbull over the river until Bay Medical Center is found (approximately 2.6 mi.)
- Total distance to hospital from site: approximately 3.5 mi.





### **13.9 OSHA Form 200**

An OSHA Form 200 (Log of Occupational Injuries and Illnesses) will be kept at the project sites. All recordable injuries or illnesses will be recorded on this form. At the end of the project, the original will be sent to the HSO for maintenance. Subcontractor employees must also meet the requirements of maintaining an OSHA 200 Form. The accident/incident report to be employed will meet the requirements of the OSHA Form 101 (Supplemental Record), which must be maintained with the OSHA Form 200 for all recordable injuries or illnesses.



## References

"Code of Federal Regulations, Title 49." U.S. Department of Transportation, Washington, D.C. October 1, 1997.

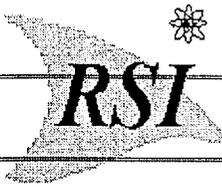
"Code of Federal Regulations, Title 29." Occupational Safety and Health Standards, Sections 1910 and 1926, Washington, D.C., October 1, 1997.

NRC. 1974. "Termination of Operating Licenses for Nuclear Reactors." Regulatory Guide 1.86. U.S. Nuclear Regulatory Commission, Washington, D.C.

"Standards for Protection Against Radiation", 10CFR Part 20, U.S. Nuclear Regulatory Commission, Washington, D.C., January 1, 1998.

## **Appendix A**

### **Resumes**



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## RADIOLOGICAL SERVICES, INC.

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**Ricardo V. Burke**  
Radiological Engineer

**Education:** **Information Removed in Accordance with PII Review.**

12/98 - Hamilton University (Jackson, Wyoming)  
B.S. in Environmental Science

**Training:** 08/90 - Philadelphia Electric Co.  
General Physics Fundamentals Training  
11/99 Commonwealth Edison  
Radioactive Material Shipping Certification

**Experience:**

05/05/2000 – Dow Chemical – THORAD Project  
Present Radiation Safety Officer

03/06/2000 - DC Cook Nuclear Power Station  
03/03/2000 Radiation Protection Specialist  
Provided radiological support for the Unit 2 Steam Generator Replacement Project.

05/03/99 Reactor Services - Commonwealth Edison Corporate  
01/14/2000 ALARA Manager  
Provided supervisory oversight to contractor ALARA personnel for all Refueling Floor activities. Generated person-Rem estimates, ALARA plans and reports as required for implementation and assessment of exposure reduction techniques. Participate in and/or perform assessments to determine the root cause of radiological incidents, inadequate personnel performance, or other identified deficiencies. Provide radiological input at and attend major modifications project meetings. Prepared and approved maintenance work packages through work control.

03/08/99- LaSalle Nuclear Power Station  
04/30/99 ALARA Manager  
Provided supervisory oversight to contractor ALARA personnel for maintenance/major modifications to support the Restart of Unit 2 activities. Generated person-Rem estimates, ALARA plans and reports as required for implementation and assessment of exposure reduction techniques. Participate in and/or perform assessments to determine the root cause of radiological incidents, inadequate personnel performance, or other identified deficiencies. Provide radiological input at and attend major modifications project meetings. Prepared and approved maintenance work packages through work control.

10/17/97 -  
03/08/99

Dresden Nuclear Power Station - Unit 1 (Decommissioning Project)  
ALARA Manager

Provided supervisory oversight to contractor/station ALARA personnel for maintenance/major modifications for Unit 1 Safe Storage/Dry Cask Storage Project activities. Generated Person-Rem estimates, ALARA plans and reports as required for implementation and assessment of exposure reduction techniques.

Participate in and/or perform assessments to determine the root cause of radiological incidents, inadequate personnel performance, or other identified deficiencies. Provide radiological input at and attend major modifications project meetings. Prepared and approved maintenance work packages through work control.

- 11/11/96 - Dresden Nuclear Power Station - Unit 1 (Decommissioning Project)  
10/17/97 Lead Radiation Protection Supervisor  
Reported directly to the Station Radiation Protection Manager. Responsible for implementation of the radiological control program for all the Unit 1 Safe Storage/Dry Cask Storage Project activities. Providing supervision and direction to the project RP Supervisors, ALARA engineers, Lead RP Technicians and all other contracted radiation protection personnel. Develop and maintain personnel schedules, budgets and other project management tracking mechanisms. Participate in and/or perform assessments to determine the root cause of radiological incidents, inadequate personnel performance, or other identified deficiencies. Provide radiological input at and attend major modifications project meetings. Conduct performance evaluations of RP Supervisors as required to ensure optimum performance.
- 03/02/96 Dresden Nuclear Power Station - Unit 1 (Decommissioning Project)  
11/01/96 ALARA Engineer/R.P. Supervisor  
Providing supervisory oversight to contractor/station Radiation Protection Technicians during the scheduled Unit 1 Safe Storage/Dry Cask Storage Project. Providing Person-Rem estimates ALARA plans and reports, as required.
- 05/08/95 - Dresden Nuclear Power Station  
03/01/96 ALARA Engineer/R.P. Work Analyst  
Provided supervisory oversight to contractor/station ALARA personnel for maintenance/major modifications for a scheduled refueling outage. Generated Person-Rem estimates, ALARA plans and reports as required for implementation and assessment of exposure reduction techniques. Specifically responsible for all Refuel Floor personnel and activities, all valve repairs/replacements, bottom head drain replacement, and all major activities outside the Drywell. Prepared and approved maintenance work packages through work control.
- 03/20/95 Pilgrim Nuclear Power Station  
04/29/95 Senior Health Physics Technician  
Provided radiological support at the Drywell during a scheduled refuel outage; provided support for various activities including ISI, valve cutouts and replacements, and various shielding operations.

01/20/95      Maine Yankee Atomic Power Station  
03/19/95      Senior Health Physics Technician  
Provided radiological support for steam generator eddy current and sludge lancing evolutions.

09/04/94 -      Pilgrim Nuclear Power Station  
10/21/94      Senior Health Physics Technician  
Provided radiological support at the Drywell during a scheduled refuel outage; provided support for various activities including ISI, valve cutouts and replacements, and various shielding operations.

06/13/94      Seabrook Nuclear Power Station  
07/02/94      Senior Health Physics Technician  
Provided radiological support for the removal at the Drywell during a scheduled refuel outage: provided support for various activities including ISI, valve cutouts and replacements, and various shielding operations.

03/28/94 -      Seabrook Nuclear Power Station  
05/27/94      Senior Health Physics Technician  
Provided radiological support for steam generator eddy current and sludge lancing evaluations.

03/29/93 -      Pilgrim Nuclear Power Station  
05/28/93      Senior Health Physics Technician  
Provided radiological support at the drywell during a scheduled refuel outage; provided support for various activities including ISI valve cutouts and replacements, and various shielding operations.

12/14/92      Dresden Nuclear Power Station  
03/27/93      Lead Health Physics Technician  
Assigned to maintenance department to coordinate all health physics activities during a scheduled refueling outage. Supervised all contract health physics personnel assigned to the department for support of CRD removal/installation, major valve/pump repairs.

10/12/92 -      Pilgrim Nuclear Power Station  
11/21/92      Senior Health Physics Technician  
Provided radiological support at the Drywell during a scheduled refuel outage; provided support for various activities including ISI, valve cutouts and replacements, and various shielding operations.

08/24/92 -      Seabrook Nuclear Power Station  
10/10/92      Senior Health Physics Technician  
Provided coverage for the removal of the reactor coolant resistance temperature detector (RTD).

03/30/92 - Calvert Cliffs Nuclear Power Plant  
07/03/92 Senior Health Physics Technician  
Providing coverage for containment/auxiliary building control points performing job specific surveys as needed.

05/07/87 - Limerick Generating Station  
03/27/92 Senior Health Physics Technician  
Received training for all health physics activities to include chemical and physical properties of matter, instrumentation and calibration, radiological fundamentals, radioactive material shipping, emergency planning and preparedness, first aid, industrial hygiene, and other related material. Provided health physics coverage for all maintenance activities performed during scheduled outages to include CRD Removal/replacement, valve/pump repairs, reactor disassembly, vessel inspection, and other routine activities. Monitored areas for radiation, contamination and airborne surveys as required. Provided instruction and supervision to Health Physics Technicians during scheduled refueling outages, analyzed survey data and prepared RWPs in accordance with established procedures and guidelines. Responsible for writing, reviewing and implementing all health physics operation and instrumentation procedures and guidelines.

# Charlene R. Loar

Associate

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## Education

Bachelor of Science in Environmental Engineering  
Graduated November 1995; GPA: 3.47/4.0  
Michigan Technological University  
Houghton, Michigan

### Valedictorian

Information Removed in Accordance with PII Review.



## Chronological Work Experience

Site Engineer, URS Radian ROS, 1995-present  
Assistant Radiation Safety Officer, Radian ROS, 1998-present  
Radiation Control Technician, Radian International, 1996-1998  
Receptionist, mail distributor, accounts payable, data entry, Manpower Temporary Services, 1993-1996  
Sales Representative, M&M Distributing, Summer 1993  
Service Operator, Dow Chemical Company, Summer 1992

## Professional Registrations

Engineer In Training, Michigan, 1995

## General Work Experience

I am currently working as the site engineer for a Soil Vapor Extraction System in Bay City, Michigan. I have been involved in the project from design, installation, start-up, sampling, to the current phase of operation and maintenance. In addition, I am the Assistant Radiation Safety Officer for a thorium decommissioning project where I am in charge of running the soil and air sample analysis laboratory. Other duties include monitoring sample activities, boom inspections, submitting reports to the state, and purchasing supplies.

## Project Assignments

Started Thorium project as a radiation control technician (RCT)/Site Engineer. Promoted to Assistant Radiation Safety Officer (RSO)/Site Engineer in April 1998. As a RCT, I helped implement and maintain equipment and documents for the air sampling program, performed gamma surveys and scans, collected and analyzed soil samples, collected thoron and radon measurements using E-PERM samplers, and performed instrument function checks. Responsibilities as the Assistant RSO include preparing employee dose reports, analyzing soil samples, calibrating multi-channel gamma analyzers, maintaining laboratory equipment, supervising activities of RCTs, and some field work. 

Site Engineer during the design, installation, start-up, operation and maintenance phases of Dow

Chemical Company's Bay City Soil Vapor Extraction System (SVE). Helped design site layout of piping, ordered required supplies and equipment, supervised installation of piping and SVE system skid. Prepared and maintained records of data collection and sampling events. Prepare and submit monthly status reports to the state. 

Task Leader for technical oversight of bi-weekly DNAPL recovery and quarterly groundwater sampling reports. Prepare quarterly groundwater sampling reports and monitor the sampling technicians schedule and data results. 

Task Leader for weekly environmental boom inspection and status reporting. Also in charge of ordering replacement booms and minor repairs. 

Supervised installation of pressure transducers in existing wells to monitor the groundwater levels along the Tittabawassee River. Set-up the Hermit 2000 datalogger to record the groundwater levels, monitored and downloaded the data, then reported it to the project manager in graphical format. 

Prepared waste characterization forms for miscellaneous chemicals stored at the Dow Chemical Facility in Midland, Michigan. Used online Material Safety Data Sheets and appropriate tables to characterize the wastes before disposal. 

Laboratory manager/technician for characterization of plutonium contaminated soil samples. Analyzed soil samples using multi-channel analyzers, printed data reports, and prepared soil samples for counting. 

## Other Training

40-Hour HAZWOPER, Midland, MI, 1996  
4-Hour HAZWOPER Refresher, Midland, MI, annually since 1996  
40-Hour Radiation Safety Officer Training, CSI - Radiation Safety Training, Kensington, MD, 1998  
8-Hour Great Lakes Safety Training, Midland, MI, 1996  
Great Lakes Safety Training Refresher, Midland, MI, annually since 1997  
General Employee Radiation Training, Bay City, MI 48706  
Rad Worker II Training, Bay City, MI, 1998  
Confined Space Entry, Midland, MI,  
Construction Safety  
First Aid & CPR, Midland, MI, 1999-2000  
(Training on storing/disposing hazardous waste)

## Publications

## Special Information

Received Individual Achievement Award, July 1998 from Radian International  
Certified in SCUBA diving, NAUI, November 1999

## Professional Societies

Chi Epsilon National Honor Society  
Tau Beta Pi

## Clearances

**Languages**

**Patents**

**ISO Experience**

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**Last Edited:** 2000-04-04 10:51:24  
**Employee Number:** 18493  
**Radian Start Year:** 1996  
**Professional Start Year:** 1996  
**Location:** MID

# MARIA A. SANDOW

## Research Associate

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### Education

Candidate, A.S., Environmental Science, Delta College, University Center, MI 2000

### Chronological Work Experience

Health and Safety Coordinator, Radian International LLC, 1994-Present

 Administrative Assistant, Radian International LLC, 1992-1994

 Co-Owner, ACL Recycling, 1988-1992

 Owner, Sandow Farm Supply, 1978-1988

 Supervisor, Saginaw Manufacturing, (division of General Motors, 1970-1981



### Professional Registrations

40 Hour Radiation Safety Officer Training in accordance with 10 CFR 20

Radiation Worker in accordance with 10 CFR 20

OSHA - Hazwoper, Site Operations and Emergency Response in accordance with 29 CFR 1910.120

OSHA - Hazwoper, Supervisor in accordance 29 CFR 1910.120

OSHA - Hazwoper, Refresher in accordance 29 CFR 1910.120(e)(8)

OSHA - Excavation Safety 29 CFR 1926, Subpart P

OSHA - Confined Space Entrant, Attendant, Supervisor, Rescue 29 CFR 1910.146

Instructor for OSHA Construction Safety Standards (OSHA 500)

10- and 30- Hour General Industry Outreach Program Trainer (OSHA 501)

DOT/IATA/IACO Certified Dangerous Goods Shipping Specialist and Trainer

American Red Cross - First Aid, CPR

Instructor of Behavioral Based Safety Program "B-Safe"

### General Work Experience

Ms. Sandow has more than twenty-five years of diversified construction and manufacturing safety experience ranging from hand-on operations through safety manager. She currently serves as Environmental, Health and Safety Coordinator for the entire Midland office of Radian International. Under this capacity she oversees overall health and safety implementation of all Michigan, Federal, and Corporate requirements, OSHA recordkeeping, personnel training, medical monitoring and interfacing with major industrial clients. Additionally, other responsibilities include oversight of all hazardous and waste shipments for projects completed by this office.

### Project Assignments

Radiation Safety Officer/Sampling Team Member, Consumers Energy Corporation, Big Rock Nuclear Plant, Charlevoix, Michigan, 1999.

Subsurface sampling of soils under and surrounding the containment building.

Superintendent and Health and Safety Officer, The Dow Chemical Company, Project THORAD, Midland and Bay City, Michigan. 1995 - Present:

Responsible for the development and implementation of the Health and Safety Plan and the Radiation Protection Program for the remediation and decommissioning of two low level radioactive waste storage facilities. The facilities represent an area of 47 acres consisting of 7 acres of upland and 40 acres of wetlands, ponds and navigable river environs requiring special wildlife and vegetation protection in addition to worker and public protection. In addition to safety, health and radiation protection in accordance with OSHA, MIOSHA, and the Nuclear Regulatory Commission (NRC), is responsible for managing site(s) security (both manned and remote systems), on-site laboratory operations, verification sampling and waste manifesting, shipping and disposal coordination of approximately 120,000 cubic yards of thorium contaminated material. This project received special recognition from the client and the Midland Area Contractors Safety Council for over 3 years (approximately 200,000 manhours) of OSHA Recordable-Free work which included several deep excavations and excavation entries as well as confined space entries.

Health and Safety Officer, Hampshire Chemical Company, Waterloo, New York, July 1999 - Present:

Responsible for the development and implementation of the Health and Safety Plan for sampling and remediation of a waste storage pit in the plant. This project involved Permit Required Confined Space Entry. Additional hazards included Hydrogen Sulfide emissions and Heat Stress.

Radiation Safety Officer/Sampling Team Leader, Consumers Energy Corporation, Big Rock Nuclear Plant, Charlevoix, Michigan, 1997.

Free Release prescreening of stormwater vault. This was the first structure free-released under the plant's decommissioning program.

Health and Safety Officer, The Dow Chemical Company, Bay City Terminal, Bay City, Michigan, June - August 1999:

Responsible for the development and implementation of the Health and Safety Plan for remediation of this site. This project involved removal of 3000 cubic yards of hydrocarbon contaminated soil and shipment to a treatment facility in Detroit, Michigan.

Health and Safety Officer, The Dow Chemical Company, Building 969 Drum Removal, Midland, Michigan, 1998

Responsible for health and safety plan development, and implementation of a major drum removal program for The Dow Chemical Company's Michigan Operations. Drum material included R&D and process waste (organic and inorganic) with both hazardous and explosive characteristics. Scope of services included sampling and analysis, staging, repackaging, manifesting and thermal destruction of more than 2300 drums under Level B conditions.

Health and Safety Officer, The Dow Chemical Company, Waste Storage Area IIB, Midland, Michigan, 1994

This project involved the removal of approximately 15,000 cubic feet of dioxin contaminated sludge and 150,000 gallons of water/brine from a storage tank known as the East Storage Tank - Waste Storage Area (WSA) IIB. This project was completed entirely under EPA Level B conditions in Permit Required Confined Space. Heat stress was an additional primary concern. This project was completed OSHA recordable free and received special recognition from the client for both safety and schedule records.

Health and Safety Officer, The Dow Chemical Company, Beaver Creek Remediation, Grayling, Michigan, 1993

Health and Safety Officer for the installations and startup of an air injection system to in situ bioremediate a petroleum hydrocarbon plume migrating off site from a natural gas well field and processing facility. Seventy-nine air injection wells were installed to remediate the groundwater and soils in a wetland area. An air injection "curtain wall" was installed downgradient to intercept the plume and stimulate native microorganisms. This project including trenching, excavation, and confined space entry.

## **Other Training**

## **Publications**

## **Special Information**

EXTRA INFO:  
Midland Office

1999 - Present: Member, Board of Directors for the Midland Area Contractors Safety Council  
1996 - Present: Member, Environmental Technician Curriculum Advisory Board, Delta College

## **Professional Societies**

## **Clearances**

## **Languages**

## **Patents**

## **ISO Experience**

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**Last Edited:** 1999-12-03 20:13:16  
**Employee Number:** 18185  
**Radian Start Year:** 1992  
**Professional Start Year:** 1970  
**Location:** MID

# GERARD A. SGRO

Sr Construction Assoc

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## Education

M.S., 1971, Limnology, Clarion State University, Clarion, PA, 1971.  
B.S., Fisheries Management, Michigan State University, East Lansing, MI, 1968.  
Graduate Studies, Radiation Biology, California State University, California, PA, 1971.

## Chronological Work Experience

Unit Leader, Pittsburgh Operations, Radian International LLC, Pittsburgh, PA, 1997-Present.  
Project Manager, Radian International LLC, Midland, MI, 1996-Present.  
Director-Remedial Projects, Dow Environmental Inc. (formerly AWD Technologies, Inc.), Midland, MI, 1989-1996.

NOTE Director Subcontracting/Program Manager, NUS Corporation, 1983-1989

NOTE Program Manager and Manager of Life Sciences, Environmental Research & Technology, Inc., 1980-1983

NOTE Project Manager, NUS Corporation, 1973-1980

NOTE Project Manager, Michael Baker, Jr., Inc., 1972-1973

NOTE Field Team Leader, NUS Corporation 1970-1972

NOTE Carlynton School District, Physics/Chemistry Teacher, 1968-1970

## Professional Registrations

U.S. Merchant Marine Officer; Master, U.S. Coast Guard, #734089, 1974.  
Certified Fisheries Scientists, American Fisheries Society, #1027, 1984.  
Radiotelephone Operator, Federal Communications Commission, U.S.A., 1973.

## General Work Experience

Mr. Sgro has more than 25 years of managerial and technical experience in hazardous waste remediation, environmental assessments, operational monitoring, and site restoration/mitigation development. Representative experience includes:

## Project Assignments

- The Dow Chemical Company, Midland and Bay City, Michigan. Served as the Project Manager for the remediation of two low-level "rad-waste" sites.

- NOTE •Project Manager responsible for overall project management, specification development, and construction implementation for the remediation of two low-level radiological waste storage sites, containing approximately 120,000 cy of material. Project scope includes waste delineation, excavation, stabilization and transport,

followed by verification sampling and onsite analyses in accordance with NRC requirements.

- Program Manager responsible for the development of specifications and start-up for a tank removal program covering 276 underground storage tanks at two pharmaceutical production laboratories. The program included tank decommissioning, excavation and decontamination, soil handling/disposal, sludge/wastewater treatment and disposal, and closure reporting.

- Project Manager for Environmental Emergency Response Unit activities. Administratively responsible for 24 individuals fully dedicated to U.S. EPA facilities in Edison, New Jersey and Cincinnati, Ohio. Activities included training, sampling and analysis, operations and assessment, and operational assistance for the U.S. EPA mobile incinerator at Denny Farm, Missouri.

- Program Administrator under contract with the State of Michigan, served as program administrator for Federal- and State-funded investigations and cleanup activities at uncontrolled hazardous waste sites. The scope of activities included emergency response and identification, site investigation, feasibility evaluations, final engineering design, and construction management.

- Subcontractor procurement and management for all Remedial Planning Office activities. On a yearly basis, represented coordination of approximately 250 subcontractor organizations at 97 job sites. Yearly expenditures were greater than \$32 million.

Mr. Sgro served as Project Manager on the following projects:

- Overall program manager for engineering design and construction oversight services at hazardous waste sites.

- Supervised QC - piping and tubing for the Space Launch Complex VI (Western Space Shuttle Port) final construction program.

- Prepared water quality and aquatic ecology portions of the U.S. Army Corps of Engineers Section 404 Permit Applications for 22 major river crossings in Washington, Idaho, and Montana.

- Prepared aquatic ecology evaluation and impact statement for the Blackbird mine-mill complex (cobalt) in the Salmon National Forest. Construction oversight of remediation of former mine and tailings areas.

- Environmental impact analysis and mitigation program development for the Endicott Development Project (offshore oil and gas development in the Beaufort Sea).<sup>NOTE</sup>
- Prepared an environmental impact report, all site studies and permit applications (environmental) for the 50,000 BPD Tennessee Coal-to-Gasoline Plant.<sup>NOTE</sup>
- Integrated process, chemical, environmental and health and safety research program results and assisted in the development of a five-year R&D Implementation Plan relative to DOE coal-based synthetic fuels technology development programs.<sup>NOTE</sup>
- Provided overview and management assistance for the environmental, health, safety, and socioeconomic program for the SRC II Demonstration Facility.<sup>NOTE</sup>
- Prepared OSM permits for surface, underground, and preparation facilities at Bradford mine No. 15, Franklin Mine No. 25, Franklin Highball Mine No. 65, Georgetown Mine No. 24, Georgetown preparation Plant, Mahoning Valley Mine No. 33, and Oak Park Mine No. 7.<sup>NOTE</sup>
- Conducted fisheries investigations relative to a proposed oil shale mine and processing facility. Studies included baseline evaluations, impact projections, and development of mitigating procedure.<sup>NOTE</sup>
- Prepared water quality and fishery evaluations related to the construction and operation of an in-situ coal gasification pilot facility.<sup>NOTE</sup>
- Completed the aquatic ecology aspects of siting and licensing a uranium mill.<sup>NOTE</sup>
- Prepared aquatic ecology and water quality assessments relating to the development and operation of a trona mine and mill.<sup>NOTE</sup>
- Prepared an environmental assessment, field studies, an environmental report, and related permit applications for the Radon Springs Uranium Mine and Mill.<sup>NOTE</sup>
- Environmental advisor for Kitts & Michelin uranium mines and process mill. Member of the Canada Environmental Advisory board under the direction of the AECB and Providence of Newfoundland.<sup>NOTE</sup>

- Prepared an environmental assessment, field studies, an environmental report and related permit applications for the Copper mountain uranium Mine and Mill. 
- Conducted baseline investigations and impact projections for a proposed nuclear powerplant. Subsequently developed and conducted aquatic environmental operational monitoring programs. 
- Conducted baseline investigations and impact projections for a proposed nuclear/fossil-fueled power plant. 
- Conducted baseline investigations and impact projections for a proposed nuclear power plant. Responsible for environmental operational monitoring at the adjacent shippingport nuclear reactor. Media included air, surface and groundwater, soil, agricultural products and fish and game. 
- Mitigation program development and construction oversight for river crossings. 
- Prepared chemical discharge definition and projection of impacts on receiving water fisheries. 
- Responsible for thermal plume evaluation under various tidal conditions. 
- Conducted baseline investigations and impact projects for offshore supertanker terminal. 
- Responsible for thermal plume assessment, NPDES permit preparation and regulatory agency negotiations for Philadelphia refinery discharges 011 and 013. 
- Conducted an environmental assessment of oil spills on commercial/recreational fish and shellfish species. 

### **Other Training**

OSHA, 40 hr HAZWOPPER & related yearly refreshers, Supervisory CPR, First Aid, Construction Safety, Great Lakes Safety, Radiation Safety, Excavation Safety

### **Publications**

G.A. Sgro, "An Ecological Comparison of Bigger and Longs Run, Beaver and Washington Counties, Pennsylvania," M.S. Thesis, 1971  
G.A. Sgro, "Iron Precipitate Deposition Rate Determination," presented at the American Fishery Society NE Regional Conference, 1971  
G.A. Sgro, "Analysis of pollution control costs-strip mine and refuse band backfilling, grading and revegetation of lands disturbed by coal mining," Appalachian Regional Commission. U.S. EPA-670/2-74-009.  
G.A. Sgro, "Life History and Habitat Requirements for Pennsylvania Salmonid Species," presented at the Pennsylvania Fish Commission Training Seminar, Indiana State University, 1978  
M.J. Massey, J.P. Fillo, G.A. Sgro, and J.H. Kreisher, "Review of U.S. Department of Energy Health and Environmental Research and Development Program," DOE/ET/10249-106(DE82009379), U.S. GPO: 1982-546-085/3055, 1980  
Malik, D.P., A.C. Middleton, D.L. Bryant, G.A. Sgro, J.P. Fillo, and R.B. Charna, "Water Usage and Treatment, Tennessee Synfuels Project," American Society of Civil Engineers, Proceedings of the Conference on Water and Energy: Technical & Policy Issues, 1982  
Fillo, J.P., G.A. Sgro, D.P. Malik, and A.J. Merritt, "Classification and Management of Process Wastes for the Tennessee Synfuels Associates Coal-to-Gasoline Facility," Proceedings: Second Ohio Environmental Engineering Conference, Ann Arbor Science Publications, Inc., 1982

## **Special Information**

### **EXTRA INFO:**

Midland  
12 years of HTRW experience  
Mr. Douglas Malik  
Vice President  
Koppers company  
2503 Acorn Court  
Wexford, PA 15090  
(412) 935-7553  
Mr. William V. Doud  
President  
DMS  
P.O. Box 432  
Fair Haven, NY 13064  
Mr. Brownie R. Johnson  
President  
Envirospec  
425 Creek Drive  
Wexford, PA  
(412)963-8038

## **Professional Societies**

## **Clearances**

## **Languages**

## **Patents**

## ISO Experience

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**Last Edited:** 1998-01-07 08:23:11

**Employee Number:** 18075

**Radian Start Year:** 1989

**Professional Start Year:** 1968

**Location:** FLD

# GARY L. WAUGH

Research Assist V

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## Education

## Chronological Work Experience

Draftsman/Engineering Technician, Radian International LLC, Pittsburgh, PA, 1990-Present.

 Draftsman/Surveyor, NUS Corporation, 1983-1989.



## Professional Registrations

## General Work Experience

Mr. Waugh serves as Construction Superintendent and has performed construction oversight and site health.

## Project Assignments

Construction Superintendent, Dow Thorad Decommissioning, Bay City, MI - Superintendent for site excavation of 60,000 yards of low level radioactive contaminated soil. Performed construction layout and site surveying.

Construction Superintendent and Health and Safety Officer, Dow Bay City Terminal Lift Station, Bay City, MI - Installation of 1500' or 4" HDPE pipe for site groundwater collection system.

Construction Superintendent Dow Elanco, Geneseo, IL - Excavation and shipment of 140 yards of contaminated soil and site restoration.

Construction Oversight and Health and Safety Officer, Beaver Creek Gas Facility, Grayling, MI - Installation of a vapor extraction system. Work included installation of 3000' of HDPE piping, injection and extraction wells and all mechanical connections.

## Other Training

## Publications

## Special Information

EXTRA INFO:  
11 years of HTRW experience  
Pittsburgh Office

## Professional Societies

## Clearances

**Languages**

**Patents**

**ISO Experience**

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**Last Edited:** 1998-02-10 13:55:48

**Employee Number:** 18088

**Radian Start Year:** 1990

**Professional Start Year:** 1983

**Location:** MID

## Appendix B

- SOP 1.1 Access Control Procedures
- SOP 1.2 Total Alpha Surface Contamination Measurements
- SOP 1.3 External Dosimetry Procedure
- SOP 1.4 Beta-Gamma Radiation Measurements using a Geiger-Muller Detector
- SOP 1.5 Measurement of Gamma-Ray Fields using a Sodium Iodide (NaI) Detector
- SOP 1.6 Intermediate Volume Air Particulate Sampling
- SOP 1.7 Sampling for Removable Alpha Contamination
- SOP 1.8 Guide to the Handling, Packaging and Shipping of Samples
- SOP 1.9 Sample Control and Documentation
- SOP 1.10 Radiation Work Permit
- SOP 1.11 Respiratory Protection Program
- SOP 1.12 Emergency Procedure for Handling Serious Injuries with Potential Radiological Contamination at the Bay City Site
- SOP 1.18 Sampling of Airborne Particulates using High Volume Air Samplers

TITLE: ACCESS CONTROL PROCEDURES			
Document No.: 1.1	Revision No.: 00	Effective Date 07/21/98	Page 1 of 3
Supercedes: N/A			
Reason for Revision: N/A			
Changes Made: N/A			
Approval:			
Radiation Safety Officer: <i>Daryl Hunt</i>		Date: 7/21/98	
Site Health & Safety Officer: <i>Maria Sandoz</i>		Date: 7/21/98	
Dow Project Manager: <i>Ben Baker</i>		Date: 7/21/98	

## 1.0 PURPOSE

To provide guidance for controlling access to the Bay City Site. The term site used in this and subsequent SOPs refers to the Bay City Site.

## 2.0 DISCUSSION

The Bay City Site has areas containing thorium, which is regulated by the Nuclear Regulatory Commission (NRC). Therefore, it is required that access to the site be restricted. Only persons with a legitimate need will be allowed onto the site. Legitimate reasons include authorized work such as mowing, inspections/audits, general labor support, environmental sampling, and remediation activities.

## 3.0 PROCEDURE

### 3.1 Associated Procedures

SOP1.3, *External Dosimetry Procedure*, should normally be used in conjunction with this procedure since workers on the site will generally be badged. Specific guidance on how and when to apply this procedure is contained in the Radiological Health and Safety Plan (RHSP), Section 6.0 *Access Control*, which states that, all persons entering the site should be admitted by the site radiation safety officer (RSO) or his/her representative.

SOP 1.10, *Radiation Work Permit (RWP)*, should always be used whenever it is necessary to access a controlled area.

<b>TITLE:</b>		<b>ACCESS CONTROL PROCEDURES</b>	
Document No.: 1.1	Revision No.: 00	Effective Date: 07/21/98	Page 1 of 3
Supercedes: N/A			
Reason for Revision: N/A			
Changes Made: N/A			
Approval:			
Radiation Safety Officer:		Date:	
Site Health & Safety Officer:		Date:	
Dow Project Manager:		Date:	

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## 3.0 PROCEDURE

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TITLE:	Access Control Procedures		
Document No.: 1.1	Revision No.: 00	Effective Date: 07/21/98	Page 2 of 3

## 3.2 Preparation

### 3.2.1 Office

- Review Radiological Health and Safety Plan, SOP 1.3 and SOP 1.10.
- Obtain copies of the site Controlled Area Access form shown in Appendix 5.3.

### 3.2.2 Field

- Ensure that the fence restricting access to each of the sites is inspected weekly to see that it is in proper condition and that all signs are easily seen and readable.
- Ensure that any persons entering the site do so through the designated access point.
- All persons entering the sites should be admitted and escorted by the site Radiation Safety Officer (RSO) or his/her representative.
- The RSO or his/her representative will require any person entering the potentially contaminated zone to fill out the information requested in the site Controlled Area Access Form. This information includes name, RWP#, work area, whether or not a respirator is worn, the date, time they checked in and out, and the result of their radiation frisk.
- Visitors to the site who will remain only in the Clean Zone or who are unlikely to receive 10% of the limit specified in 10 CFR Part 20 will not be issued a TLD badge or be required to complete the Controlled Area Access form. Instead all visitors are required to fill out the Visitors Pass Register (Appendix 5.1) with the date, their signature, their company, whom they are visiting, whom they were escorted by, time in, and time out.
- All site personnel and workers who enter the potentially contaminated zone inside the controlled area must be surveyed (frisked) prior to leaving the potentially contaminated zone. Their escort must frisk visitors. If contamination is found, decontamination will be under the direct supervision of the RSO or his/her representative.
- Once a Controlled Area Access Form has been completed, a copy of it should be given to the site safety manager and the original filed.

<b>TITLE:</b>	<b>Access Control Procedures</b>		
Document No.: 1.1	Revision No.: 00	Effective Date 07/21/98	Page 3 of 3

#### **4.0 SOURCE**

10 CFR Part 20.1502, "Standards for Protection Against Radiation"  
10 CFR Part 20.1201 states the 10% threshold limit for monitoring personnel.

U.S. Nuclear Regulatory Commission, Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data," Revision 1, June 1992.

#### **5.0 APPENDICES**

**5.1 Visitor Pass Register**

**5.2 Visitors Escorted Controlled Area Entry Log**

**5.3 Controlled Area Access Form**

VISITORS' PASS REGISTER

WAIVER

"I the undersigned, in accepting a pass or permit to go onto the premises of The Dow Chemical Company (Dow), do hereby waive any claim for damage or loss to my person or property that may arise out of any injury resulting from any act of the company, its officers, employees or agents while I am on said premises. I assume all risks and waive notice of the existence of any and all dangerous conditions that may exist at any place or at any time while I am on said premise. I will not disclose information concerning Dow and its operations obtained as a result of my visit, without Dow's approval."

Date	Signature	Representing	To Visit	Escorted By	Time In	Time Out

VISIITORS ESCORTED CONTROLLED AREA ENTRY LOG

NAME \_\_\_\_\_

SSN \_\_\_\_\_

DATE \_\_\_\_\_ TIME OF ENTRY \_\_\_\_\_ TIME OF EXIT \_\_\_\_\_

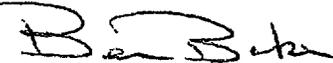
ESCORTED BY: \_\_\_\_\_

PURPOSE OF ENTRY \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

COMMENTS \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
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\_\_\_\_\_

LOG REVIEW \_\_\_\_\_



<b>TITLE:</b>		<b>TOTAL ALPHA SURFACE CONTAMINATION MEASUREMENTS</b>	
Document No.: 1.2	Revision No.: 01	Effective Date 08/10/2000	Page 1 of 6
Supercedes: N/A			
Reason for Revision: 1) Replaced reference of NRC Reg. Guide 1.86 w/ NRC Guideline. 2) Lowered limits for surface contamination.			
Changes Made: See Appendix 5.5			
Approval:			
Radiation Safety Officer:		Date:	8/14/2000
Site Health & Safety Officer:		Date:	
Dow Project Manager:		Date:	8/14/2000

**1.0 PURPOSE**

To provide guidance for determining levels of total surface alpha contamination on equipment, vehicles, and personnel that have been in contact with material that was potentially contaminated with alpha-emitting radionuclides.

**2.0 DISCUSSION**

Equipment and vehicles must be monitored for contamination before release from radiologically controlled areas for unrestricted use. Levels of alpha contamination on equipment will be determined and compared to release criteria. The recommended limit may be at or near the minimum sensitivity of portable equipment used in the scanning mode, depending on the detector and the surface type. Equipment must be decontaminated to levels that are as low as reasonably achievable and below the applicable release criterion in all cases. Personnel must be monitored for contamination before leaving the Contamination Zone and decontaminated to the lowest reasonably achievable levels. Limits derived specifically for the Bay City site are given in Appendix 5.5.

High-voltage plateau curves and National Institute of Standards and Technology (formerly National Bureau of Standards) traceable source calibrations must be performed on the detector annually to ensure proper operation. Alpha detector counting efficiencies must be determined daily before using the instrument for contamination monitoring and to ensure the instrument is functioning properly. The counting efficiency also must be determined following any adjustments or repairs on the instrument. The counting efficiency is used to convert instrument readings to a measure of activity in units of disintegrations per minute (dpm) per 100 cm<sup>2</sup>.

TITLE:	TOTAL ALPHA SURFACE CONTAMINATION MEASUREMENTS		
Document No. 1.2	Revision No. 00	Effective Date 07/21/98	Page 2 of 6

### 3.0 PROCEDURE

#### 3.1 Associated Procedures

Standard Operating Procedure (SOP) 1.7, *Sampling for Removable Alpha Contamination*, should normally be used in conjunction with this procedure since contamination criteria specify limits for both total and removable contamination.

In addition, specific guidance on how and when to apply this procedure at the Site is found in the Radiological Health and Safety Plan (RHSP), Section 1.2.2, *Procedures for Handling Potentially Contaminated Property and Equipment*.

The instrumentation used in this SOP is capable of measuring levels specified in Appendix 5.5 providing the surfaces are free of dirt and dry. Therefore, no surveys will be performed on equipment of vehicles unless the dirt has been removed and the surface is dry. For personnel monitoring, personnel will be encouraged to wash, if necessary, prior to frisking. For wet clothing or shoes, a Ludlum 44-40 beta-gamma probe or equivalent may be used in addition to the alpha probe for monitoring, since the beta particles have greater penetrating power.

#### 3.2 Preparation

The sections below describe tasks that must be completed prior to beginning work.

##### 3.2.1 Office

The following tasks must be completed in the office, prior to entering the field:

- Review the RHSP, Section 12.2, and SOP 1.7;
- Coordinate schedules/actions with the installation staff;
- Obtain appropriate permission for property access;
- Assemble the equipment and supplies listed in Appendix 5.1 and ensure the proper operation of all field equipment; and
- Ensure that the alpha scintillator and the ratemeter/scaler have current calibrations.

TITLE:	TOTAL ALPHA SURFACE CONTAMINATION MEASUREMENTS		
Document No. 1.2	Revision No.: 00	Effective Date 07/21/98	Page 3 of 6

### 3.2.2 Documentation

The following documentation tasks must be performed prior to beginning work:

- Obtain a logbook from the Radiation Safety Officer (RSO);
- Record results of the equipment check in the logbook;
- Obtain a sufficient number of the appropriate data collection forms; and
- Consult the data administrator for a current list of codes used in the completion of data forms.

### 3.2.3 Field

The following tasks must be completed in the field:

- Complete the *Daily Alpha Efficiency Check* form (Appendix 5.2) by following instructions in Appendix 5.4, *Data Form Completion*;
- Perform a daily 10-minute background count and a 1-minute alpha source count during use and record the results on the *Daily Alpha Efficiency Check* form. To perform a background count, place the probe on a clean, uncontaminated surface and record the number of counts accumulated over a period of 10 minutes. To perform a check source count, place the alpha source in the detector tray or against the detector surface and record the number of counts accumulated per minute (cpm);  
Calculate the counting efficiency (E); and
- If the background count rate increases (indicating possible probe contamination) repeat the 10-minute background count. If the background count rate is more than 50% above the average value, the detector should be cleaned.

### 3.3 Operation

The following operations are required during the Total Alpha Survey:

- Complete the Total Alpha Contamination Survey Data form (Appendix 5.3) by following instructions in Appendix 5.4, *Data Form Completion*.
- List the items to be surveyed in the first column on the form. Items must be identified as specifically as possible with serial numbers, model numbers, license numbers, or other forms of unique descriptions. If the items to be surveyed need to be labeled with the assigned identification number, use an indelible marker, spray paint, or some type of permanent marker. Use a separate line of the form to list each area surveyed on the items.

TITLE:	TOTAL ALPHA SURFACE CONTAMINATION MEASUREMENTS		
Document No. 1.2	Revision No. 00	Effective Date 07/21/98	Page 4 of 6

- List the surveyor's name, date of survey, and identification number of the monitoring instrument/detector.
- Switch the instrument on, check the batteries for adequate power, and check the instrument for damage. Record the instrument daily background, efficiency, and calibration factor in the appropriate spaces. The instrument background and efficiency should be determined at least once during each operational day.
- Monitor potentially contaminated surfaces by passing the probe face along each surface at a rate of 5 cm/sec or less. Hold the probe face as close as possible to the surface being monitored, without touching it, and not more than 0.5 cm away. Be careful not to damage the Mylar face of the probe. Hold the probe steady at any area that appears to indicate an elevated reading. Record the highest reading for each separate area of the item monitored, listing a description of each area in the space provided under the first column.
- When monitoring potentially contaminated skin and clothing surfaces, hold the probe face as close as possible to the surface being monitored, no more than 0.5 cm away. Move the probe along the surface at a rate of 5 cm/sec or less. At a minimum, monitor the areas listed below:
  - Both sides of each hand
  - Tops, sides, and bottoms of shoes and boots.
  - The torso of the body, both the front and back
  - All loose equipment (for example, papers, clipboards, and hand-carried tools).
- Instrument readings will fluctuate during monitoring. Investigate any significant elevation of the meter reading by holding the meter in the suspected area. A noticeable elevation in the meter reading identifies contamination that may need to be removed.
- Multiply each instrument reading (cpm) by the calibration factor to obtain the contamination level in dpm/100cm<sup>2</sup>.
- If the results of the survey for total alpha contamination are below the applicable release criterion for removable contamination, the item may be released without a survey for removable alpha contamination. If the total alpha activity is above the release criterion for removable contamination, perform the swipe or smear survey procedure. See SOP 1.7, *Sampling for Removable Alpha Contamination*.
- Wash contaminated skin and equipment with water and soap. Contaminated clothing may be removed and laundered at a licensed facility.
- Give the survey results to the person responsible for releasing equipment. Equipment that fails to meet the release limits must undergo additional decontamination.

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### 3.4 Postoperation

The following tasks must be completed after completion of the total alpha surface contamination measurements.

#### 3.4.1 Field

The following must be completed prior to leaving the field:

- Turn the instrument power off; and
- Ensure that all equipment is accounted for, decontaminated, and ready for shipment.

#### 3.4.2 Documentation

Prior to leaving the field, the technician will:

- Record any uncompleted work (like additional monitoring) in the logbook;
- Complete logbook entries, verify the accuracy of entries, and sign/initial all pages; and
- Review data collection forms for completeness.

#### 3.4.3 Office

The following must be completed in the office after total alpha surface contamination measurements have been collected:

- Deliver original forms and logbooks to the RSO with copies to the site manager and files; and
- Inventory equipment and supplies;
- Repair or replace all broken or damaged equipment;
- Replace expendable items; and
- Return equipment to the equipment manager and report incidents of malfunction or damage.

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#### **4.0 SOURCE**

NRC. 1974. Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors." U.S. Nuclear Regulatory Commission, Washington, DC, U.S. Government Printing Office.

#### **5.0 APPENDICES**

##### **5.1 Equipment and Supplies Checklist**

##### **5.2 Daily Efficiency Check Form**

##### **5.3 Total Alpha Contamination Survey Data Form**

##### **5.4 Data Form Completion**

##### **5.5 Limits for Surface Contamination**

## SOP 1.2 – Appendix 5.1

### EQUIPMENT AND SUPPLIES CHECKLIST

- \_\_\_\_\_ Alpha scintillation probe (Ludlum 43-5 or the equivalent)
- \_\_\_\_\_ Ratemeter/scaler (Ludlum Model 12 or the equivalent)
- \_\_\_\_\_ Alpha check source (Am-241 or the equivalent)
- \_\_\_\_\_ Data forms
- \_\_\_\_\_ Voltage meter
- \_\_\_\_\_ Hand-held calculator
- \_\_\_\_\_ Tape measure

## SOP 1.2 – Appendix 5.2

Insert Excel Spreadsheet SOP1.2app52.xls



## SOP 1.2 – Appendix 5.4

### DATA FORM COMPLETION

Use a pen with black ink that is not water-soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

#### Daily Efficiency Check Form

1. **Ratemeter/Scaler Make & Model:** The manufacturer and model number of the ratemeter/scaler.
2. **Ratemeter/Scaler Serial #:** The serial number of the ratemeter/scaler.
3. **Ratemeter/Scaler Calibration Date:** The date when the ratemeter/scaler was last calibrated.
4. **Detector Make & Model:** The manufacturer and model number of the alpha detector probe.
5. **Detector Serial #:** The serial number of the alpha probe.
6. **Detector Calibration Date:** The date the probe was last calibrated.
7. **Detector Configuration Setting:** Any special notes about the threshold, high voltage, and other special settings on the instruments.
8. **Window:** The window is in the out position unless otherwise specified.
9. **Source Type:** The identity of the radioactive isotope contained in the source given as element and mass number, like Am-241.
10. **Source Activity:** The activity of the radioactive source in disintegrations per minute (dpm). If the check source activity is given in microcuries ( $\mu\text{Ci}$ ), it can be converted to dpm using  $1 \mu\text{Ci} = 2.22 \times 10^6 \text{ dpm}$ .
11. **Source Identification Number:** The serial number of the radiation source.
12. **Start Date:** The date when the form was began in the DD-MMM-YY (01-JAN-88) format.
13. **Technician Signature:** The signature of the field representative who started the form.
14. **Comments:** Any special notes about the instruments or procedure.
15. **Date:** The date the information recorded on the form was obtained in the DD-MMM-YY (01-JAN-88) format.
16. **Time (HH:MM):** The time the efficiency was determined using the 24-hour clock in the hours:minutes format.
17. **Check Source - Scale:** The scale setting on the instrument when the source was counted.
18. **Check Source - cpm or rate:** The number of pulses recorded by the scaler during the counting time. Enter N/A if using a ratemeter.
19. **CT. Time:** (Counting-Time (min)). The time in minutes over which the scaler counts. Enter N/A if using a ratemeter.
20. **Background cpm or rate:** The count rate with no source present.
21. **Net Counts cpm:** Net cpm equals check source cpm minus background cpm.
22. **Eff. cpm/dpm:** The ratio of the observed count rate to the true disintegration rate. Efficiency = Net counts cpm / Activity dpm
23. **Battery Voltage:** The battery voltage reading at the beginning of the measurement.

## SOP 1.2 – Appendix 5.4

24. **High Voltage:** The voltage that is applied to the alpha scintillation probe shown on the calibration sticker or the instrument display. This voltage is determined annually using a voltage plateau.
25. **Threshold Setting:** The adjustment for the lower energy level of the discriminator shown on the calibration sticker or calibration certificate.
26. **Tech Init.:** Initials of the technician who performed the efficiency check.
27. **Source Response Limits:** The range of cpm or rate expected for the check source. If the daily source check does not fall within this range, there may be a problem with the instrument.
28. **Stat Check Date/Time:** The date and time when the last statistical (stat) efficiency check was done. The stat check determines the source response limits in 27.
29. **Reviewed by/Date:** The signature of the person who reviewed the form and the date it was reviewed.

### Total Alpha Contamination Survey Data Form

1. **Survey Date:** The date the information recorded on the form was obtained in the DD-MMM-YY (01-JAN-88) format.
2. **Field Rep.:** The name of the field representative.
3. **Ratemeter/Scaler Model No.:** The model number of the ratemeter/scaler.
4. **Ratemeter/Scaler Serial No.:** The serial number of the ratemeter/scaler.
5. **Ratemeter/Scaler Calibration Date:** The date when the ratemeter/scaler was last calibrated.
6. **Window:** The window will be in the out position unless otherwise specified.
7. **Threshold:** The adjustment for the lower energy level of the discriminator shown on the calibration sticker or the calibration certificate.
8. **High Voltage:** The voltage applied to the alpha detector shown on the calibration sticker, calibration certificate, or instrument display.
9. **Battery:** The battery voltage reading at the beginning of the measurement.
10. **Alpha Probe Model No.:** The model number of the alpha detector probe.
11. **Alpha Probe Serial No.:** The serial number of the alpha detector probe.
12. **Alpha Probe Calibration Date:** The date when the alpha probe and ratemeter/scaler combination was last calibrated.
13. **Alpha Probe Efficiency:** The ratio of observed net count rate to the known disintegration rate of the check source from the Daily Alpha Efficiency Check form (Appendix 5.2).
14. **Probe Face Area:** The surface area of the Mylar window on the alpha scintillation detector in square centimeters (cm). Values for Ludlum Models 43-90 and 43-5 are listed at the bottom of the form.
15. **Calibration Factor:** Factor that takes the detector efficiency and surface area into account to convert from cpm to dpm per 100 cm<sup>2</sup>. The calibration factor in (dpm/100cm<sup>2</sup>)/cpm equals (100/Probe Face Area in cm<sup>2</sup>)/efficiency in cpm/dpm.
16. **Item Surveyed (Specify):** A description or identification number of the article surveyed. A separate line on the form is used to list and describe each area to be surveyed on the article.
17. **Gross Counts:** The total counts collected during the counting period.
18. **Count Time:** The time (in minutes) during which the counts were collected.
19. **Net cpm.:** Gross count (cpm) minus background (cpm).

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20. **Contamination Level (in dpm/100cm<sup>2</sup>):** This is calculated by multiplying the net cpm by the calibration factor.

Contamination level = (Net cpm) (Calibration Factor)

21. **Meets Release Limit (Yes/No):** If the contamination level is greater than or equal to the applicable release limit, a no is written here. If the contamination level is less than the release limit, a yes is written here.
22. **Swipe Necessary (Yes/No):** If the total alpha contamination level exceeds the applicable removable contamination criteria, a swipe must be performed to determine the activity contribution of fixed and loose contamination.

## SOP 1.2 – Appendix 5.5

### LIMITS FOR SURFACE CONTAMINATION

U.S. NRC

Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material

I	Removable Contamination <sup>1</sup> (dpm/100cm <sup>2</sup> )	
	A. Average over any surface <sup>2</sup>	---
	B. Maximum on any surface	26 <sup>3</sup>
II	Total Contamination <sup>4</sup> (dpm/100cm <sup>2</sup> )	
	A. Average over any surface <sup>5</sup>	129 <sup>3</sup>
	B. Maximum on any surface <sup>6</sup>	387 <sup>3</sup>

<sup>1</sup> Per the NRC Guideline, "The amount of removable radioactive material per 100 cm<sup>2</sup> of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped."

<sup>2</sup> The NRC Guideline does not specify an average removable contamination level.

<sup>3</sup> These values were determined by taking the ratios of Th-232 and Th-230 at the site and applying them to the values from NRC Guideline Table 1.

<sup>4</sup> Total contamination indicates fixed plus removable.

<sup>5</sup> Per the NRC Guideline "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."

<sup>6</sup> Per the NRC Guideline, "The maximum contamination level applies to an area of not more than 100 cm<sup>2</sup>."

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Supercedes: N/A			
Reason for Revision: N/A			
Changes Made: N/A			
Approval:			
Radiation Safety Officer:		<i>Paul Huth</i>	Date: 7/21/98
Site Health & Safety Officer:		<i>Maria Sandow</i>	Date: 7/21/98
Dow Project Manager:		<i>Ben Baker</i>	Date: 7/21/98

## 1.0 PURPOSE

This procedure provides guidance for the Site external dosimetry program.

## 2.0 DISCUSSION

Methods are presented for issuing thermoluminescent dosimeters (TLDs), preparing exposure history request and response letters, exchanging TLDs at the end of each quarter, updating the dosimetry records, determining dose for lost badges, terminating employees from the dosimetry program, and preparing annual exposure summary reports.

This procedure applies to all Site personnel who may work in the potentially contaminated area for more than 40 hours per quarter (three-month period) or who may receive more than 10% of the limit specified in 10CFR20.

## 3.0 PROCEDURES

### 3.1 Associated Procedures

The procedures needed to implement and maintain the external dosimetry program are described below. In addition, the Radiological Health and Safety Plan (RHSP) Section 10 provides guidance on how and when employees should be monitored.

### 3.2 TLD Issue for New Employees

1. Obtain the "Current Employee List" for the current quarter from the dosimetry files.
2. Obtain the dosimeters available for issue to new employees.
3. Enter the employee's name and badge number at the bottom of the list.

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4. Write "issued on DD/MM/YY" in the comments column on the "Current Employee List".
5. Obtain any additional equipment listed in the Equipment and Supplies Checklist Appendix 5.1, along with blank copies of the Dosimetry Data Form in Appendix 5.2 and the Thermoluminescent Dosimetry (TLD) Guidelines form in Appendix 5.3. Verbally go through the TLD guidelines form with the new employee.
6. Issue the employee a copy of Appendix 5.4, "Discussion of Radiation". Any new female employees will also have to undergo a fertile female briefing.
7. Have the employee read the appendix and complete both forms.

NOTE: Fill in the badge number and badge start date on the Dosimetry Data Form for the employee.

8. Retain both forms in the permanent dosimetry records.
9. Write the employee's last name on the badge and give the badge to employee.
10. If the employee has been exposed to ionizing radiation at a previous job, complete section 3.3 of this procedure.

### **3.3 Exposure History Request**

This section covers the Radiation Safety Officer's (RSO's) requests for exposure histories from other employers and the RSO's responses to requests from other employers.

#### **3.3.1 Request for Exposure History**

1. Write a letter, similar to that shown in Appendix 5.5, requesting the employee's previous exposure history.
2. Have the employee read the letter and sign the waiver at the bottom of the letter.
3. Sign, photocopy, and mail the letter.

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4. File the copy in the pending exposure history records.
5. When the data is received from the previous employer, attach it to the request letter in the exposure history records.

### 3.3.2 Response to Request for Exposure History

When another employer requests an exposure history record for a former Site employee, a prompt response will be made. The request must include a signed waiver.

1. Compile all whole body, skin, and internal dosimetry measurements for the employee from the external dosimetry and bioassay records. Obtain the employees social security number and birth date from Appendix 5.2, "Dosimetry Data Form."
2. Complete the NRC Form 4 in Appendix 5.6 from this data.
3. Write a letter similar to that in Appendix 5.7.
4. Copy the form and the letter and send the originals to the requestor.
5. Attach the original request letter to the copy of the response letter and the response form then file in the records.

### 3.4 TLD Badge Exchange

1. At the end of each quarter (April, July, October, January), copy all active employees' names from the current quarter's "Current Employee List" to a new list.
2. Exchange new badges for old badges with each employee on the list.
3. Examine the "Current Employee List" from the ending quarter to determine which employees have been added and terminated during the past quarter.
4. Insert these employees' names in a Landauer correspondence form letter similar to the one shown in Appendix 5.8.
5. Type an invoice list of badge numbers and employee names. Indicate that terminated employees have two badges being returned.

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6. File one copy of the letter with attached invoice list in the Landauer correspondence.
7. Place the other copy of the letter, the invoice list, and the badges to be returned in the self-addressed envelope to Landauer.
8. Mail the badges.

### 3.5 Records Update

1. When the dosimetry report is received from Landauer, review the data to ensure that they are not anomalous.
2. Check each badge result against the "Current Employee List" for the previous quarter to ensure that the badge was issued.
3. If the badge was not issued, write "not listed" in the employee information section.
4. Check the name, social security number, and birth date of each employee. Correct any errors.
5. Check the TLD log to see if any employees lost their badge during the previous quarter.
6. For all TLDs issued temporarily because of lost badges, write the appropriate name, social security number, and birth date on the Lost Badge Information form Appendix 5.9. Also, if the total dose calculated on the Lost Badge Information form is different from the dose measured by the temporary badge, correct the temporary badge dose to reflect the total from the form.
7. For lost badges where a temporary badge was not issued, record the employee information and estimated dose on one of the blank lines at the end of the Landauer report.
8. Copy all changes made to the second copy of the dosimetry report.
9. Initial all changes made on both reports. Write "reviewed and approved" with your signature and the date on each copy of the report.
10. File a copy in the dosimetry records file.

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11. Write a letter to Landauer documenting all the changes. File the letter with the other Landauer correspondence.
12. When the annual exposure summary is received, review it against the corrected quarterly reports. Make any necessary corrections following the same methods for the quarterly reports.
13. File the copy of Landauer's annual report in the dosimetry records file.

### 3.6 Lost Badges

1. Have the employee fill out the Lost Badge Information form in Appendix 5.9. File the completed form in the permanent dosimetry records.
2. Issue the highest number available badge as a temporary badge for the employee for the remainder of the quarter.
3. Record the temporary badge number and issue date on Appendix 5.9.
4. Record in the TLD Log that the employee lost his/her badge on DD/MM/YY and was issued badge # \_\_\_\_\_ temporarily.
5. At the end of the quarter, examine the doses received by the other employees who were present with the employee who lost his/her badge. Record on the Lost Badge Information form the highest dose (or sum of doses) for any of these employees as the dose received by the employee for the lost badge. Also, record the dose from the temporary badge on the form.
6. Sum the doses from temporary badge and the lost badge on the Lost Badge Information form. Record this total dose in the TLD Log with the employee's name, social security number, and the current date.

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### 3.7 Employee Termination

The termination reports specified in this section must be completed within 90 days of the employee's termination date.

1. When an employee is terminated from employment, collect his/her dosimeter and obtain the employee's new address.
2. Enter the employee's name, social security number, new address, and birth date in the TLD log and note that the employee was terminated on the specific date.
3. In the comments column of the "Current Employee List" write terminated on DD/MM/YY.
4. On the Dosimetry Data Form for that employee, enter the termination date.
5. Send the dosimeter to Landauer immediately to meet the 90-day reporting requirement for terminated employees.
6. When the report is received, file it in the dosimetry records and attach it to the quarterly report at the end of the quarter.
7. Determine the employee's annual and cumulative dose equivalents from shallow and whole body exposure from the dosimetry records, then complete NRC Form 5, Appendix 5.10.
8. Write a termination letter to the former employee advising him/her of his/her annual and cumulative dose, see Appendix 5.11.
9. Copy the NRC Form 5 and the termination letter and retain the copies in the employee's permanent files.
10. Mail the original termination letter and the form to the former employee.

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### **3.8 Preparation of the Annual Summary Report**

1. When the annual dosimetry report is received from Landauer, complete the NRC Form 5 (Appendix 5.10) for each employee who is employed at the end of the year.
2. Obtain the cumulative whole body, annual whole body, and annual shallow doses from the Landauer annual summary report and enter on the NRC Form 5 for that employee.
3. When the forms for all employees have been completed, copy them and retain the copies in the employee's personnel files.
4. Attach an explanation form to each of the forms and personally distribute to the employees.
5. Inform the employees that if they have questions they are free to contact members of the radiological services staff for further information.

### **4.0 SOURCE**

Radiological Health and Safety Plan

### **5.0 APPENDICES**

#### **5.1 Equipment and Supplies Checklist**

#### **5.2 Dosimetry Data Form**

#### **5.3 Thermoluminescent Dosimetry (TLD) Guidelines**

#### **5.4 Discussion of Radiation**

#### **5.5 Request for Exposure History Letter**

#### **5.6 NRC Form 4 – Lifetime Occupational Exposure History**

#### **5.7 Response to Request for Exposure History Letter**

#### **5.8 Landauer Correspondence Form Letter**

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5.9 Lost Badge Information Form

5.10 NRC Form 5 – Occupational Exposure Record For a Monitoring Period

5.11 Termination Letter

SOP 1.3 – APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

\_\_\_\_\_ Landauer two chip thermoluminescent dosimeters

\_\_\_\_\_ Dosimetry Forms

SOP 1.3 – APPENDIX 5.2  
DOSIMETRY DATA FORM

First Name: \_\_\_\_\_

Middle Name: \_\_\_\_\_

Last Name: \_\_\_\_\_

Social Security Number: \_\_\_\_\_

Sex: \_\_\_\_\_ Birth Date: \_\_\_\_\_

Hire Date: \_\_\_\_\_

Termination Date: \_\_\_\_\_

Employer: \_\_\_\_\_

Badge Number: \_\_\_\_\_ Badge Start Date: \_\_\_\_\_

SOP 1.3 – APPENDIX 5.3

THERMOLUMINESCENT DOSIMETRY (TLD) GUIDELINES

The following guidelines should be followed when using your TLD:

1. Take your TLD on all trips to the Site.
2. Wear your TLD on the front side of your body between the waist and chest.
3. When not using your TLD, it should be stored in the cabinet provided in your work area. Do not leave it near any source of radiation or heat or in your car.
4. Do not expose your TLD to airport X-ray equipment.
5. TLDs will be exchanged quarterly (April 15, July 15, October 15, and January 15). If you are going to be unavailable on these dates, make arrangements for TLD exchange with the dosimetry manager before you depart for the field.
6. Take care to not lose your TLD. If you do lose your TLD, report the loss to the dosimetry manager immediately.
7. Read the information regarding radiation exposure of women during pregnancy and ask the dosimetry manager to clarify any points that you do not understand.

I have read and understand the above guidelines and the information on radiation exposure of women during pregnancy and have been issued a TLD.

\_\_\_\_\_  
Name

\_\_\_\_\_  
Social Security Number

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\_\_\_\_\_ I have no history of previous exposure to ionizing radiation.

\_\_\_\_\_ I have been exposed to radiation at a previous job.

\_\_\_\_\_ I have no previous history with thorium, plutonium, or uranium.

Provide address for all employers who monitored your radiation exposure.

\_\_\_\_\_  
\_\_\_\_\_

Also, complete the necessary release form(s). \_\_\_\_\_

## SOP 1.3 – APPENDIX 5.4

### DISCUSSION OF RADIATION

The amount of radiation an individual receives is called “dose” and is measured in “rems.” The average individual in the United States accumulates a dose of one rem from natural sources every 12 years. The dose from natural radiation is higher in some states such as Colorado, Wyoming, and South Dakota, primarily because of cosmic radiation. There the average individual gets one rem every 8 years.

Natural background radiation levels are also much higher in certain local areas. A dose of one rem may be received in some areas on the beach at Guarapari, Brazil, in only about 9 days, and some people in Kerals, India, get a dose of one rem every 5 months.

Many people receive additional radiation for medical reasons. In 1970, an estimated 212 million X-ray examinations were performed in the U.S. The estimated average surface skin dose from one radiographic chest X-ray is 0.027 rem. The estimated average surface skin dose per abdominal X-ray is 0.62 rem.

Radiation can also be received from natural sources such as rock or brick structures, from products such as television and glow-in-the-dark watches, and from air travel. The possible annual dose from working 8 hours a day near a granite wall at the Redcap Stand in Grand Central Station, New York City, is 0.2 rem, and the average annual dose in the U.S. from TV, consumer products, and air travel is 0.0026 rem.

Radiation, like many things, can be harmful. A large dose to the whole body (such as 600 rems in one day) would probably cause death in about 30 days, but such large doses result only from rare accidents. Control of exposure to radiation is based on the assumption that any exposure, no matter how small, involves some risk. The occupational exposure limits are set so low, however, that medical evidence gathered over the past 50 years indicates no clinically observable injuries to individuals due to radiation exposures when the established radiation limits are not exceeded. This was true even for exposures received under the early occupational exposure limits, which were many times higher than the present limits. Thus the risk to individuals at the occupational exposure level is considered to be very low. However, it is impossible to say that the risk is zero. To decrease the risk still further, licensees are expected to keep actual exposures as far below the limits as is reasonably achievable.

The current exposure limits for people working with radiation have been developed and carefully reviewed by nationally and internationally recognized groups of scientists. It must be remembered, however, that these limits are for adults. Special consideration is appropriate when the individual being exposed is, or may be, an expectant mother, because the exposure of an unborn child may also be involved.

**SOP 1.3 APPENDIX 5.4**  
**(continued)**

**PRENATAL IRRADIATION**

The prediction that an unborn child would be more sensitive to radiation than an adult is supported by observations for relatively large doses. Large doses delivered before birth alter both physical development and behavior in experimentally exposed animals. A report of the National Academy of Sciences states that short-term doses in the range of 10 to 20 rems cause subtle changes in the nerve cells of unborn and infant rats. The report also states, however, that no radiation induced changes in development have been demonstrated to result in experimental animals from doses up to about 1 rem per day extended over a large part of the period before birth.

The National Academy of Sciences also noted that doses of 25 to 50 rems to a pregnant human may cause growth disturbances in her offspring. Such doses substantially exceed, of course, the maximum permissible occupational exposure limits.

Concern about prenatal exposure (i.e., exposure of a child while in its mother's uterus) at the permissible occupational levels is primarily based on the possibility that cancer (especially leukemia) may develop during the first 10 years of the child's life. Several studies have been performed to evaluate this risk. One study involved the follow-up of 77,000 children exposed to radiation before birth (because of diagnostic abdominal X-rays made for medical purposes during their mother's pregnancy). Another study involved the follow-up of 20,000 such children. In addition, 1292 children who received prenatal exposure during the bombing of Hiroshima and Nagasaki were studied. Although contradictory results have been obtained, most of the evidence suggests a relationship between prenatal exposure and an increased risk of childhood cancer.

**SUMMARY**

Occupational exposures to radiation are being kept low. However, qualified scientists have recommended that the radiation dose to an embryo or fetus as a result of occupational exposure of the expectant mother should not exceed 0.5 rem because of possible increased risk of childhood leukemia and cancer. Since this 0.5 rem is lower than the dose generally permitted to adult workers, women may want to take special actions to avoid receiving higher exposures, just as they might stop smoking during pregnancy or might climb stairs more carefully to reduce risks to their unborn children.

SOP 1.3 – APPENDIX 5.5  
REQUEST FOR EXPOSURE HISTORY LETTER

Date

Address:

To Whom It May Concern:

We would appreciate obtaining any radiation exposure data (internal and external) available for the employee listed below. This information is necessary so that our dosimetry program may comply with the Nuclear Regulatory Commission 10CFR20. This data should be sent to the above address. Please mark your response, "Attention (            )."

Thank you for your cooperation.

Sincerely,

(            )  
Health Physicist

JD/

To Whom It May Concern:

I authorize the release of my radiation exposure history while associated with your organization to ??????. These data shall include any internal or external exposures.

\_\_\_\_\_  
Name

\_\_\_\_\_  
Social Security Number

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

NRC FORM 4  
(9-1998)  
10 CFR Part 20

U. S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0005

EXP. DATE: 09/30/2001

# CUMULATIVE OCCUPATIONAL DOSE HISTORY

Estimated burden per response to comply with this mandatory information collection request 12 minutes. The record is used to ensure that doses to individuals do not exceed regulatory limits. This information is required to record an individual's lifetime occupational exposure to radiation to ensure that the cumulative exposure to radiation does not exceed regulatory limits. Forward comments regarding burden estimate to the Records Management Branch) (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, and to the Paperwork Reduction Project (3150-0005), Office of Management and Budget, Washington, DC 20503. If an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. NAME (LAST, FIRST, MIDDLE INITIAL)				2. IDENTIFICATION NUMBER				3. ID TYPE		4. SEX MALE FEMALE		5. DATE OF BIRTH			
6. MONITORING PERIOD			7. LICENSEE NAME				8. LICENSE NUMBER			9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD			7. LICENSEE NAME				8. LICENSE NUMBER			9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD			7. LICENSEE NAME				8. LICENSE NUMBER			9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD			7. LICENSEE NAME				8. LICENSE NUMBER			9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD			7. LICENSEE NAME				8. LICENSE NUMBER			9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD			7. LICENSEE NAME				8. LICENSE NUMBER			9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD			7. LICENSEE NAME				8. LICENSE NUMBER			9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD			7. LICENSEE NAME				8. LICENSE NUMBER			9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
19. SIGNATURE OF MONITORED INDIVIDUAL				20. DATE SIGNED				21. CERTIFYING ORGANIZATION				22. SIGNATURE OF DESIGNEE		23. DATE SIGNED	

**SOP 1.3 – APPENDIX 5.7**  
**RESPONSE TO REQUEST FOR EXPOSURE HISTORY LETTER**

Date

Address:

Dear <Person>:

Enclosed are the radiation exposure data that you requested for John Doe and Jane Doe. If you have any questions regarding these data, please contact me at the above address.

Sincerely,

(                    )  
Health Physicist

**SOP 1.3 – APPENDIX 5.8**  
**LANDAUER CORRESPONDENCE FORM LETTER**

Date

Landauer  
2 Science Road  
Glenwood, Illinois 60425-1586

To Whom It May Concern:

I have enclosed the TLD badges for the fourth quarter of YEAR with an invoice. The following badges have been terminated. Please do not reissue these badges:

Badge #	Employee Name	Birth Date	Social Security #
0001	Doe, John	01-01-80	345-66-5832
0002	Doe, Jane	01-10-70	472-60-6923

The following employees have been added to our program and should be added to the database:

Badge #	Employee Name	Birth Date	Social Security #
0003	Doe, Mike	05-02-62	584-53-6453
0004	Doe, Susan	01-25-59	153-60-9786

Thank you for your information.

Very Truly Yours,

(                    )  
Health Physicist

**SOP 1.3 – APPENDIX 5.9**  
**LOST BADGE INFORMATION FORM**

Fill out the following information regarding your site work during the quarter listed below.

Quarter: \_\_\_\_\_ Date: \_\_\_\_\_

Name: \_\_\_\_\_ Social Security #: \_\_\_\_\_

Temporary Badge #: \_\_\_\_\_ Issue Date: \_\_\_\_\_

Location and Nature of Work: \_\_\_\_\_

Duration of work (days): \_\_\_\_\_

Other employees on the visit: \_\_\_\_\_

Location and Nature of Work: \_\_\_\_\_

Duration of work (days): \_\_\_\_\_

Other employees on the visit: \_\_\_\_\_

Location and Nature of Work: \_\_\_\_\_

Duration of work (days): \_\_\_\_\_

Other employees on the visit: \_\_\_\_\_

List any other sites that you visited on the back of the form in the above format.

The following information will be completed by the Dosimetry Manager

Dose assigned for the lost badge (mrem):                      Whole Body \_\_\_\_\_ Skin \_\_\_\_\_

Dose from the temporary badge (mrem):                      Whole Body \_\_\_\_\_ Skin \_\_\_\_\_

Total dose for the quarter (mrem):                      Whole Body \_\_\_\_\_ Skin \_\_\_\_\_

NRC FORM 5  
(9/1998)  
10 CFR Part 20

U. S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0006

EXPIRES 03/30/2001

## OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD

Estimated burden per response to comply with this mandatory information request 20 minutes.  
This information is used to ensure that doses to individuals do not exceed regulatory limits. This information is required to record/annually report individual occupational exposure to radiation to ensure that the exposure does not exceed regulatory limits. Forward comments regarding burden estimate to the Information and Records Management Branch (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, and to the Paperwork Reduction Project (3150-0006), Office of Management and Budget, Washington, DC 20503. If an information collection does not display a currently valid OMB control number, NRC may not conduct or sponsor, and a person is not required to respond to the information collection.

1. NAME (LAST, FIRST, MIDDLE INITIAL)		2. IDENTIFICATION NUMBER		3. ID TYPE	4. SEX <input type="checkbox"/> MALE <input type="checkbox"/> FEMALE		5. DATE OF BIRTH						
6. MONITORING PERIOD			7. LICENSEE NAME		8. LICENSE NUMBER(S)		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">9A.</td> <td style="width: 50%;">9B.</td> </tr> <tr> <td>RECORD</td> <td>ROUTINE</td> </tr> <tr> <td>ESTIMATE</td> <td>PSE</td> </tr> </table>	9A.	9B.	RECORD	ROUTINE	ESTIMATE	PSE
9A.	9B.												
RECORD	ROUTINE												
ESTIMATE	PSE												

INTAKES				DOSES (in rem)	
10A. Radionuclide	10B. Class	10C. Mode	10D. Intake in microCuries		
				DEEP DOSE EQUIVALENT	11.
				EYE DOSE EQUIVALENT TO THE LENS OF THE EYE	12.
				SHALLOW DOSE EQUIVALENT, WHOLE BODY	13.
				SHALLOW DOSE EQUIVALENT, MAX EXTREMITY	14.
				COMMITTED EFFECTIVE DOSE EQUIVALENT	15.
				COMMITTED DOSE EQUIVALENT, MAX. EXPOSED ORGAN	16.
				TOTAL EFFECTIVE DOSE EQUIVALENT	17.
				TOTAL ORGAN DOSE EQUIVALENT, MAX ORGAN	18.
				19. COMMENTS	

20. SIGNATURE - LICENSEE	21. DATE PREPARED
--------------------------	-------------------

## SOP 1.3 – APPENDIX 5.11

### TERMINATION LETTER

Date

Employee Name

Address

City, State Zip Code

Subject: Occupational Exposure Record

Dear :

Attached is a summary of your radiation dose assessment record from working at the THORAD Site during your employment with RADIAN, International, LLC (NRC FORM 5). Your external radiation doses were measured using a commercial thermoluminescent dosimeter (TLD) from Landauer, Incorporated. The TLD badge measured your radiation exposure to the whole body and skin. Radiation doses due to gamma and beta radiation were recorded in units of rem.

In addition to measuring your external radiation dose with the TLD, a radiological dose estimate was determined for internal deposition of radioactive materials through the use of whole body counts, monitoring data, and pathway analysis. Both your external and internal radiation dose results are recorded on NRC FORM 5, "*Occupational Exposure Record for a Monitoring Period*," and is provided for your information only. The dose categories listed on your NRC Form 5 and other terms used in establishing personnel doses are listed in Attachment 2.

Your exposure records on the NRC Form 5 may be compared with those listed in Table 1, Occupational Radiation Dose Limits, established under 10 Code of Federal Regulations Part 20. If a dose was less than the minimum detection the letters ND for Non-Detect were used. Where a dose was not recorded the abbreviation NR was used.

The limit for annual effective dose equivalent is intended to reduce the risk from stochastic health effects to acceptable levels. Stochastic health effects are those which have no dose threshold for occurrence, and the probability of occurrence increases with dose. Examples of stochastic health effects that may be caused by radiation are cancer and leukemia.

**SOP 1.3 APPENDIX 5.11**  
**(continued)**  
**Table 1**

<b>Occupational Radiation Dose Limits</b>	
Exposure Type	Dose Equivalent Annual Limit
Whole Body (sum of external (DDE) & internal dose (CEDE)) - TEDE	5 rem
Extremity - SDE, ME	50 rem
Skin of Whole Body - SDE, WB	50 rem
Maximum Exposed Organ (sum of external (DDE) and internal dose (CDE)) - TODE	50 rem
Eye Dose Equivalent - LDE	15 rem
Minor	0.5 rem
Declared Pregnant Woman has a limit of 0.5 rem over the gestation period.	

For the skin of the whole body, the limit is intended to prevent the occurrence of nonstochastic health effects. Nonstochastic health effects occur only when a certain dose threshold is exceeded and may therefore be prevented entirely by setting the limit below this level. A reddening of the skin (erythema) occurs at doses above 300 rem and is the most common nonstochastic effect associated with radiation exposure of the skin. The recommended limit (30 rem) should prevent any occurrence of erythema and other nonstochastic effects to the skin of exposed persons.

It is your responsibility to report your radiation dose history to future employers. Official requests for your radiation exposure history, while you were employed at the THORAD Site, should be directed to:

RADIAN International, LLC  
 Attn: Charlene Loar  
 304 W. Wackerly  
 Midland, MI 48640  
 517-638-4293

Information on your TLD records while at the THORAD site can be obtained by sending a request to:

Landauer, Inc.  
 2 Science Road  
 Glenwood, IL 60425-1586  
 708-755-7000

If you have any questions please contact Ms. Charlene Loar, Assistant Radiation Safety Officer (517) 638-0227.

Sincerely,  
 Radiation Safety Officer

**SOP 1.3 APPENDIX 5.11**  
**(continued)**  
**Definitions Used as Part of the NRC Form 5,**  
***"Occupational Exposure Record for a Monitoring Period"***

**Dose:** The amount of energy deposited in body tissue due to radiation exposure. Various technical terms, such as dose equivalent, effective dose equivalent and collective dose, are used to evaluate the amount of radiation an exposed worker receives. These terms are used to describe the differing interactions of radiation with tissue as well as to assist in the management of personnel exposure to radiation. Definitions for dose terms necessary for various exposure calculations and recordkeeping purposes include the following:

**Committed dose equivalent (CDE, HT,50):** The dose equivalent calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or sievert).

**Committed Effective Dose Equivalent (CEDE, HE,50):** The sum of the committed dose equivalents to various tissues in the body (HT,50), each multiplied by the appropriate weighting factor (wT) - that is  $HE,50 = \sum wTHT,50$ . Committed effective dose equivalent is expressed in units of rem (or sievert).

**Deep Dose Equivalent (DDE):** The dose equivalent from external radiation determined at a tissue dose of 1 centimeter. Recorded from TLD badge issued to personnel during a monitoring period.

**Dose Assessment:** Process of determining radiological dose and uncertainty included in the dose estimate, through the use of exposure scenarios, bioassay results, monitoring data, source term information and pathway analysis.

**External Dose Or Exposure:** That portion of the dose equivalent received from radiation sources outside the body (e.g., "external sources").

**Internal Dose Or Exposure:** That portion of the dose equivalent received from radioactive material taken into the body (e.g., "internal sources").

**Lens Of The Eye Dose Equivalent (LDE):** The external exposure of the lens of the eye is taken as the dose equivalent at a tissue depth of 0.3 cm.

**Nonstochastic Effect:** Means health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect (also called a deterministic effect).

**Shallow Dose Equivalent (SDE):** The dose equivalent deriving from external radiation at a depth of 0.007 cm in tissue.

**SOP 1.3 APPENDIX 5.11**  
**(continued)**

**Stochastic Effects:** Means health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

**Total Effective Dose Equivalent (TEDE):** The sum of the deep dose equivalent (DDE, for external exposures) and the committed effective dose equivalent (CEDE, for internal exposures).

**Total Organ Dose Equivalent (TODE):** The sum of the deep dose equivalent (DDE, for external exposures) and the committed dose equivalent (CDE, for internal exposures) for maximally exposed organ.

**Whole Body:** For the purposes of external exposure, head, trunk including male gonads, arms above and including the elbow, or legs above and including the knee.

TITLE:	BETA-GAMMA RADIATION MEASUREMENTS USING A GEIGER-MÜLLER DETECTOR		
Document No. 1.4	Revision No. 00	Effective Date 07/21/98	Page 2 of 6

Portable GM counters have battery-operated power supplies and amplifiers. The sensitive element is a small Geiger tube contained in a probe. The probe is attached to a ratemeter/scaler that has several different scales, a time-response switch, and an audible output.

Two GM probe configurations are described in this procedure: a pancake probe and an energy-compensated tube. The pancake probe consists of a flat, thin-windowed GM tube in a shielded housing. It measures radiation coming primarily from in front of the thin window and is used for measuring beta-gamma contamination on surfaces. The energy-compensated probe is typically a thick-walled GM tube measuring 4 to 6 inches long that is covered with a material of sufficient thickness to allow consistent measurement over a broad energy range. The GM tube measures radiation from any direction and absorbed dose rates from beta-gamma radiation fields of energies greater than about 100 kilo-electron volts (keV).

## 2.1 Limitations

GM counters have several characteristics that can lead to erroneous results unless the user is aware of them.

- At high radiation levels, the counter will not recover from a count soon enough to measure the next entering particle. This causes a decreased response at higher radiation levels; at extremely high levels, the response may no longer increase with increased radiation. In certain cases, the response may decrease or get to zero at very high levels.
- At extreme temperatures, the instrument may respond erratically or not at all. Under these conditions, a check source is needed to ensure reliable behavior.
- The GM tube is delicate and sensitive to damage if dropped or exposed to significant changes in air pressure. If a rattling sound is heard when the user blows air across the probe face, it is likely that the tube has broken. To avoid a common means of tube breakage, do not ship the probe in an unpressurized airplane.

TITLE:	BETA-GAMMA RADIATION MEASUREMENTS USING A GEIGER-MÜLLER DETECTOR		
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### 3.0 PROCEDURE

#### 3.1 Associated Procedures

The Radiological Health and Safety Plan (RHSP) provides information on the scope of specific operations, related health and safety requirements, and the applicability of this procedure to the activities.

#### 3.2 Preparation

The sections below describe tasks that must be performed prior to making beta-gamma measurements.

##### 3.2.1 Office

The following items must be completed in the office, prior to entering the field:

- Review the RHSP;
- Coordinate schedules/actions with the installation staff;
- Obtain appropriate permission for property access; and
- Assemble the equipment and supplies listed in Appendix 5.1. Ensure the current calibration of the probe and the ratemeter/scaler.

##### 3.2.2 Documentation

The following must be completed prior to entering the field:

- Obtain a logbook from the Radiation Safety Officer (RSO);
- Record results of the equipment check and calibration in the logbook;
- Obtain a sufficient number of the appropriate data collection forms; and
- Consult the data administrator for a current list of information management codes, location Ids and sample numbers used in the completion of data forms.

##### 3.2.3 Field

The following must be completed in the field, prior to taking beta-gamma measurements:

- Take five 1-minute background counts to ensure that the probe is not contaminated and to determine background levels. If the count rate is

TITLE:	BETA-GAMMA RADIATION MEASUREMENTS USING A GEIGER-MÜLLER DETECTOR		
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greater than normal, check for surface contamination and be sure that the high-voltage setting is as marked on the probe. Calculate the mean background, the standard deviation of the mean, and three times the standard deviation (see Appendix 5.3 for formula).

- Take a 1-minute count using a check source (like Th-232) to check the instrument response. The efficiency of the Ludlum 44-9 is typically about 15%.

### 3.3 Operation

The following operations are required when making beta-gamma measurements.

#### 3.3.1 Obtaining Measurements

The following procedures must be performed when making beta-gamma measurements:

- Record beta-gamma measurements with the GM detector on the Beta-Gamma Measurements form (Appendix 5.2). Complete the form according to Appendix 5.3, *Data Form Completion*;
- Place the GM probe at a small distance (one-half inch) from the location to be monitored (*NOTE: The thin window of the probe is easily punctured. Care should be taken to protect the surface from sharp objects.*);
- Take a count of predetermined duration (0.5 minute to 2 minutes) and record the count rate;
- If using an energy-compensated GM, multiply the count rate by the calibration factor and determine the beta-gamma dose rate in millirads/hour (mrad/hr); and
- Compare the counts to the background counts. The RHSP or Site Safety Officer may require further characterization of samples or locations exceeding background (samples or locations with counts greater than  $x + 3SDX$  are considered contaminated).

TITLE:	BETA-GAMMA RADIATION MEASUREMENTS USING A GEIGER-MÜLLER DETECTOR		
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### 3.4 Postoperation

The following tasks must be completed after the collection of beta-gamma radiation measurements.

#### 3.4.1 Field

The following must be performed in the field:

- Turn all switches to the off position;
- Ensure that all equipment is accounted for, decontaminated, and ready for shipment; and
- If necessary, make sure all survey or sampling locations are properly staked and the location ID is readily visible on the location stake.

#### 3.4.2 Documentation

Prior to leaving the field, the technician will:

- Record any uncompleted work (like additional monitoring) in the logbook;
- Complete logbook entries, verify the accuracy of entries, and sign/initial all pages; and
- Review data collection forms for completeness.

#### 3.4.3 Office

The following must be completed in the office, after collecting beta-gamma radiation measurements:

- Deliver original forms and logbooks to the document control officer with copies to the site manager and files;
- Ensure that all radiological sources and standards have been stored in a locked area;
- Inventory equipment and supplies;
- Repair or replace all broken or damaged items;
- Replace expendable items; and
- Return equipment to the equipment manager and report incidents of malfunctions or damage.

<b>TITLE:</b>	<b>BETA-GAMMA RADIATION MEASUREMENTS USING A GEIGER-MÜLLER DETECTOR</b>		
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#### 4.0 SOURCE

Healy, J. W. 1970. "Los Alamos Handbook of Radiation Monitoring." Los Alamos Scientific Laboratory Report LA-4400. Los Alamos, New Mexico.

#### 5.0 APPENDICES

5.1 Equipment and Supplies Checklist

5.2 Beta-Gamma Measurements Form

5.3 Data Form Completion

SOP 1.4 – Appendix 5.1

**EQUIPMENT AND SUPPLIES CHECKLIST**

- \_\_\_\_\_ GM pancake probe (Ludlum 44-9 or the equivalent)
- \_\_\_\_\_ Ratemeter/scaler (Ludlum 2221 or the equivalent)
- \_\_\_\_\_ Energy-compensated GM (Ludlum 44-38 or the equivalent)
- \_\_\_\_\_ Cable
- \_\_\_\_\_ Beta source (Tc-99 or Sr-90)



**DATA FORM COMPLETION**

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

**BETA-GAMMA MEASUREMENT FORM**

1. **Facility Code:** Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.
2. **Log Date:** The date that information recorded on the form was obtained in the format DD-MMM-YY. (01-JAN-88).
3. **Logger Code:** Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.
4. **Field Rep:** The name of the field representative.
5. **Acceptance Code:** One-character code assigned by the site manager.
6. **Ratemeter/Scaler Model No.:** The model number of the ratemeter/scaler.
7. **Ratemeter/Scaler Serial No.:** The serial number of the ratemeter/scaler.
8. **Ratemeter/Scaler Calibration Date:** The date when the ratemeter/scaler was last calibrated.
9. **Voltage:** The voltage that is applied to the detector. For a pancake Geiger-Müller (GM), this is usually about 900 volts.
10. **Battery:** The battery voltage reading at the beginning of the measurements.
11. **GM Probe Model No.:** The model number of the GM probe.
12. **GM Probe Serial No.:** The serial number of the GM probe.
13. **GM Probe Calibration Date:** The date when the GM probe was last calibrated.

## SOP 1.4 – Appendix 5.3

14. **Average Background cpm + 3 Standard Deviation:** This field is used to establish contamination criteria for use in sample selection for analyses or general screening.

$$\text{Average background} = x = (x_1 + x_2 + x_3 + \dots + X_i) / N$$

where

$x$  = the mean

$x_1 + x_2 + x_3 + \dots + X_i$  = a summation of all the background counts obtained

$X_i$  = the number of background counts for each observation

$N$  = the total number of background counts taken (observations)

$$3 \text{ standard deviation} = 3SDX = 3 * \sqrt{\frac{\sum_i (x_i - x)^2}{N}}$$

15. **Source Check Date/Time:** The date and time the system was last source checked.
16. **Window Open (O) or Window Closed (C):** When using an energy-compensated GM, the window can be open or closed as specified in the site Health and Safety Plan. Enter N/A if using a pancake GM.
17. **Calibration Factor:** The calibration factor in millirads per hour (mrad/hr)/counts per minute (cpm) used to convert cpm to mrad/hr when using an energy-compensated GM. Enter N/A if using a pancake GM.
18. **Comments:** Any additional information
19. **Location ID:** Four-character code assigned sequentially to each borehole, test pit, or surface location where physical, chemical, biological, radiological, and other measurements are taken.
20. **Coordinates (Ft):** The coordinates of the measurement location in feet. The format is north and east.
21. **Sample ID or Item Description:** The sample identification number or description of the item being counted. Enter N/A if not applicable.
22. **Counts:** The counts obtained over the counting period. Enter N/A if using a ratemeter.

## SOP 1.4 – Appendix 5.3

23. **Count Time:** The time in minimum over which the counts were collected. Enter N/A if using a ratemeter.
24. **CPM:** The counts per minute obtained by dividing the total counts by the counting time or by recording the ratemeter cpm reading.
25. **mrad/hr:** The dose rate obtained using a calibration factor applied to an energy-compensated GM.
26. **Contaminated (Yes/No):** If the counts obtained are greater than the average background + 3 standard deviations, the item or location has measurable contamination (yes) and should be evaluated according to the release criteria.
27. For performing contamination release surveys with the GM-Pancake probe, the probe face area is equal to 15.5 cm<sup>2</sup>.

<b>TITLE:</b>	<b>MEASUREMENT OF GAMMA-RAY FIELDS USING A SODIUM IODIDE (NaI) DETECTOR</b>		
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### 3.3 Preparation

The sections below describe tasks that must be completed prior to measuring gamma-ray fields.

#### 3.2.1 Office

The following tasks must be complete prior to entering the field:

- Review the RHSP;
- Coordinate schedules/actions with the installation staff;
- Obtain appropriate permission for property access;
- Assemble the equipment and supplies listed in Appendix 5.1;
- Ensure the proper operation of all field equipment; and
- Ensure current calibration of the probe and the ratemeter/scaler.

#### 3.2.2 Documentation

The following must be completed prior to entering the field:

- Obtain a logbook from the Radiation Safety Officer;
- Record results of the equipment check and calibration in the logbook;
- Obtain a sufficient number of the appropriate data collection forms; and
- Consult the data administrator for a current list of codes and location Ids used in the completion of data forms.

#### 3.2.3 Field

The following tasks must be completed in the field, prior to measuring gamma-ray fields:

- Visually inspect the equipment, including the connector cable, for breakage;
- Check the battery charge. If necessary, replace the batteries;
- Set the threshold to the value given on the calibration certificate (usually 100 volts);
- Check the detector voltage to the value given on the calibration certificate. The operating voltage for an NaI probe is usually 700 to 1000 volts;
- Set the window to the out position (gross mode);
- Note the response of the detector to the check source; and
- Record the results of the equipment check on the function check form (Appendix 5.2).

TITLE:	MEASUREMENT OF GAMMA-RAY FIELDS USING A SODIUM IODIDE (NaI) DETECTOR		
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### 3.4 Operation

The sections below describe procedures that must be followed when measuring gamma-ray fields:

#### 3.3.1 Count-Rate Measurements

The following steps are required to measure count-rate:

- Record the gamma count-rate measurements taken with the NaI detector in the logbook or appropriate form;
- Turn on the instrument;
- Hold the detector first at a height of 3 ft. above the ground (waist height), then at the ground surface if an above-background level is noted;
- Allow the ratemeter/scaler to integrate the count rate for at least 10 sec; and
- Record the results on the appropriate form.

#### 3.3.2 Recognizing Area and Point Sources

Walk slowly in the area of interest, holding the NaI detector waist high, and note the count rate. Determine the location of the highest observed gamma count rate (sometimes called the HOG). At the HOG, compare the count rate obtained at waist height with the count rate obtained at ground level. If both count rates are above background and increase rapidly as the detector is held closer to the ground surface, the anomalous area may be an isolated hot spot with an area of only a few square feet. If the HOG is broad in extent and there is no difference in the count rate at ground level and waist height, the anomalous area probably is not highly localized.

#### 3.3.3 Recognizing Gamma Shine from Nearby Anomalies

Walk slowly in the area of interest, holding the NaI detector at waist height. If the count rate increases while leaving the area of interest, some of the gamma count rate observed at the area of interest may be due to emission from an adjacent gamma source, or "shine". If the count rate increases as the height of the detector above the ground increases, some of the gamma count rate at the area of interest may be due to shine.

### 3.5 Postoperation

The sections below describe tasks that must be completed after measurement of gamma-ray fields.

TITLE:	MEASUREMENT OF GAMMA-RAY FIELDS USING A SODIUM IODIDE (NaI) DETECTOR		
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### 3.4.1 Field

The following must be completed prior to leaving the field:

- Turn all switches to the off position;
- Ensure that all equipment is accounted for, decontaminated, and ready for shipment; and
- If necessary, make sure all survey or sampling locations are properly staked and the location ID is readily visible on the location stake.

### 3.4.2 Documentation

The following must be completed prior to leaving the field:

- Record any uncompleted work (like additional monitoring) in the logbook;
- Complete logbook entries, verify the accuracy of entries, and sign/initial all pages; and
- Review data collection forms for completeness.

### 3.4.3 Office

The following must be completed after returning to the office:

- Deliver original forms and logbooks to the Radiation Safety Officer;
- Inventory equipment and supplies;
- Repair or replace all broken or damaged equipment;
- Replace expendable items;
- Return all field equipment to the equipment manager and identify any operational problems from previous use; and
- Ensure that all radiological sources and standards have been stored in a locked area.

## 4.0 SOURCE

"Instruction Manual Model 2221 Portable Scaler Ratemeter." Ludlum Measurements, Inc. April 1982. Sweetwater, Texas.

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**5.0 APPENDICES**

**5.1 Equipment and Supplies Checklist**

**5.2 Daily Efficiency Check Form**

**5.3 Data Form Completion**

## SOP 1.5 – Appendix 5.1

### EQUIPMENT AND SUPPLIES CHECKLIST

- \_\_\_\_\_ Portable ratemeter/scaler, Ludlum 2221 (or equivalent)
- \_\_\_\_\_ Sodium iodide (NaI) gamma scintillometer, Ludlum 44-10
- \_\_\_\_\_ D-cell batteries (4)
- \_\_\_\_\_ Connector cable
- \_\_\_\_\_ Hand-held calculator
- \_\_\_\_\_ Gamma check source
- \_\_\_\_\_ Collimated lead shield (OPTIONAL)



## SOP 1.5 – Appendix 5.3

### DATA FORM COMPLETION

Use a pen with black ink that is not water-soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

#### Daily Efficiency Check Form

1. **Ratemeter/Scaler Make & Model:** The manufacturer and model number of the ratemeter/scaler.
2. **Ratemeter/Scaler Serial #:** The serial number of the ratemeter/scaler.
3. **Ratemeter/Scaler Calibration Date:** The date when the ratemeter/scaler was last calibrated.
4. **Detector Make & Model:** The manufacturer and model number of the alpha detector probe.
5. **Detector Serial #:** The serial number of the alpha probe.
6. **Detector Calibration Date:** The date the probe was last calibrated.
7. **Detector Configuration Setting:** Any special notes about the threshold, high voltage, and other special settings on the instruments.
8. **Window:** The window is in the out position unless otherwise specified.
9. **Source Type:** The identity of the radioactive isotope contained in the source given as element and mass number, like Am-241.
10. **Source Activity:** The activity of the radioactive source in disintegrations per minute (dpm). If the check source activity is given in microcuries ( $\mu\text{Ci}$ ), it can be converted to dpm using  $1 \mu\text{Ci} = 2.22 \times 10^6 \text{ dpm}$ .
11. **Source Identification Number:** The serial number of the radiation source.
12. **Start Date:** The date when the form was began in the DD-MMM-YY (01-JAN-88) format.
13. **Technician Signature:** The signature of the field representative who started the form.
14. **Comments:** Any special notes about the instruments or procedure.
15. **Date:** The date the information recorded on the form was obtained in the DD-MMM-YY (01-JAN-88) format.
16. **Time (HH:MM):** The time the efficiency was determined using the 24-hour clock in the hours:minutes format.
17. **Check Source - Scale:** The scale setting on the instrument when the source was counted.
18. **Check Source - cpm or rate:** The number of pulses recorded by the scaler during the counting time. Enter N/A if using a ratemeter.
19. **CT. Time:** (Counting-Time (min)). The time in minutes over which the scaler counts. Enter N/A if using a ratemeter.
20. **Background cpm or rate:** The count rate with no source present.

## SOP 1.5 – Appendix 5.3

21. **Net Counts cpm:** Net cpm equals check source cpm minus background cpm.
22. **Eff. cpm/dpm:** The ratio of the observed count rate to the true disintegration rate. Efficiency = Net counts cpm / Activity dpm
23. **Battery Voltage:** The battery voltage reading at the beginning of the measurement.
24. **High Voltage:** The voltage that is applied to the alpha scintillation probe shown on the calibration sticker or the instrument display. This voltage is determined annually using a voltage plateau.
25. **Threshold Setting:** The adjustment for the lower energy level of the discriminator shown on the calibration sticker or calibration certificate.
26. **Tech Init.:** Initials of the technician who performed the efficiency check.
27. **Source Response Limits:** The range of cpm or rate expected for the check source. If the daily source check does not fall within this range, there may be a problem with the instrument.
28. **Stat Check Date/Time:** The date and time when the last statistical (stat) efficiency check was done. The stat check determines the source response limits in 27.
29. **Reviewed by/Date:** The signature of the person who reviewed the form and the date it was reviewed.

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### 3.1.2 Documentation

1. Obtain logbook from the Radiation Safety Officer
2. Record results of equipment check in logbook.
3. Obtain sufficient number of appropriate forms.

### 3.1.1 Lab Preparation

1. Before handling any filter holders put on a pair of nitrile gloves.
2. Obtain quick-connect filter holders, usually located next to the vent hood.
3. Inspect filter holders to ensure that they are clean and free of dirt. If they are not, turn on the vent hood and use the compressed air to clean any dirty filter holders.
4. Load 47-mm-diameter filter into an open-faced filter holder with rough-irregular pattern facing outward.
5. Put a plastic cap over the top of the filter holder to ensure filter is not contaminated before connecting to the pump.
6. Obtain an appropriate number of clean Ziploc<sup>®</sup> bags and the metal field folder used for air sampling. Inside there should be two sets of coin envelopes: one set for the sample you will be collecting and the other set for writing down the starting information on the new sample. Make sure you also have a sharpie for numbering the Ziploc<sup>®</sup> bags.

### 3.2 Field

1. Start at any environmental station.
2. Before changing out quick connect filter and turning off pump, be sure to write down on the proper coin envelope the date/time off, the flow rate, and the hours on the in-line timer.
3. Turn off the pump, and disconnect the filter holder and cover with a plastic cap. Put into a Ziploc<sup>®</sup> bag and number it with the corresponding environmental station number.
4. Reset the in-line timer, then connect the clean filter holder to the pump.
5. Remove the plastic cap then turn the pump on.
6. Let pump run for a few seconds then write down the date/time on, flow, and the starting hours on the in-line timer (should be 0) on the second set of coin envelopes.
7. Repeat until all environmental stations are changed out. Samplers should run for at least 4 hours. **Note: Actual flow must be obtained from the pump calibration paper. The flowmeter on the pump is indicated flow not actual flow.**

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### 3.3 Lab

1. Bring back all filter holders to lab and put next to the vent hood.
2. Have the filled out coin envelopes ready.
3. With a clean pair of nitrile gloves put one of the filter holders under the vent hood.
4. Remove holder from Ziploc® and twist top off.
5. Using the plastic sampling scissors or a set of tweezers remove filter by grasping the clean outer edge of the filter and put it into its proper envelope.
6. Remove envelope from under the vent hood and place aside. With the compressed air hose, spray the filter holder to remove any lingering particulates.
7. Repeat until all filters are put into their proper envelope and all holders are cleaned off.
8. Determine and record the background of the Alpha counting instrument by counting a blank filter for at least 60 minutes. (NOTE: Use of a longer time, such as overnight, is preferred.)
9. After waiting at least three hours (or 72 hours for thoron decay) from the end of sampler collection, place the sample in the detector and make a count of at least 60 minutes.
10. Record the start time and the result on the Radioactive Particulate Sampling Log Appendix 5.2.
11. Use the following formula to calculate the long-lived alpha concentration:

$$C = \frac{(S-B) (FA)}{(2.22E + 6) (E) (V)}$$

where:

C = concentration in air  $\mu\text{Ci}/\text{ml}$

S = sample alpha count rate (cpm)

= gross sample counts/sample counting time (min)

B = background count rate (cpm)

= background counts/background counting time (min)

E = detector efficiency (cpm/dpm)

V = volume sampled (ml)

= average actual flowrate of air (lpm) x sample collecting time (min)  
x 1000 ml/l

2.22E + 6 = Conversion factor, dpm to  $\mu\text{Ci}$

FA = Filter absorption factor

= 1.25 for glass fiber filter

CL = concentration limit

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dpm = disintegrations per minute

12. The concentration in the previous step should be compared to the insoluble thorium-230 concentration limit ( $3 \times 10^{-12}$   $\mu\text{Ci/ml}$ ). If the limit is exceeded, the sample must be stored for at least 72 hours and the previous three steps repeated. This is to allow any Rn-222 or Rn-220 collected on the filter to decay. If the result still exceeds the applicable limit, notify the Site Environmental Health and Safety Manager.
13. If the result exceeds 25% of the limit, all personnel in the area of the work shall wear respiratory protection.
14. Ensure that the Radioactive Particulate Sampling Log contained in Appendix 5.2 is completed.
15. Give this form to the Radiation Safety Officer for review before filing.

#### 4.0 SOURCES

UMTRA Project Environmental, Health and Safety Plan. UMTRA-DOE/AL-150224.0006.

#### 5.0 APPENDICES

##### 5.1 Equipment Checklist

##### 5.2 Radioactive Particulate Sampling Log

**SOP 1.6 - APPENDIX 5.1**  
**Equipment and Supplies Checklist**

- Calibrated Ras-1 air sampling pump
- Calibrated alpha counting detector/scaler
- AC Power or generator
- Logbook
- Appendix 5.2 Radioactive Particulate Sampling Log
- Nitrile gloves
- Quick-connect filter holders
- 47mm glass fiber filters
- Compressed air or nitrogen
- Plastic caps (non-static)
- Ziploc<sup>®</sup> bags
- Field folder
- Coin envelopes (for samples)
- Sharpie permanent marker
- Vent hood
- Sampling scissors or tweezers
- Calculator



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Supersedes: Document No. 1.7, Revision No. 00, Effective Date 07/21/98			
Reason for Revision: Changed guideline			
Changes Made: Limits for Surface Contamination – Appendix 5.5			
Approval:			
Radiation Safety Officer:		Date: 8/14/2000	
Site Health & Safety Officer:		Date:	
Dow Project Manager:		Date: 8/14/2000	

## 1.0 PURPOSE

To establish a procedure for verifying that equipment leaving a controlled area that contains radioactive materials meets unrestricted release criteria for removable contamination. This equipment may include tools, vehicles, and miscellaneous items brought into contact with radioactive materials.

## 2.0 DISCUSSION

During the course of sampling in radiologically contaminated areas, various pieces of equipment handled by workers may become contaminated. To ensure safety for workers and compliance with the equipment release criteria set forth in section 12.0 of the Radiological Health and Safety Plan (RHSP) for the Sites, equipment must be analyzed for removable contamination. Equipment must be decontaminated to levels that are as low as reasonably achievable—below the applicable release criterion for removable contamination in all cases.

The standard technique for verification is to wipe (swipe) an area on a piece of equipment and analyze the swipe sample for elevated levels of radioactivity. A gross-alpha count is performed with an alpha sample counter connected to a portable scaler. The 2π efficiency of the counter must be at least 20%.

It may also be necessary to take direct instrument measurements with portable alpha scintillators or Geiger-Müller detectors. A comparison of swipe results and direct instrument readings will distinguish between amounts of removable and total contamination.

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### 3.0 PROCEDURE

#### 3.1 Associated Procedure

Standard Operating Procedure 1.2, *Total Alpha Surface Contamination Measurements*, should normally be used in conjunction with this procedure since contamination criteria specify limits for both total and removable contamination. In addition, specific guidance on how and when to apply this procedure is found in the Radiological Health and Safety Plan.

#### 3.2 Preparation

##### 3.2.1 Office

Before entering the field, the following tasks must be completed:

- Review the Radiological Health and Safety Plan and SOP 1.2;
- Coordinate schedules/actions with the installation staff;
- Obtain appropriate permission for property access;
- Arrange for a laboratory counting system and personnel to perform the desired radiological analysis of swipes on-site;
- Assemble the equipment and supplies listed in Appendix 5.1; and
- Ensure the proper operation and calibration of all field equipment.

##### 3.2.2 Documentation

Before entering the field, the following tasks must be completed:

- Obtain a logbook from the QA officer;
- Record results of the equipment check in the logbook;
- Obtain a sufficient number of the appropriate data collection forms; and
- Consult the data administrator for a current list of codes used in the completion of data forms.

##### 3.2.3 Field

While in the field, the following tasks must be performed:

- Complete the Daily Alpha Efficiency Check form (Appendix 5.2) by following instructions in Appendix 5.4, *Data Form Completion*; and

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- Perform a 10-minute background count and a 1-minute NIST-traceable alpha source count daily when using the instrument. Record the results on the Daily Alpha Efficiency Check form (Appendix 5.2) and under efficiency on the Removable Alpha Contamination Survey Data form (Appendix 5.3). The efficiency is calculated as shown below.

$$\text{Efficiency} = \frac{\text{net source counts per minute (cpm)} - \text{background cpm}}{\text{source dpm}}$$

### 3.3 Operation

#### 3.3.1 Swipe Test

The following tasks must be completed when performing a swipe test:

1. Label all swipe envelopes with the date, time, description or number of the item swiped, the location, and the initials of the person who collected the swipe sample.
2. Make sure a sufficient number of swipes are available for the desired tasks.
3. If swipes are to be taken in a controlled area, wear appropriate protective clothing (consult the RHSP for the level of protection).
4. Obtain swipes from a 100 cm<sup>2</sup> area when possible, noting the area in cm<sup>2</sup> on the Removable Alpha Contamination Survey Data form (Appendix 5.2). When it is not possible to cover this area, make an estimate of the surface area in cm<sup>2</sup>. For convenience, 100 cm<sup>2</sup> can be approximated by a square that is 4 inches on each side. If contamination is detected on a swipe taken from an area greater than 100 cm<sup>2</sup>, the area must be reswiped in 100 cm<sup>2</sup> increments to ensure that a hot spot in excess of the limit is not present.
5. Use sufficient pressure on the swipe to pick up loose contamination without tearing or separating the swipe. Rough surfaces like concrete, cast iron, and rough-cut lumber should be surveyed according to SOPs 1.2, *Total Alpha Surface Contamination Measurements* and 1.4, *Beta-Gamma Radiation Measurements Using a Geiger-Müller Detector*.
6. During routine swipe surveys, pay particular attention to areas on equipment where contamination is most likely to occur (for example, handles, footrests, and tires).
7. Return the swipe to a properly labeled sample holder or glassine envelope. Maintain the swipe integrity and ensure that the sample material is not dislodged from the swipe.
8. Count each swipe with the alpha sample counter and scaler by inserting the swipe into the slide tray, closing the tray, and starting a 1-minute count. Any swipe that exceeds the release criterion should be counted more than

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once for confirmation. Release criteria are described in Appendix 5.5, *Limits for Surface Contamination*.

9. Record all results on the *Removable Alpha Contamination Survey Data* form (Appendix 5.3) according to instructions in Appendix 5.4, *Data Form Completion*.
10. Give the survey results to the person responsible for releasing the equipment. Save any swipes that exceed the removable contamination limit in case a recount or additional analysis is needed. Equipment that fails to meet the release limits must undergo additional decontamination.

### 3.4 Postoperation

#### 3.4.1 Field

Prior to leaving the field, the sampler will:

- Ensure that all equipment is accounted for, decontaminated, and ready for shipment;
- Return all equipment to the storage area. Be certain the ratemeter/scaler is in the off position;
- Ensure that equipment that fails to meet the release criteria after repeated decontamination efforts is held from unrestricted release; and
- Make sure that swiped items are properly numbered or marked and identifications are readily visible and permanent.

#### 3.4.2 Documentation

Prior to leaving the field, the sampler will:

- Record any uncompleted work (like uncounted swipes or items needing decontamination) in the logbook;
- Complete logbook entries; verify the accuracy of entries, and sign/initial all pages; and
- Review data collection forms for completeness.

#### 3.4.3 Office

The sampling technician will perform the following tasks after returning to the office:

- Deliver original forms and logbooks to the document control officer (with copies to the site manager and files);

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- Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage; and
- Ensure that all radiological sources and standards have been stored in a locked area.

#### 4.0 SOURCE

NRC. 1987. Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material

#### 5.0 APPENDICES

##### 5.1 Equipment and Supplies Checklist

##### 5.2 Daily Efficiency Check Form

##### 5.3 Removable Alpha Contamination Survey Data Form

##### 5.4 Data Form Completion

##### 5.5 Limits for Surface Contamination

## SOP 1.7– Appendix 5.1

### EQUIPMENT AND SUPPLIES CHECKLIST

- \_\_\_\_\_ Round swipe pads, 2-inch diameter
- \_\_\_\_\_ Sample holders or glassine envelopes
- \_\_\_\_\_ Indelible marker
- \_\_\_\_\_ Latex gloves
- \_\_\_\_\_ Alpha detector, Ludlum model 43-10 or the equivalent
- \_\_\_\_\_ Portable scaler (Ludlum 2221 or the equivalent) and connecting cable
- \_\_\_\_\_ Forceps (for handling contaminated swipes)
- \_\_\_\_\_ NIST-traceable alpha source, like Am-241
- \_\_\_\_\_ Hand-held calculator





## SOP 1.7– Appendix 5.4

### DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

#### Daily Alpha Efficiency Check Form

1. **Ratemeter/Scaler Make & Model.** The manufacturer and model number of the ratemeter/scaler.
2. **Ratemeter/Scaler Serial #.** The serial number of the ratemeter/scaler.
3. **Ratemeter/Scaler Calibration Date.** The date when the ratemeter/scaler was last calibrated.
4. **Detector Make & Model.** The manufacturer and model number of the alpha detector probe.
5. **Detector Serial #.** The serial number of the alpha probe.
6. **Detector Calibration Date.** The date the probe was last calibrated.
7. **Detector Configuration Setting.** Any special notes about the threshold, high voltage, and other special settings on the instruments.
8. **Window.** The window is in the out position unless otherwise specified.
9. **Source Type.** The identity of the radioactive isotope contained in the source given as element and mass number, like Am-241.
10. **Source Activity.** The activity of the radioactive source in disintegrations per minute (dpm). If the check source activity is given in microcuries ( $\mu\text{Ci}$ ), it can be converted to dpm using  $1 \mu\text{Ci} = 2.22 \times 10^6 \text{ dpm}$ .
11. **Source Identification Number.** The serial number of the radiation source.
12. **Start Date.** The date when the form was started in the DD-MMM-YY (01-JAN-98) format.
13. **Technician Signature.** The signature of the field representative who started the form.

## SOP 1.7– Appendix 5.4

14. **Comments.** Any special notes about the instruments or procedure.
15. **Date.** The date the information recorded on the form was obtained in DD-MM-YY (01-JAN-98) format.
16. **Time (HH:MM).** The time the efficiency was determined using the 24-hour clock in the hours:minutes format.
17. **Check Source - Scale.** The scale setting on the instrument when the source was counted.
18. **Check Source - cpm or rate.** The number of pulses recorded by the scaler during the counting time. Enter N/A if using a ratemeter.
19. **CT. Time.** (Counting-Time (min)). The time in minutes over which the scaler counts. Enter N/A if using a ratemeter.
20. **Background cpm or rate.** The count rate with no source present.
21. **Net Counts cpm.** Net cpm equals check source cpm minus background cpm.
22. **Eff. cpm/dpm.** The ratio of the observed count rate to the true disintegration rate.  
Efficiency = Net counts cpm / Activity dpm
23. **Battery Voltage.** The battery voltage reading at the beginning of the measurement.
24. **High Voltage.** The voltage that is applied to the alpha scintillation probe shown on the calibration sticker or the instrument display. This voltage is determined annually using a voltage plateau.
25. **Threshold Setting.** The adjustment for the lower energy level of the discriminator shown on the calibration sticker or calibration certificate.
26. **Tech Init.** Initials of the technician who performed the efficiency check.
27. **Source Response Limits.** The range of cpm or rate expected for the check source. If the daily source check does not fall within this range, there may be a problem with the instrument.
28. **Stat Check Date/Time.** The date and time when the last statistical (stat) efficiency check was done. The stat check determines the source response limits in 27.

## SOP 1.7– Appendix 5.4

- 29. Reviewed by, Date.** The signature of the person who reviewed the form and the date it was reviewed

### Removable Alpha Contamination Survey Data Form

1. **Facility Code.** Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.
2. **Log Date.** The date the information recorded on the form was obtained in DD-MM-YY (01-JAN-98) format.
3. **Logger Code.** Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.
4. **Field Rep.** The name of the field representative.
5. **Acceptance Code.** One-character code assigned by the site manager.
6. **Ratemeter/Scaler Model No.** The model number of the ratemeter/scaler.
7. **Ratemeter/Scaler Serial No.** The serial number of the ratemeter/scaler.
8. **Ratemeter/Scaler Calibration Date.** The date when the ratemeter/scaler was last calibrated.
9. **Window.** The window will be in the out position unless otherwise specified.
10. **Threshold.** The adjustment for the lower energy level of the discriminator. This is determined during calibration before instrument use in the field.
11. **High Voltage.** The voltage that is applied to the detector. The operating voltage for an alpha detector is typically 500 to 700 volts. The voltage is determined by a voltage plateau during calibration.
12. **Battery.** The battery voltage reading at the beginning of the measurement.
13. **Alpha Probe Model No.** The model number of the alpha scintillation probe.
14. **Alpha Probe Serial No.** The serial number of the alpha scintillation probe.
15. **Alpha Probe Calibration Date.** The date when the probe was last calibrated.
16. **Date/Time of Eff. Check.** The date and time of the last efficiency check from the Daily Alpha Efficiency Check form.

## SOP 1.7– Appendix 5.4

17. **Efficiency.** Ratio of observed count rate to the known disintegration rate of the check source from the Daily Alpha Efficiency Check form.
18. **Comments.** Any additional information.
19. **Item Surveyed (Specify).** A description of the article swiped.
20. **Instrument Reading (cpm).** The count rate in counts per minute for the swipe.
21. **Area Surveyed (cm<sup>2</sup>).** The swiped area measured in cm<sup>2</sup>.
22. **Adjusted Count Rate (cpm/100 cm<sup>2</sup>).** If the area swiped was 100 cm<sup>2</sup>, this is the meter cpm reading. If the swiped area was not 100 cm<sup>2</sup>, the cpm reading must be adjusted to cpm/100 cm<sup>2</sup> in order to apply the release limits from Appendix 5.5. The formula shown below is used.

$$\text{Adjusted cpm} = \frac{100 \text{ cm}^2}{\text{area swiped in cm}^2} \times \frac{\text{Instrument reading in cpm}}{\text{area swiped in cm}^2}$$

23. **Contamination Level (dpm/100 cm<sup>2</sup>).** The surface contamination level in units of dpm per 100 cm<sup>2</sup>. Because the swiped area was adjusted to 100 cm<sup>2</sup>, the removable contamination level is the instrument reading divided by the efficiency.

$$\frac{\text{Contamination level (dpm/100 cm}^2\text{)}}{\text{Efficiency}} = \text{Adjusted cpm}$$

24. **Within Release Limit? (Yes/No).** The result of a comparison of the contamination level with the applicable release limit. The result may be abbreviated Y for yes if the measured contamination is less than the limit; N is used for no if above the limit.

## SOP 1.7– Appendix 5.5

### LIMITS FOR SURFACE CONTAMINATION

U.S. NRC

Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material

I	Removable Contamination <sup>1</sup> (dpm/100cm <sup>2</sup> )	
	A. Average over any surface <sup>2</sup>	---
	B. Maximum on any surface	26 <sup>3</sup>
II	Total Contamination <sup>4</sup> (dpm/100cm <sup>2</sup> )	
	A. Average over any surface <sup>5</sup>	129 <sup>3</sup>
	B. Maximum on any surface <sup>6</sup>	387 <sup>3</sup>

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<sup>1</sup> Per the NRC Guideline, "The amount of removable radioactive material per 100 cm<sup>2</sup> of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped."

<sup>2</sup> The NRC Guideline does not specify an average removable contamination level.

<sup>3</sup> These values were determined by taking the ratios of Th-232 and Th-230 at the site and applying them to the values from NRC Guideline Table 1.

<sup>4</sup> Total contamination indicates fixed plus removable.

<sup>5</sup> Per the NRC Guideline, "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."

<sup>6</sup> Per the NRC Guideline, "The maximum contamination level applies to an area of not more than 100 cm<sup>2</sup>."

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- The health and safety of laboratory personnel receiving samples must be protected. Special precautions are used at laboratories when samples that are not environmental are received.

Hazardous materials defined by the transportation regulations contained in 49 CFR (Subchapter C, Part 171) or the current edition of IATA implementing the ICAO regulations for dangerous goods (Sections 3 and 4) should be shipped only by the method of transportation specified in these regulations. Typically, overnight shipments by air within the United States (Federal Express, for example) follow IATA requirements. All international air shipments follow IATA requirements. Transportation of hazardous materials exclusively by ground shipment is governed by the requirements of 49 CFR.

This SOP ensures compliance with the appropriate regulations and, at times, requires the implementation of packaging instructions that are more conservative and stringent than those required by regulation. Employees should be aware that regulatory bodies with jurisdiction have the authority to levy substantial fines and penalties to violators. Failure on the part of any employee to follow the requirements of these procedures is cause for disciplinary action, including discharge.

This SOP provides general guidance for training, packaging, marking, labeling, and shipping samples of environmental and hazardous materials and should not be misconstrued as the equivalent of or replacement for the DOT or IATA/ICAO regulations. When shipping any potentially hazardous samples, the DOT regulations (49 CFR 171—178) and IATA/ICAO regulations must be followed. This SOP must be used in conjunction with DOT and IATA/ICAO regulations to ensure that all regulations governing transportation are being followed. This SOP will also prompt questions to the selected freight carrier to verify that the carrier will transport the specific samples and to determine whether the carrier implements more stringent requirements than the applicable regulations.

Any questions about the instructions for shipping environmental samples or hazardous materials in this SOP should be directed to the site health and safety officer, who provides technical assistance.

## 2.1 TRAINING

Any site employee who is involved in any aspect (handling, packaging, marking/labeling, documentation, etc.) of shipping samples that meet the criteria of any of the nine DOT hazard classes is required to be trained in hazardous material shipping.

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If samples are shipped exclusively by ground transportation, 49 CFR requires three types of training:

- General Awareness (basic overview of hazardous material shipping);
- Function-specific (tailored to the specific shipping activity performed);
- Driver safety (if the employee will be transporting the samples).

DOT requires retraining every 3 years. If samples are shipped by air, IATA/ICAO training is required, with retraining every 2 years.

### **3.0 PROCEDURES**

#### **3.1 Associated Procedures**

SOP1.9, Sample control and Documentation, should normally be used in conjunction with this procedure. In addition, specific guidance on how and when to apply this procedure at the Sites is found in the RHSP.

#### **3.2 Preparation**

##### **3.2.1 Office**

- Review the RHSP and SOP 1.9.
- Coordinate schedules/actions with the installation staff.
- Obtain appropriate permission for property access.
- Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.
- Contact the carrier that will transport samples to obtain information on regulations and specifications.

##### **3.2.2 Documentation**

- Obtain a logbook from the Radiation Safety Officer.
- Obtain a sufficient number of the appropriate data collection forms.
- Consult the data administrator for a current list of information management codes, location IDs, and sample numbers used in the completion of data forms.

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### 3.3 Operation

Procedures for shipping samples under DOT and IATA/ICAO regulations are provided in Appendices 5.1 through 5.4. The following step-by-step procedure will ensure that all applicable requirements for classifying, packing, marking, labeling, and documenting samples can be met:

1. Classification: Determine the correct technical name or composition of substances that might be in the samples. Check to see if the substance is forbidden on aircraft. Section 1 of the IATA requirements for dangerous goods contains a list of the substances that cannot be transported by air.
2. Packaging: Consult the DOT or IATA references (Appendices 5.1 to 5.4) to select the appropriate shipping container and packing material.
  - IATA provides a "limited quantity" exception from UN specification packaging, if shipping limited, specified volumes of hazardous materials. In many cases, the small amounts of samples collected will qualify for these exceptions. This exception allows samples to be transported in strong outer packaging, including Igloo-type coolers, which keep the samples cold. This exception is valid only for passenger and cargo.
  - DOT's "limited quantity" exception for ground shipping provides relief from both UN specification packaging and labeling.
  - In certain cases, UN specification packaging may be required. These appropriate packaging materials must be procured from a packaging vendor.
3. Prepare the consignment according to applicable requirements.
4. Ensure that all appropriate markings are printed on the packages and required labels are affixed.
5. Make any appropriate advance arrangements with the carrier and obtain current information about regulations and specifications that might affect the shipment.
6. Prepare the cargo airbill; complete the appropriate hazardous material bill of lading (ground) or shipper's declarations for dangerous goods (air), and sign the shipper's certification.

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7. Deliver the shipment to the local office of the freight carrier or arrange for a pickup at the site.
8. Ensure that all chain-of-custody procedures are observed. The copy of the bill of lading form will be retained as evidence of the chain-of-custody transfer.

### 3.4 Postoperation

#### 3.4.1 Field

- When transferring the samples, have the transferee sign and record the date and time on the Custody Transfer Record/Lab Work Request form (see SOP 1.9 Sample Control and Documentation). Custody transfers made to a sample custodian in the field should account for each sample, although samples may be transferred as a group. Every person who takes custody should fill in the appropriate section of the Custody Transfer Record/Lab Work Request form. Minimize the time of possession.
- The field custodian is responsible for properly packaging and dispatching samples to the appropriate laboratory. This responsibility includes completing, dating, and signing, the appropriate portion of the Custody Transfer Record/Lab Work Request form. When samples of hazardous materials are shipped to a laboratory, provide advance notice.
- Verify that all sample containers have been correctly identified and labels include necessary information (for example, location, time, and date).

#### 3.4.2 Documentation

- Complete chain-of-custody logbook entries, verify the accuracy of entries, and sign/initial all pages.
- As in any other activity that may be used to support litigation, regulatory agencies must be able to provide the chain of possession and custody of any samples that are offered for evidence or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever samples for evidence are collected, transferred, stored, analyzed, or destroyed. The primary objective of these procedures is to create an accurate, written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and the introduction as evidence.

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A sample is in someone's custody under any of the conditions listed below:

- It is in one's actual possession.
  - It is in one's view (after being in one's physical possession).
  - It is in one's physical possession and then locked up so that no one can tamper with it.
  - It is kept in a secured area that is restricted to only authorized personnel.
- Send all packages to the laboratory with the Custody Transfer Record/Lab Work Request form and other pertinent forms. Retain a copy of these forms at the originating office (either carbon or photocopy). Register mailed packages with a return receipt requested. For packages sent by common carrier, retain receipts as part of the permanent chain-of-custody documentation. Pack samples to eliminate the possibility of breakage during shipment. Seal or lock the package so that any tampering can be readily detected.
  - Additional guidelines for chain of custody, a sample of the form, and instructions for completing the Custody Transfer Record/Lab Work Request form are included in SOP 1.9 Sample Control and Documentation.

### 3.4.3 Office

- Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files).
- Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

## 4.0 SOURCES

International Air Transport Association. Dangerous Goods Regulations. January 1998. Montreal, Quebec, Canada.

CFR 49. Code of Federal Regulations, Title 49, U.S. Department of Transportation, Parts 100-100. October 1, 1997 Washington, DC. U.S. Government Printing Office.

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**5.0 APPENDICES****5.1 Shipping Environmental Samples****5.2 Samples of Hazardous Materials****5.3 Classification Hierarchy for Unknown Hazardous Materials (by ground or air shipment)****5.4 Transportation of Unknown Hazardous Materials by IATA****5.5 Transportation of Unknown Hazardous Materials (RAM)**

**SOP 1.8 – Appendix 5.1**  
**SHIPPING ENVIRONMENTAL SAMPLES**

**Non DOT Restricted Environmental Samples**

A. Environmental Samples

If it has been determined that the substances contained in the environmental samples do not meet the criteria of any of the 9 DOT hazard classes, then the environmental samples may be packaged and shipped according to the following procedures.

B. Packaging

Environmental samples must be packaged according to the following procedures.

1. Place a sample container, properly identified with a sealed lid, into a polyethylene bag and seal the bag.
2. Place a sample in a fiberboard container approved by the DOT or picnic cooler that has been lined with a large polyethylene bag.
3. Pack container with enough noncombustible, absorbent cushioning material to minimize the possibility of breakage and absorb any materials that may have leaked from the sample jars. Vermiculite is recommended.
4. If there are multiple samples, be sure there is sufficient cushioning material between the sample containers (each in its individual polyethylene bag) to prevent breakage from dropping or severe shock.
5. Seal large bag and add any needed absorbent.
6. Seal outside container with duct tape or strapping tape.

Before any samples are placed in their final shipping containers, the exterior of the sample containers should be wiped clean with a detergent solution.

C. Marking/Labeling

Sample containers must have a completed sample identification tag (see SOP 1.9, Sample Control and Documentation), and the outside container must be marked Environmental Sample. The appropriate side of the container must be marked This End Up, and arrow labels should be used accordingly. No DOT placards or labeling are required. Ensure that all sample containers are labeled identically to labels on the shipping container.

D. Shipping Papers

No DOT or IATA shipping papers are required.

E. Transportation

There are no DOT or IATA restrictions on the mode of transportation. An overnight carrier is recommended for prompt delivery to ensure sample integrity.

**Samples of Hazardous Materials**

## SOP 1.8 – Appendix 5.2 SHIPPING SAMPLES OF HAZARDOUS MATERIALS

Samples that are not environmental samples as described in Section 2.0 or samples that are known or suspected to contain hazardous materials/dangerous goods must be considered samples of hazardous materials and transported according to the following requirements.

If the hazardous material in the sample is known or can be identified accurately through generator's knowledge or standard field test procedures, then it is packaged, marked, labeled, and shipped according to the specific instructions for that material described in the DOT Hazardous Material Table (49 CFR §172.101) or the latest edition of the IATA Dangerous Goods Regulations.

### **MOTS Exception**

The DOT Materials of Trade exception can be used for shipments of samples of hazardous materials by car or truck when driven by Radian employees (not by common carrier).

Table 1 presents individual packaging limits by hazardous material class for the materials of trade exception. For quantities of hazardous materials meeting these packaging limits, the materials of trade exception applies to a gross weight up to 440 pounds (200 kg). Hazardous materials above this limit (up to 1,000 lb.) must be prepared in accordance with the hazardous material regulations.

Packaging requirements are as follows:

Liquids and gases must be contained in leak-tight packages. Solids must be contained in sift-proof packages. All packages must be securely closed, secured against movement, and protected against damage.

Materials must be packaged in the manufacturer's original packaging *or in packaging of equal or greater strength and integrity.*

If materials contained in bottles or cans are secured against movement inside boxes, bins, or compartments, no outer packagings are required.

Cylinders must meet required cylinder specifications.

Marking requirements are as follows:

Packages must be marked with the common name or the proper shipping name. "RQ" must be marked if the package contains a hazardous substance in a Reportable Quantity.

**SOP 1.8 – Appendix 5.2**  
**SHIPPING SAMPLES OF HAZARDOUS MATERIALS**

DOT specification cylinders must be marked and labeled as required.

**Driver Awareness:**

The driver must be informed of the presence of the hazardous material onboard the vehicle, informed if he/she is transporting a hazardous substance in a reportable quantity, and aware of the requirements of the materials of trade requirements found in 49 CFR §173.6.

**Table 1. Individual Packaging Limits by Hazardous Material Class**

<b>Class or Division</b>	<b>Name</b>	<b>Individual Package Limits for Shipping as Material of Trade</b>
Class 1	Explosives	<i>Cannot be shipped as a Material of Trade!</i>
Division 2.3	Toxic Gas	
Class 7	Radioactive	
Division 2.1 Division 2.2	Flammable Gas Non-Flammable/ Non-Toxic Gas	220 lb (100 kg) maximum gross weight of each cylinder
Class 3	Flammable Liquid	Packing Group I: ≤ 1 pound (0.5 kg) or 1 pint (0.5 L)  Packing Group II: ≤ 66 pounds (30 kg) or 8 gallons (30L).
Division 4.1	Flammable Solids	
Division 5.1	Oxidizers	
Division 6.1	Toxic	
Class 8	Corrosive	
Class 9	Miscellaneous	
ORM-D	Consumer Commodity	
Division 4.3	Dangerous When Wet	
Class 9 (applies to	Miscellaneous	≤ 1500 L (400 gallons) for a diluted mixture, ≤ 2% concentration of the Class 9 material

**SOP 1.8 – Appendix 5.2**  
**SHIPPING SAMPLES OF HAZARDOUS MATERIALS**

hazardous substances)		
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Relief from the regulations includes:

- Materials must be packaged in the manufacturer's original packaging, or packaging of equivalent strength and integrity.
- Packagings must be leak-tight for liquids or gases, sift-proof for solids, securely closed, secured against movement, and protected against damage.
- Outer packagings are not required for a can or bottle that is secured against movement in a bin, cart, cage, box, or compartment.
- No hazardous material paperwork or labeling is required.
- The common name or the proper shipping name must be marked on each package.
- Although training is not expressly required, the vehicle driver must be aware that materials of trade are being transported and aware of the applicable requirements.
- The aggregate gross weight of all materials of trade onboard a single vehicle cannot exceed 440 pounds.
- Materials of trade can be transported on a vehicle along with other hazardous materials.

For samples of hazardous materials of unknown content that will be shipped by ground carrier under 49 CFR Transportation Regulations or by air under IATA/ICAO requirements, the appropriate transportation category is selected through a process of elimination using the DOT Hazardous Materials Classification system (found in 49 CFR 173.2a). Although it is probable that most unknown samples of hazardous materials shipped by field personnel will not contain radioactive materials (Class 7), toxic gases (Division 2.3), or toxic (Division 6.1) packing group I inhalation hazard materials, it is essential for the following gradient hierarchy to be considered.

1. If radiation survey instruments demonstrate (or reasonable probability exists) that the unknown hazardous sample is radioactive, the appropriate DOT shipping regulations for radioactive material must be followed. (See Appendix 5.5) Contact the site health and safety officer for specific details.

**SOP 1.8 – Appendix 5.2**  
**SHIPPING SAMPLES OF HAZARDOUS MATERIALS**

2. If radioactive material is eliminated, the classification of toxic gas must be considered. It is unlikely that a gas would be found in glass or drum-like containers. Based upon information available, judgment must be made as to whether a sample from a closed container is a toxic gas. For specific instructions on the proper procedures for shipping toxic gases, contact the site health and safety officer.
3. If radiation survey instruments demonstrate (or reasonable probability exists) that the unknown hazardous sample is radioactive, the appropriate DOT shipping regulations for radioactive material must be followed. (See Appendix 5.5) Contact the site health and safety officer for specific details.
4. If radioactive material is eliminated, the classification of toxic gas must be considered. It is unlikely that a gas would be found in glass or drum-like containers. Based upon information available, judgment must be made as to whether a sample from a closed container is a toxic gas. For specific instructions on the proper procedures for shipping toxic gases, contact the site health and safety officer.
5. If toxic gas is eliminated as a shipment category, the next two classifications are flammable or nonflammable gases. Because an open container is not expected to contain a significant amount of gas, it is unlikely that either of these classifications would apply. However, if the classification does apply, contact the site health and safety officer for specific shipping instructions.
6. If flammable and nonflammable gases are eliminated, the classification of toxic, Division 6.1, packing group I, poisonous by inhalation, must be considered. According to DOT, these materials are extremely dangerous liquids that emit a vapor that is dangerous to life. These materials are identified in 49 CFR §172.101 with a letter A through D in the Special Provisions Column (Column 7). For specific instructions on the proper procedures for shipping toxic materials, poisonous by inhalation, contact the site health and safety officer.
7. If toxic, poisonous by inhalation, materials are eliminated, the classification of a pyrophoric material (Division 4.2) or a self-reactive material (Division 4.1) must be considered. For specific instructions on the proper procedures for shipping pyrophoric materials or self-reactive materials, contact the site health and safety officer.
6. If pyrophoric materials and self-reactive materials are eliminated, then the procedures outlined below would be applicable for Class 3 (flammable liquids), Class 8 (corrosive materials), Division 4.1 (flammable solids), Division 4.2 (spontaneously combustible materials), Division 4.3 (dangerous when wet materials), Division 5.1 (oxidizers), or Division 6.1 (toxic materials other than packing group I, poisonous by inhalation).
7. If all of the hazard classes in Item #7 are eliminated, then combustible liquid must be considered.
8. If combustible liquid is eliminated, then miscellaneous hazards (Class 9) must be considered. If no other hazard classes appear to apply and shipping the sample as

## SOP 1.8 – Appendix 5.2 SHIPPING SAMPLES OF HAZARDOUS MATERIALS

a hazardous material is desired (due to noxious fumes or some other reason), an appropriate proper shipping name would be: Other regulated substances.

### **Packaging And Chain-Of-Custody Requirements For Samples Containing Hazardous Materials (Either Known Or Suspected) (By Ground Or Air Shipment)**

1. Collect the sample in a glass or polyethylene container with a metallic, Teflon-lined screw cap. The container may be no larger than 16 fluid oz. To prevent leakage, fill the container no more than 90% full. Mark the fluid level on the outside of the sample container. If an air space in the sample container would affect sample integrity (for example, the case of a volatile organics analysis vial), place that container within a second container to meet the 90% requirement. Before any samples are placed in the final shipping container, the exterior should be wiped clean with a detergent solution.
2. Complete the sample identification tag (see SOP 1.9, Sample Control and Documentation) and attach it securely to the sample container. The sample identification tag should contain information needed to trace the sample to its point of origin and sample taker, as well as any quality assurance/quality control information.
3. Seal the container and place it in a 2-ml-thick (or thicker) polyethylene bag with one sample in each bag. Position the identification tag so that it can be read through the bag. Seal the bag.
4. Place the sealed bag inside a metal can and cushion it with enough noncombustible, absorbent material (for example, vermiculite) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to secure the lid onto the can.
5. Depending upon the applicable shipping instructions for the item being shipped, place one or more metal cans into the appropriate type of packaging [e.g., strong outer packaging (like an Igloo cooler) or a UN specification packaging (like a 4G box)]. If the applicable shipping instructions require UN specification packaging and you are required to keep your samples cold, there are 4G fiberboard boxes available that contain a polystyrene cooler inside for this purpose. Surround cans with noncombustible, absorbent cushioning material for stability during transport. Total weight of the strong outer packaging should not exceed 66 pounds. If UN specification packaging is required, the weight limit in kilograms is included as part of the specification marking on the package.

### **Chain of Custody**

**SOP 1.8 – Appendix 5.2**  
**SHIPPING SAMPLES OF HAZARDOUS MATERIALS**

Include the Custody Transfer Record/Lab Work Request form (properly executed) in the outside container. It is also recommended to use chain-of-custody tape over each can lid.

**SOP 1.8 – Appendix 5.3**  
**TRANSPORTATION OF HAZARDOUS MATERIALS BY GROUND—49 CFR**

If sample shipments are not subject to the DOT Materials of Trade exception:

- Then ground shipments of hazardous materials must be prepared according to the Hazardous Material Table in 49 CFR §173.101.
- Additionally, sample containers must be firmly secured so that they will not bounce against the sides of the vehicles during transit or in an accident.
- Limit shipments to 1000 lbs gross weight or less. Under 1000 lbs gross weight, there are no placarding requirements under 49 CFR 172.504 (C)

**Marking and Labeling Hazardous Material Samples by Ground**

- a) Use abbreviations only where specified.
- b) Place the information listed below on each can:
  - Laboratory name and address
- c) On the outside of the strong outer packaging:
  - Write the proper shipping name and identification number: For example: Flammable Liquid, N.O.S. (samples for analysis), UN1993. The designation N.O.S. means not otherwise specified. Note that because this is a sample being sent for analysis sample [per 49 CFR §173.203(4)], use the statement “samples for analysis” rather than the technical name in parentheses following the “N.O.S.”
  - Use the appropriate hazard class label(s), if required.
  - For tracking purposes, information placed on cans should also be placed on at least one side of the outside shipping container.

**Hazardous Material Bill of Lading/Certification Statement**

- a) A hazardous material bill of lading must be provided when shipping all samples of known or suspected hazardous materials (including those transported by rental, government, company, or personal cars), unless the MOTs exception is used. b) Complete the hazardous material bill of lading and sign the certification statement. If the carrier does not provide it, use a standard industry form. It is acceptable to list more than one hazardous material item on each bill of lading. Each unique hazardous material must be given a separate line item. Place an “X” in the “HM” column on the hazardous material bill of lading next to each unique item, or list all of the hazardous material items first.
  - Provide the DOT basic description in the following listed order:
    - **S**=Shipping Name,
    - **H**=Hazard Class
    - **I**=I.D. Number
    - **P**=Packing Group
      - For example: Flammable Liquid, N.O.S. (samples for analysis), 3, UN 1993. PGII.

**SOP 1.8 – Appendix 5.3**  
**TRANSPORTATION OF HAZARDOUS MATERIALS BY GROUND—49 CFR**

- Include the appropriate packing group (I, II, or III) depending upon the flashpoint of the material. Note that because this is a sample being sent for analysis [per 49 CFR §173.203(4)], the phrase “samples for analysis” rather than the technical name is required in parentheses following the “N.O.S.” The proper shipping name: Other Regulated Substances, Solid (samples for analysis), 9, NA3077, PGIII, or Other Regulated Substance, Liquid, 9, NA3082, PGIII may be used if the sample is suspected to be hazardous, but the hazard is unknown or unverifiable.
- Use Limited Quantity (or Ltd. Qty.) where appropriate.
- Net weight or net volume (weight or volume may be abbreviated) in the designated column on the bill of lading.
- Further description (like “Samples for Analysis”) is allowed following the DOT basic description if it does not contradict required information.
- Emergency response phone number

**SOP 1.8 – APPENDIX 5.3  
TRANSPORTATION OF UNKNOWN HAZARDOUS MATERIALS  
BY IATA/ICAO**

Air shipments of samples containing known or suspected hazardous material must be prepared according to the current edition of the IATA Dangerous Goods Regulations. Typically, commercial air carriers, such as Federal Express, will transport such samples.

Sometimes air carriers and specific countries have more stringent requirements than the regulations set out. For example, Fed-ex has very stringent packaging requirements for transporting PCBs and France does not accept limited quantity shipments. To ensure that your shipment will not be rejected for this reason, check the list of operator and state variations in Section 2 of IATA prior to preparing your shipment.

**Marking and Labeling Packages of Samples Containing Known or Suspected Dangerous Goods for Air Shipment**

1. Use abbreviations only where specified.
2. Place the information listed below on each can.
  - Laboratory name and address.
3. On the outside of the strong outer packaging (if it is a limited quantity shipment) or on the outside of the UN specification packaging write:
  - The appropriate proper shipping name and identification number. For example: Flammable Liquid, N.O.S. (toluene), UN1993. Include the applicable technical name in parentheses.
  - If the technical name for the chemical responsible for the hazard is unknown or unverifiable, then the proper shipping name: Other Regulated Substances, Solid, ID8027 may be used. No technical name is required in parentheses for this proper shipping name. Note also that no packing group is associated with the proper shipping name.
  - Use Limited Quantity (or Ltd. Qty.) where appropriate.
  - For tracking purposes, information placed on cans should also be placed on at least one side of the outside shipping containers.
  - “UP” arrows must appear on two opposite sides of the package.

**A Shipper's Declaration for Dangerous Goods**

A Shipper's Declaration for Dangerous Goods must be provided. The Shipper's Declaration is a standard form, typically provided by the air carrier. It includes the certification statement.

**SOP 1.8 – APPENDIX 5.3**  
**TRANSPORTATION OF UNKNOWN HAZARDOUS MATERIALS**  
**BY IATA/ICAO**

The following information is required on the Shippers Declaration:

- Proper shipping name
- Hazard class
- Identification number
- Packing group
- Quantity and type of packaging (e.g., 1 fiberboard box x 4 L)
- Packing instructions
- Authorizations (such as limited quantity), where applicable
- Under additional handling, the statement: “Samples for analysis”
- Emergency response phone number

## SOP 1.8 – Appendix 5.4

### TRANSPORTATION OF UNKNOWN HAZARDOUS MATERIALS BY IATA/ICAO

Air shipments of samples containing known or suspected hazardous material must be prepared according to the current edition of the IATA Dangerous Goods Regulations. Typically, commercial air carriers, such as Federal Express, will transport such samples.

Sometimes air carriers and specific countries have more stringent requirements than the regulations set out. For example, Fed-ex has very stringent packaging requirements for transporting PCBs and France does not accept limited quantity shipments. To ensure that your shipment will not be rejected for this reason, check the list of operator and state variations in Section 2 of IATA prior to preparing your shipment.

#### **A. Marking and Labeling Packages of Samples Containing Known or Suspected Dangerous Goods for Air Shipment**

1. Use abbreviations only where specified.
2. Place the information listed below on each can.
  - Laboratory name and address.
3. On the outside of the strong outer packaging (if it is a limited quantity shipment) or on the outside of the UN specification packaging write:
  - The appropriate proper shipping name and identification number. For example: Flammable Liquid, N.O.S. (toluene), UN1993. Include the applicable technical name in parentheses.
  - If the technical name for the chemical responsible for the hazard is unknown or unverifiable, then the proper shipping name: Other Regulated Substances, Solid, ID8027 may be used. No technical name is required in parentheses for this proper shipping name. Note also that no packing group is associated with the proper shipping name.
  - Use Limited Quantity (or Ltd. Qty.) where appropriate.
4. For tracking purposes, information placed on cans should also be placed on at least one side of the outside shipping containers.
5. “UP” arrows must appear on two opposite sides of the package.

#### **B. A Shipper’s Declaration for Dangerous Goods**

A Shipper’s Declaration for Dangerous Goods must be provided. The Shipper’s Declaration:

- Is a standard form, typically provided by the air carrier;
- Includes the certification statement;

## SOP 1.8 – Appendix 5.4

- The following information is required:
  - Proper shipping name
  - Hazard class
  - Identification number
  - Packing group
  - Quantity and type of packaging (e.g., 1 fibreboard box x 4 L)
  - Packing instructions
  - Authorizations (such as limited quantity), where applicable
  - Under additional handling, the statement: “Samples for analysis”
  - Emergency response phone number

## SOP 1.8 – Appendix 5.5

### TRANSPORT OF RADIOACTIVE MATERIALS

#### 1.0 PURPOSE

To provide guidance for packaging and shipping radioactive materials (RAM) from the Site.

#### 2.0 DISCUSSION

This procedure is used to assure compliance with applicable shipping requirements of the Department of Transportation. For the purposes of transportation, radioactive materials are defined as those materials that spontaneously emit ionizing radiation and have a specific activity in excess of 2 nanocuries per gram (nCi/g); i.e., concentration is  $> 2$  nCi or 2000 picocuries (pCi)/g of material. If the sum of the activities from each radionuclide within the package (including any short lived daughters, regardless of half-life) per gram of radioactive material is less than 2000 pCi/g, the package is not considered radioactive for the purpose of transportation, and no specific transport requirements need to be met.

Before shipping packages of RAM, obtain a copy of the intended recipients license to ensure that they are licensed to possess the quantity of RAM you are sending them and notify the recipient before you make RAM shipments so that they can take the necessary handling precautions upon receiving the shipment.

#### 3.0 PROCEDURES

##### 3.1 Associated Procedures

SOP 1.7      Sampling for Removable Alpha Contamination

SOP 1.9      Sample Control and Documentation

##### 3.2 Preparation

###### 3.2.1 Office

- Review the associated procedures for familiarity with the project.
- Coordinate schedules/actions with project staff and RAM package recipient.

## SOP 1.8 – Appendix 5.5

### 3.2.2 Laboratory

- Maintain adequate supply of RAM shipment forms on-site.
- Ensure that gamma spectroscopy system, alpha wipe counter, and survey meter are calibrated.

### 3.2.3 Operation for DOT NonRadioactive Sample

- Determine the specific activity of the package proposed for shipment.
- If the specific activity of the material is less than 2000 pCi/g, it may be shipped without regard to its radioactive contents as an environmental sample.

### 3.2.4 Operation for DOT Radioactive Limited Quantity Shipment

- Determine the specific activity of the package proposed for shipment.
- If the specific activity of the material is greater than or equal to 2000 pCi/g, then evaluate the package as a limited quantity shipment. Using the results of the laboratory Th-232 analysis, calculate the total specific activity of the sample by multiplying the Th-232 concentration by 10 to account for the Th-232 daughter activity and then add twice the Th-232 activity (not including daughters) to account for Th-230 at a 2:1 ratio. If the package contains more than 167 pCi/g of Th-232, then it cannot be shipped without meeting DOT requirements for Limited Quantity or Type A.
- Determine the total activity of the package by multiplying the specific activity of the package contents by the mass of package contents. If may be necessary to sum the activities of individual sample containers to determine the total package activity.

Limited Quantity Example:

Site contaminated soil/slag contain Th-232 with daughters and twice the Th-230 without significant Th-230 daughter ingrowth.

$$\begin{array}{ccccccc} \text{Th-230} & & \text{Th-232} & & \text{Ra-228} & & \text{Th-228} \\ 2R/10^{-3} (0.003) & + & R/10^{-3}(3) & + & R/10^{-3}(.05) & & R/10^{-3}(.008) = 1 \end{array}$$

$$R = 1.2 \times 10^{-6} \text{ Ci of Th-232 per package}$$

The maximum Limited Quantity package activity limit for a shipment from each Site is  $1.2 \times 10^{-6}$  Ci of Th-232.

- Tape the container lids of each sample container to ensure that there will be no leaking of individual sample containers during transport and place all of the containers into a plastic bag and tape the plastic bag shut.

## SOP 1.8 – Appendix 5.5

- Place the bag into a strong, tight, package that will not leak any RAM during conditions normally incident to transport or into a Type A container if necessary (see 3.3.2).
- Using the pressurized ion chamber, measure the radiation level on the external surface of the package. Survey every side and the top and bottom of the package. The package cannot be shipped Limited Quantity unless the radiation level at every point on the external surface of the package is less than or equal to 0.5 millirem per hour (mR/h). Record results on the RAM shipment form (Appendix 5.6).
- Wipe the external surface of the package for removable surface contamination level to ensure that it is less than the limits specified in 173.443(a) (2.22 dpm/cm<sup>2</sup> removable activity from a 300 cm<sup>2</sup> area wipe satisfies the most stringent requirements and can always be used). Record the results on the RAM shipment form (Appendix 5.6)
- For a limited quantity shipment, the only labeling requirement is that the packaging bear the marking “RADIOACTIVE” on an internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.
- The shipment must be certified as being acceptable for transport by having a notice enclosed in or on the package, included with the packing list, or otherwise forwarded with the package that includes the name of the consignor or consignee and the statement “This package conforms to the conditions and limitations specified in 49 CFR 173.421 for excepted radioactive material, limited quantity, n.o.s., UN2910.” Mark the appropriate block on the RAM shipment form to satisfy this requirement.

### 3.3.2 Operation for Type A Shipment

If the package contents cannot be separated for shipment as multiple Limited Quantity packages, the package contents can be shipped in a Type A container if the following equation is satisfied.

$$\begin{array}{ccccccc} \text{Th-230} & & \text{Th-232} & & \text{Ra-228} & & \text{Th-228} \\ 2R/(0.003) & + & R/(3) & + & R/(.008) & = & 1 \end{array}$$

$R = 1.2 \times 10^{-3}$  Ci of Th-232 per package is the maximum quantity that can be shipped in a Type A container.

- Tape the container lids of each sample container to ensure that there will be no leaking of individual sample containers during transport and place all of the containers into a plastic bag and tape the plastic bag shut.
- Place the bag into the “paint bucket” Type A container.
- Using the pressurized ion chamber, measure the radiation level on the external surface of the package. Survey every side and the top and bottom of the package. Record results on the RAM shipment form (Appendix 5.6).

## SOP 1.8 – Appendix 5.5

- If the surface radiation level is greater than 0.5 mR/h, the package will require a RADIOACTIVE yellow II label, and a measurement of the radiation level 1 meter from the point on the package exhibiting highest radiation level (transport index [TI]) is required. Record results on RAM shipment form (Appendix 5.6).
- Apply “RADIOACTIVE” labels on two opposite sides of the package in accordance with 49 CFR 172.403. The category of label depends on external radiation level at package surface, and one meter (the TI). The label to be applied shall be the highest category required for any of the two determining conditions of the package shown below.

Label	Package Surface	Rad level	TI	49 CFR
White-I	< or =0.5 mR/h	N/A	173.436	
Yellow-II	0.5 mR/h to 50 mR/h up to 1		173.438	

- The following applicable items of information must be entered in the blank spaces on the RADIOACTIVE white or yellow label: 1) radionuclides or symbols of isotope (for mixtures, list the most restrictive radiotoxic nuclides); 2) activity in mCi; 3) TI (the exposure rate in mR/h at 1m) for yellow II labels.
- Wipe the external surface of the package for removable surface contamination level to ensure that it is less than the limits specified in 173.443 (a) (2.22 dpm/cm<sup>2</sup> removable activity from a 300 cm<sup>2</sup> area wipe satisfies the most stringent requirements and can always be used). Record the results on the RAM shipment form (Appendix 5.6).
- Attach the package security seal.
- The shipment must be certified as being acceptable for transport by having a notice enclosed in or on the package, included with the packing list, or otherwise forwarded with the package that includes the name of the consignor or consignee and the statement “This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and in proper conditions for transportation according to the applicable regulations of the Department of Transportation”.
- Each package of RAM which conforms to the requirements for Type A packaging must be marked on the outside of the package in letters at least ½-inch high, with the words TYPE A.

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### 3.0 Preparation

#### 3.1.1 Office

The following tasks must be completed prior to performing field work:

- Review the RHSP and SOP 1.8;
- Coordinate schedules/actions with the installation staff;
- Obtain appropriate permission for property access;
- Assemble the equipment and supplies needed. Ensure the proper operation of all sampling equipment;
- Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date; and
- Contact the carrier that will transport samples to obtain information on regulations and specifications.

#### 3.1.2 Documentation

- Obtain a logbook from the QA officer;
- Record results of the equipment check in the logbook;
- Obtain a sufficient number of the appropriate data collection forms; and
- Consult the data administrator for a current list of location IDs and sample numbers used in the completion of data forms.

#### 3.1.3 Field

Field preparation requires organizing sample containers, sample labels, and documentation in an orderly, systematic manner that promotes consistency and traceability of all data. The following items should be completed before a sample is collected:

- Record all pertinent information (for example, date, site, ID number, and location) in the logbook. Note field conditions, unusual circumstances, and weather conditions;
- Fill out information on the sample identification label and attach the label to the sample container or write the sample information directly on the sample container using a permanent water-proof marker; and
- Complete initial information required on data collection form.

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## 3.2 Operation

### 3.2.1 Logbook

Logbooks will be kept under the supervision of the Radiation Safety Officer (RSO) or his designee. There may be several logbooks: for example, there may be a separate logbook for field activities, one for samples, and one for instruments. The RSO numbers the logbooks and assigns them to individuals designated for specific tasks of the project. All information pertinent to a field activity must be entered into a logbook. A record of uncompleted work is kept in a logbook. All project logbooks are turned over to the RSO at the end of each work period and to a central file at the end of the field activity.

All logbooks are numbered and bound, and the pages are consecutively numbered. Waterproof black ink is used for recording all data. Logbook pages shall never be removed, and no data shall be removed. To change an incorrect entry, the individual draws a line through the entry, writes the change above the entry, dates and initials each change. If anyone other than the person to whom the logbook is assigned makes an entry, that person dates and signs the entry.

Record all information pertinent to the sampling activity (for example, date, site, ID number, and location) in the logbook. Note the field conditions, weather conditions, and any unusual circumstances. Notes should be as descriptive and inclusive as possible. A person reading the entries should be able to reconstruct the sampling situation from the recorded information. Language should be objective, factual, and free of personal feelings and inappropriate terminology.

If not included on a data collection form, entries in the logbook should include at least the information listed below:

- Date and time of entry;
- Purpose of sampling;
- Name and address of field contact;
- Site identification;
- Type of process producing waste (if known);
- Type of waste (sludge or wastewater);
- Description of sample waste components and concentration;
- Sample identifier and size of sample taken;
- Description of sampling point;
- Date and time for collection of samples;
- Collector's sample identification number(s) and/or name;

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- References of the sampling site (like maps or photographs);
- Field observations and sampling locations;
- Associated field measurements;
- Method of sample collection, preservation techniques, and any deviations or anomalies noted;
- Transfer of a logbook to the individuals designated for specific tasks of the project; and
- The status of any uncompleted work.

Because sampling situations vary significantly, make notes as descriptive and inclusive as possible. A person reading the entries should be able to reconstruct the sampling situation from the recorded information. Use language that is objective, factual, and free of personal feelings or any other inappropriate terminology. If anyone other than the person to whom the logbook was assigned makes an entry, he/she should date and sign the entry. Never remove logbook pages. If a mistake is made, draw a single line through the mistake, write the new information above the line, and date and initial the change.

### 3.2.2 Photographs

Photographs provide the most accurate record of field worker's observations. They can be significant during future inspections, informal meetings, and hearings. A photograph must be documented to be a valid representation of an existing situation. For each photograph taken, record the items listed below in the logbook and on the back of each processed photograph.

- Date and time;
- Signature of photographer;
- Name and identification number of site;
- Type of camera, lens, f-stop, shutter speed and film used;
- General direction faced and description of the subject;
- Distance from photographer to object;
- Location at the site; and
- Sequential number of photograph and the roll number.

Any remarks about the contents of a photograph could jeopardize its value as legal evidence, so limit comments to the photograph's location. Photographs should be taken with a perspective similar to that afforded by the naked eye. Telephoto or wide-angle shots cannot be used in enforcement proceedings.

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### 3.2.3 Sample Labels

When appropriate, use an etching tool to mark sample containers in the field, rather than immediately applying a sample label or tag. This avoids possible label contamination problems and subsequent decontamination difficulties. In this case, write the data intended for the sample label in the logbook and transcribe them onto the label (if required) after the sample containers have been decontaminated. All labels will be filled out with waterproof black ink. The containers must be dry enough for gummed labels to be securely attached. Sample information to be included on the sample are sampler name, date and time of collection, sampler #/description, location/depth of sample, and any special comments.

### 3.2.4 Samples Collection and Inventory

The number of persons involved in collecting and handling samples should be kept to a minimum. Use the guidelines established in this SOP and SOP 1.8, *Guide to the Handling, Packaging, and Shipping of Samples*. Complete data collection forms at the time the sample is collected and have the sample collector(s) sign or initial them. Include the date and time. On liquid containers, mark the liquid level with waterproof black ink. If the container is glass, place tape over the mark to prevent it from being rubbed off. This requirement is not necessary for completely filled volatile organics analysis (COA) septum vials. If the volume received by the laboratory is different than when collected, the sample container may have leaked, been tampered with, or spilled hazardous materials. Use the *Custody Transfer Record/Lab Work Request* form (Appendix 5.1), to inventory all samples collected in the field. Instructions for the form are in *Data Form Completion* (Appendix 5.2).

### 3.2.5 Chain of Custody

#### Objective

The primary purpose of the chain-of-custody procedure is to create an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and introduction as evidence. A sample is in someone's custody when one of the criteria listed below has been satisfied.

1. The sample is in one's actual possession.
2. The sample is in one's view after being in one's physical possession.
3. The sample is in one's physical possession and is then locked up so that no one can tamper with it.
4. The sample is kept in a secure area that is restricted to authorized personnel.

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### Transfer of Custody and Shipment

When transferring the samples, the transferee should sign and record the date and time on the Custody Transfer Record/Lab Work Request form. Custody transfers made to a sample custodian in the field should account for each sample, although samples may be transferred as a group. Every person who takes custody should fill in the appropriate section of the Custody Transfer Record/Lab Work Request form. To reduce the number of custody records, minimize the number of custodians in the chain of possession.

The field custodian is responsible for properly packaging and dispatching samples to the appropriate laboratory. This responsibility includes filling out, dating, and signing the appropriate portion of the Custody Transfer Record/Lab Work Request form.

Send all packages to the laboratory with the chain-of-custody record and other pertinent forms. Retain a copy of these forms at the originating office (either carbon or photocopy). Register mailed packages with a return receipt requested. For packages sent by common carrier, retain receipts as part of the permanent chain-of-custody documentation. Pack samples so that they do not break in shipment. Seal or lock the package so that any tampering can be readily detected. SOP 1.8, *Guide to the Handling, Packaging, and Shipping of Samples*, describes these procedures in detail.

## 3.3 Postoperation

### 3.3.1 Field

Prior to leaving the field, the sample custodian will:

- Verify that all sample containers have been correctly identified and labels have all necessary information (location, time, and date);
- Cross-check filled sample containers in possession against those recorded in the logbook.;
- Maintain custody of filled sample containers by keeping them in actual possession, within view, locked or sealed up to prevent tampering, or bringing them into a secure area; and
- Prepare samples for transport according to SOP 1.9, *Sample Control and Documentation*; and SOP 1.8, *Guide to the Handling, Packaging, and Shipping of Samples*.

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### 3.3.2 Documentation

Prior to leaving the field, each record keeper will:

- Record data and any uncompleted work in the logbook;
- Complete logbook entries, verify the accuracy of entries, and date and sign/initial all pages;
- Document the chain of custody on the Custody Transfer Record/Lab Work Request form; and
- Review data collection forms for completeness.

### 3.3.3 Office

After returning to the office, the field team will:

- Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to files);
- Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage; and
- Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

## 4.0 SOURCE

EPA. 1986. "RCRA Ground-water Monitoring Technical Enforcement Guidance Document." U.S. Environmental Protection Agency document. Washington DC, U.S. Government Printing Office.

## 5.0 APPENDICES

### 5.1 Custody Transfer Record/Lab Work Request Form

### 5.2 Data Form Completion



## SOP 1.9 – Appendix 5.2

### DATA FORM COMPLETION

Use a pen with black ink that is not water-soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

#### **Soil Sample Identification Label**

1. Sample ID. Number assigned to ensure that data collected retains uniqueness from other data collected at the same location ID.
2. Sampler. Name of person(s) collecting sample.
3. Location ID. Code assigned sequentially to each borehole, test pit, or surface location where chemical, biological, radiological, and other measurements are taken.
4. Log Date. The date the information recorded on the label was obtained in the format DD-MMM-YY (01-JAN-98).
5. Log Time. The time the sample was collected (HH:MM).
6. Sample Depth Interval from Datum:
  - a. Beginning Depth (Ft. From Datum). Depth from the ground surface to the top of the sampling interval in the format of feet and tenths of feet.
  - b. Ending Depth (Ft. From Datum). Depth from the ground surface to the bottom of the sampling interval in the format of feet and tenths of feet.
7. Comments. Any additional information.

#### **Water Sample Identification Label**

1. Sample ID. Number assigned to ensure that data collected retains uniqueness from other data collected at the same location ID.
2. Sampler. Name of person(s) collecting sample.
3. Location ID. Code assigned sequentially to each borehole, test pit, or surface location where chemical, biological, radiological, and other measurements are taken.
4. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-98).
5. Log Time. Time the sample was collected (HH:MM)
6. Preservation Method. Type of preservative used.
7. Comments. Any additional information.

## SOP 1.9 – Appendix 5.2

### Custody Transfer/Lab Work Request Form

1. Client. Client name.
2. Work Order. Project number under which work is billed.
3. Date Rec'd. Date sample was received by the laboratory.
4. Date Due. Date analysis is due from the laboratory.
5. Client Contact/Phone. Site person and their phone number who will be the laboratory contact.
6. Item #. Number assigned to each sample in the shipment.
7. Sample No. Unique name assigned to each sample.
8. Matrix. Matrix type for sample; see valid matrix codes on lower half of form.
9. Date Collected. Date the sample was collected in the format DD-MMM-YY (01-JAN-98)
10. Analyses Requested. The type of analysis requested for each sample. The column heading indicating the type.

PCB=Polychlorinated Biphenyl

HE=High Explosive

HSL=Hazardous Substance List

EPTOX=Extraction Procedure Toxicity

VOA=Volatile Organic Analysis

BNA=Base Neutral Acid

TCLD=Toxic Characterization Leach Procedure

PEST=Pesticides

MAJ=Major Cation/Anion

Th=Thorium

11. Special Instructions. Any special instructions
  - Ex.1 Description. Any descriptive information about the sample.
  - Ex.2. Container/Preservative. Container size and type (500-ml glass).
12. Items/Reason. The reason the custody is transferred for all or selected items of the shipment.
13. Relinquished By. Signature of person sending samples.
14. Received By. Person or (shipping company) who received samples.
15. Date. Date sample is relinquished or accepted.

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Supercedes: N/A			
Reason for Revision: N/A			
Changes Made: N/A			
Approval:			
Radiation Safety Officer: <i>Paul Hunte</i>		Date: <i>7/21/98</i>	
Site Health & Safety Officer: <i>Maria Sanders</i>		Date: <i>7/21/98</i>	
Dow Project Manager: <i>Ben Baker</i>		Date: <i>7/21/98</i>	

**1.0 PURPOSE**

The purpose of this procedure is to describe the contents and use of the Radiation Work Permit (RWP). The Radiation Safety Officer (RSO) or his/her designee shall issue a RWP for any work in the Bay City Site Controlled Zone(s). All work in the Controlled Zone(s) must be performed under the guidance of a RWP or Standard Operating Procedure (SOP). A RWP is used to maintain radiation exposures of workers to As Low As Reasonably Achievable (ALARA). The RWP controls exposures to radiation by establishing radiation protection requirements and any radiological monitoring necessary to protect the worker.

The THORAD site has areas containing thorium (Th-232), which is regulated by the Nuclear Regulatory Commission (NRC) under NRC Source Material License Number STB-527. Therefore work must be restricted in any area when occupational radiation exposure is possible. Only persons with a legitimate need and proper radiation worker training (Rad Worker II) will be allowed onto the site. If an individual needs access to the Bay City THORAD Site and they do not have the Rad Worker II training, they can be escorted by the Site Health & Safety officer, Radiation Safety officer or his/her designee. Legitimate reasons for requesting entrance to the site include authorized work such as environmental sampling, inspections/audits, general labor support, and remediation activities. All work of this type and any intrusive activities must be performed under the guidance of a RWP and the Site Radiological Health and Safety Plan (RHSP).

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Supercedes: N/A			
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Radiation Safety Officer:		Date:	
Site Health & Safety Officer:		Date:	
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## 2.0 PROCEDURE

The following sections describe required procedures for completing the RWPs.

### 2.1 Associated Procedure

SOP 1.1, *Access Control Procedures*, and SOP 1.3, *External Dosimetry Procedure*, should normally be used in conjunction with this procedure since workers on the site will be entering the contamination zone and will generally be issued a Thermoluminescent Dosimeter (TLD). Specific guidance on how and when to apply this procedure is contained in the RHSP, Section 6.0 *Access Control*.

### 2.2 Preparation

The sections below describe tasks that must be completed prior to filling out a RWP.

#### 2.2.1. Office

Prior to leaving the office, one must:

- Review RHSP and SOPs 1.1 and 1.3; and
- Obtain Copies of the Site RWP form and the RWP acknowledgment log (Appendixes 5.1 and 5.2).

#### 2.2.2. Completing the RWP

The following are required to complete an RWP:

- The Site Health & Safety Officer, RSO or his/her designee shall authorize all work in the Controlled Zone for which no SOP exists in advance by issue of a RWP.
- A RWP may be initiated by Dow, Radian International LLC, or any individual or subcontractor who is responsible for the work in the control area, but requires the approval of the RSO or his/her designee.
- The RSO or his/her designee shall review past data and determine the radiological status of the work area prior to the approval of the RWP. If radiological conditions have changed in the work area, a re-survey may be necessary in order to properly complete certain sections of the RWP. Any other Health Physics survey requirement shall be specified on the RWP.

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- The RSO or his/her designee will estimate the worker's radiation exposure based upon the work description and the other information provided in the RWP.
- Any Personal Protective Equipment (PPE) and radiation monitoring equipment necessary shall be assembled by the Radiation Control Technician staff.
- Personnel involved in performing the work shall be given a pre-job briefing by the RSO or his/her designee that will inform them of the work restrictions and other RWP requirements. Discussions shall include but not be limited to:
  - a) scope of work;
  - b) dosimetry;
  - c) PPE;
  - d) control area rules;
  - e) survey results;
  - f) radiation hazards; and
  - g) emergency procedures.
- All personnel in the briefing shall sign the RWP signature form. This indicates that they have read the RWP and that they fully understand the requirements, conditions, and hazards related to their work.
- Work detailed on a RWP shall only begin after the above requirements have been met.
- The RWP and RWP acknowledgment log shall contain details of all required protection procedures and shall identify all personnel involved in the work, including the Health Physics staff, respectively.
- The RWP may be terminated at any time as specified by the RSO or his/her designee. Reasons for termination may be a change in work scope or a change in radiological conditions. A RWP may be amended with approval by the RSO or his/her designee.

### 2.2.3. Field

The following are required in the field:

- The RWP and signature form shall be posted in a convenient, accessible location to the workers; and
- Access by all workers must be in compliance with SOP 1.1 and the Site Health and Safety Plan.

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### 3.0 POST OPERATION

The procedures below must be completed after the termination or expiration of an RWP.

#### 3.1 Documentation

The terminated RWPs and any other paper work generated by this procedure shall be maintained in the Bay City Site project files.

### 4.0 SOURCES

None

### 5.0 APPENDICES

#### 5.1 Radiation Work Permit

#### 5.2 RWP Acknowledgment Log

**SOP 1.10 – Appendix 5.1  
RADIATION WORK PERMIT**

RWP Title \_\_\_\_\_  
RWP No. \_\_\_\_\_ Date of Issue: \_\_\_\_\_ Date of Expiration: \_\_\_\_\_  
Requested By: \_\_\_\_\_ Work Location: \_\_\_\_\_  
Scope of Work to be Performed: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Radiological Survey Results/Radiation Hazards:

Radiation Levels \_\_\_\_\_  $\mu\text{R/hr}$  General Area  
Radiation Levels \_\_\_\_\_  $\mu\text{R/hr}$  Work Area  
Air Activity Particulate \_\_\_\_\_  $\mu\text{Ci/ml}$   
Alpha Surface Contamination Levels \_\_\_\_\_  $\text{dpm}/100\text{ cm}^2$ , Total  
Alpha Surface Contamination Levels \_\_\_\_\_  $\text{dpm}/100\text{ cm}^2$ , Removable

Surveyed By: \_\_\_\_\_ Date: \_\_\_\_\_

Monitoring Schedule and Frequency:

Lapel Sampling \_\_\_\_\_  
General Air Sampling \_\_\_\_\_  
Radon Sampling \_\_\_\_\_  
Gamma Exposure Rate \_\_\_\_\_

Personal Protective Equipment Required:

____ TLD Badges	____ Gloves - Cotton	____ Respiratory Protection
____ Coveralls	____ Gloves - Rubber	____ 1/2 Face ____ Full Face
____ Shoe Covers-Plastic or Rubber	____ Goggles/Safety Glasses	____ Air Supplied
____ Steel-Toed Boots	____ Plastic or Rubber Suit	____ Face Shield
____ Orange Vests	____ Hard Hats	____ Other
____ Other	____ Other	

Special Instructions: \_\_\_\_\_

Emergency Procedures: \_\_\_\_\_

\_\_\_\_ Urine Sample Required      \_\_\_\_ Other \_\_\_\_\_

Controlled Area Rules for Working in the Controlled Zone:

1. All work will be conducted in a practical manner maintaining a minimum of exposure to personnel.
2. TLD Badges will be worn at all times or as required by the RSO or his/her designee.
3. The required items of protective equipment will be worn by all personnel while in the potentially contaminated zone.
4. Eating, drinking, smoking, and chewing are prohibited in the potentially contaminated zone.
5. Visitors and/or persons unfamiliar with site radiation safety regulations will require an escort when entering site.
6. Each individual engaged in work under a RWP will record his/her name and time upon entry and departure from the potentially contaminated zone on the Site Access Control form.
7. Personnel leaving the controlled area will be monitored for contamination at the access control point before leaving the potentially contaminated zone.
8. Personnel will notify the RSO or his/her designee of the malfunctioning of any radiation protective equipment.

Reviewed By: \_\_\_\_\_ Date: \_\_\_\_\_

Approved By: \_\_\_\_\_ Date: \_\_\_\_\_  
(RSO or his/her designee)

Terminated For: \_\_\_\_\_ Completion of Job \_\_\_\_\_ Expiration of RWP \_\_\_\_\_ Cancellation of RWP  
Other: \_\_\_\_\_

Change in Radiological Condition: \_\_\_\_\_

Termination Approved By (Signature): \_\_\_\_\_ Date: \_\_\_\_\_  
(RSO or his/her designee)

*Dow Confidential*



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In an area where the airborne radioactive material concentrations are unknown or where the work to be performed may cause an unknown concentration, respiratory protection shall be worn until the airborne concentration is determined to be within the requirement of Section 3.2

If an individual working in a mask experiences any of the following, he or she shall leave the area, adhere to normal exiting procedures detailed in Section 3.3, step 11, and immediately contact his or her supervisor:

- Equipment malfunction;
- Physical or emotional distress;
- Procedural or communication failure;
- Significant deterioration of operating conditions; or
- Any other condition that might require relief.

Due to the health effects associated with the inhalation of contaminated dust particles, respirators should be worn by workers walking in the controlled area when there is a potential for contaminated dust inhalation.

No individual shall wear a respiratory protection device (mask) for a period of more than five consecutive hours without a one-hour break and for no more than a total of ten hours in any workday

### 3.2 Associated Procedures

Information applying to the Thorad Project Respiratory Protection Plan is provided in the Radiological Safety Health and Safety Plan (RHSP). In addition to the RHSP, Procedures directly associated with this SOP are located in SOP 1.7, *Sampling for Removable Alpha Contamination* and SOP 1.10 *Radiation Protection Program*. These SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies, decontamination procedures, and documentation requirements.

### 3.3 Determination of Airborne Radioactive Material Concentrations

The Radiation Control Technician shall collect and analyze air samples to determine the DAC present and the estimated DAC-hours for a work area.

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### 3.4 Respiratory Protection Training

A comprehensive Respiratory Protection Training program shall be established and presented to all personnel requiring respiratory protection and will be performed annually or more often if necessary. This training program shall cover, at a minimum, the following:

- Why and when respiratory protection is required;
- Discussion of respiratory protection, operating principles, and limitations;
- Procedures used to ensure proper fit and use;
- Use, care, and maintenance of respiratory protection devices; and
- Emergency procedures.

### 3.5 Respirator Fit Test Procedure

#### 3.5.1 Purpose

To provide guidance for respirator selection and qualitative fit testing of selected respirators for use at the Site. At a minimum, full-face negative pressure respirators with a protection factor of 50 times the Permissible Exposure Limit (PEL) will be used.

#### 3.5.2 Procedures

Fit testing will not be conducted if there is any hair growth between the skin and the facepiece-sealing surface, such as stubble beard growth, beard, mustache or sideburns which cross the respirator-sealing surface. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the test subject has:

- A weight change of 20 pounds or more;
- Significant facial scarring in the area of the face piece seal;
- Significant dental changes;
- Reconstructive or cosmetic surgery; or
- Any other condition that may interfere with face piece sealing.

Prior to commencement of the fit tests, the employee shall be given a description of the fit test and the employee's responsibilities during the test procedure. The description of the process shall include a description of the test exercises that the employee will be performing. The respirator to be tested shall be worn for at least 10 minutes before the start of the fit test.

Qualitative fit testing shall be repeated at least every six months

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### 3.5.3 Equipment

- A selection of respirators including various sizes from different manufacturers;
- Irritant ventilation smoke tubes containing stannic oxychloride and a low pressure pump;
- Isoamyl Acetate (banana oil)
- A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator;
- Fit test chamber similar to a clear 55-gallon drum liner suspended inverted over a 2-foot-diameter frame so that the top of the chamber is about 6 inches over the test subject's head; and
- Organic vapor cartridges or cartridges offering protection against organic vapors (ex: GMC-P100).

### 3.5.4 Respirator Selection

- The test subject shall be allowed to choose the most comfortable respirator from a variety of sizes and different manufacturers.
- The selection process shall be conducted in a room separate from the fit test chamber to prevent odor fatigue.
- The test subject shall conduct the conventional positive and negative pressure fit checks before fit testing. Failure of either check shall be cause to select another respirator.
- The employee shall be given the opportunity to select a different face piece if the chosen face piece becomes increasingly uncomfortable at any time.
- Respirators shall be equipped with a combination of high-efficiency and acid-gas cartridges such as the MSA combination cartridge, GMC-H.

### 3.5.5 User Seal Check Procedures

The individual who uses a tight-fitting respirator is to perform a user seal check to ensure that an adequate seal is achieved each time the respirator is put on. Before conducting the negative and positive pressure checks, the subject shall be told to seat the mask on the face by moving the head from side-to-side and up and down slowly while taking in a few slow deep breaths. Both the positive and negative pressure checks listed below must be used.

#### Positive Pressure Checks

Close off the exhalation valve and exhale gently into the facepiece, the facepiece 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.

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### Negative Pressure Checks

Close off the inlet opening of the cartridges by covering with the palm of the hands. Inhale gently so that the facepiece collapses slightly and hold the breath for 10 seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory. Another mask should be selected and retested if the test subject fails the user seal check tests.

### 3.5.6 Test Exercises

The following test exercises are to be performed for all fit tests. The test conductor shall review this protocol with the test subject before testing. Each test exercise shall be performed for one minute except for the grimace exercise that shall be performed for 15 seconds. The test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become unacceptable, another model of respirator shall be tried. The respirator shall not be adjusted once the fit test exercises begin. Any adjustment voids the test, and the fit test must be repeated.

1. **Normal breathing.** In a normal standing position, without talking, the employee shall breathe normally.
2. **Deep breathing.** In a normal standing position, the subject shall breathe slowly and deeply, taking caution so as not to hyperventilate.
3. **Turning head side to side.** Standing in place, the subject shall slowly turn his/her head from side to side between the extreme positions on each side. The head shall be held at each extreme momentarily so the subject can inhale at each side.
4. **Moving head up and down.** Standing in place, the subject shall slowly move his/her head up and down. The employee shall be instructed to inhale in the up position (i.e., when looking toward the ceiling).
5. **Talking.** The employee shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song.

#### *Rainbow Passage*

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

6. **Grimace.** The test subject shall grimace by smiling or frowning.

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7. **Bending over.** The test subject shall bend at the waist as if he/she were to touch his/her toes. Jogging in place shall be substituted for this exercise in those test environments such as shroud type units that do not permit bending over at the waist.

### 3.5.7 Irritant Smoke Fit Test

The following steps describe the procedure to follow when performing an irritant smoke fit test when the subject is wearing a full-face mask with organic vapor cartridges or cartridges offering protection against organic vapors (ex: GMC-P100):

1. The test subject shall be allowed to smell a weak concentration of the irritant smoke to familiarize the subject with the characteristic odor.
2. The test subject shall properly don the respirator selected as above, and wear it for at least 10 minutes before starting the fit test.
3. Break both ends of a smoke tube containing stannic oxychloride. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low-pressure pump.
4. The test conductor shall direct the stream of irritant smoke from the tube towards the face seal area of the test subject. The person conducting the test shall begin with the tube at least 12 inches from the face piece and gradually move to within 1 inch, moving around the whole perimeter of the mask.
5. The test subject shall indicate to the test conductor if the irritant smoke is detected. If smoke is detected, the test conductor shall stop the test. In this case, the tested respirator is rejected and another respirator shall be selected.
6. Each subject passing the smoke test (i.e., without detecting the smoke) shall be given a sensitivity check of smoke from the same tube to determine if the test subject reacts to the smoke. Failure to evoke a response shall void the fit test.

### 3.5.7 Isoamyl Acetate Fit Test

The following steps describe the procedure to follow when performing an isoamyl acetate fit test when the subject is wearing a full-face mask with cartridges:

1. The test subject shall be allowed to smell a weak concentration of the Isoamyl Acetate (IAA) to familiarize the subject with the characteristic odor.
2. The test subject shall properly don the respirator selected as above, and wear it for at least 10 minutes before starting the fit test.
3. Upon entering the test chamber, the test subject shall be given an IAA ampule that will generate an IAA test atmosphere inside the chamber.

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4. Allow two minutes for the IAA test concentration to stabilize before starting the fit test exercises. This is an appropriate time to talk with the test subject; to explain the fit test, the importance of his/her cooperation, and the purpose for the test exercises; or to demonstrate some of the exercises.
5. If at any time during the test, the subject detects the banana-like odor of IAA, the test is failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.
6. If the test is failed, the subject shall return to the selection room and remove the respirator. The test subject shall repeat the odor sensitivity test, select and put on another respirator, return to the test area and again begin the fit test procedure described in (1) through (5) above. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait at least 5 minutes before retesting. Odor sensitivity will usually have returned by this time.
7. If the subject passes the test, the efficiency of the test procedure shall be demonstrated by having the subject break the respirator face seal and take a breath before exiting the chamber.
8. When the test subject leaves the chamber, the subject shall remove the ampule and return it to the person conducting the test, so that there is no significant IAA concentration buildup in the chamber during subsequent tests.

### 3.6 Use of Full Face Mask with Cartridges

The following steps describe the procedure to follow when using a full-face mask with cartridges:

1. Obtain full-face respirator with appropriate cartridges from mask storage area.
2. Perform visual inspection of mask, insuring all valves and straps are in perfect working order.
3. Proceed to work area and don protective clothing, as required.
4. Loosen mask webbing.
5. If the cartridge is not attached to the mask, screw the cartridge to the mask and tug on it to ensure that it is fastened tightly and not cross-threaded to mask.
6. Grip the webbing with both hands, insert chin in the mask, and pull the webbing over head.

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7. Place one hand against faceplate to position the mask on face and tighten the webbing straps with the other hand. Adjust the webbing straps from bottom to top.
8. Once the mask is on, perform the negative pressure test by covering the cartridge openings and inhaling. The mask will collapse against face and stay collapsed until exhalation if a proper seal is obtained.
9. Then perform the positive pressure test by covering the exhalation valve and exhale gently into the facepiece. The pressure in the mask will build up inside the mask, without any evidence of outward leakage of air at the seal if a proper seal is obtained.
10. If the above tests fail to ensure a proper fit, repeat steps 6 through 9. If a seal cannot be achieved, subject will have to be fit tested again to find a suitable mask.
11. When a proper seal is obtained, enter work area.
12. Upon egress, place the mask in a plastic bag, seal, and place bag in the appropriate used mask container.

### 3.7 Mask Cleaning

The following steps describe the procedure to follow when cleaning a full-face mask with cartridges:

1. Collect used masks and cartridges.
2. Wear required anti-contamination clothing to unpackage masks.
3. Transport masks to the cleaning area; gently open each bag and survey for contamination. Remove cartridge from mask. Dispose of used cartridges.
4. To prevent cross contamination, separate and repackage any masks reading greater than 20,000 dpm/100 cm<sup>2</sup> alpha smearable. Clean these later in a separate batch (Refer to SOP 1.7).
5. Disassemble masks by removing speaking diaphragms, valve assemblies, or any other components recommended by the manufacturer.
6. Discard or repair any defective parts.

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7. Wash masks in a solution of warm water (120°-140°F) and cleaner/sanitizer.
8. Rinse masks completely in warm or hot water (140°F maximum). *Note: the importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on facepieces may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.*
9. Components should be hand-dried with a clean lint-free cloth or air-dried.
10. After masks have completely dried and been reassembled, survey each mask for residual radiation/contamination. Dispose of masks that cannot be decontaminated to background levels.
11. Test the respirator to ensure that all components work properly.

### 3.5 Radiation Control Technician Mask Inspection

All masks and related equipment shall be inspected before being returned to service. After the masks have been cleaned and monitored for radiation/contamination, inspect each mask for the following:

- Straps, webbing, suspension – in good working order with no cuts, cracks, etc.;
- Facepiece or nosepiece have no tears, defects, or cracks;
- Cartridge mounts have threads in good condition and rubber seal in place;
- Lens (if full face) has no large scratches or cracks; and
- Exhalation valve is still supple with no damage.

### 3.6 Documentation

The Fit Test Record form (Appendix 5.2) shall be completed for each test subject. Submit the forms to the Site Health and Safety Officer for retention in the employee files.

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#### 4.0 Sources

Title 10, Code of Federal Regulations, part 20, *Standards for Radiation Protection*

ANSI Z288.2-1980, *Practices for Respiratory Protection*

United States NRC Regulatory Guide 8.15; *Acceptable Programs for Respiratory Protection*

Title 29 (OSHA), Code of Federal Regulations, part 1910.134, *Respiratory Protection, and 1910.134 Appendix B-2*

#### 5.0 APPENDICES

##### 5.1 Equipment List

##### 5.2 Fit Test Record Form

## SOP 1.11 – Appendix 5.1

### EQUIPMENT AND SUPPLIES CHECKLIST

- \_\_\_\_\_ Selection of full face air purifying respirators
- \_\_\_\_\_ Organic vapor cartridges
- \_\_\_\_\_ Isoamyl Acetate (banana oil) ampules
- \_\_\_\_\_ Stannic oxychloride (smoke tubes)
- \_\_\_\_\_ Current medical certificate approving the use of respirators
- \_\_\_\_\_ Fit test chamber
- \_\_\_\_\_ Mirror
- \_\_\_\_\_ Cleaning wipes for respirators
- \_\_\_\_\_ Fit Test Record Forms

SOP 1.11 – APPENDIX 5.2

RESPIRATOR FIT TEST WORKSHEET

Employee Name \_\_\_\_\_ Social Security # \_\_\_\_\_  
 Radian Office \_\_\_\_\_ Test Date \_\_\_\_\_  
 Project Name \_\_\_\_\_ Project Number \_\_\_\_\_

	Respirator 1	Respirator 2	Respirator 3
Equipment Type	_____	_____	_____
Manufacturer's Name	_____	_____	_____
Model	_____	_____	_____
Size	_____	_____	_____

Test Results	Respirator 1	Respirator 2	Respirator 3
(1) Negative Pressure Test	P ( ) F ( )	P ( ) F ( )	P ( ) F ( )
(2) Positive Pressure Test	P ( ) F ( )	P ( ) F ( )	P ( ) F ( )
(3) Isoamyl Acetate Test	P ( ) F ( )	P ( ) F ( )	P ( ) F ( )
(4) Irritant Smoke Test	P ( ) F ( )	P ( ) F ( )	P ( ) F ( )

Employee briefed on fundamental principles of respiratory protection, use, inspection, cleaning, maintenance, and storage of equipment? Yes ( ) No ( )

Additional Information

Most recent employee physical examination conducted on \_\_\_\_\_

Corrective lenses required for normal work tasks? Yes ( ) No ( )

Facial characteristics preventing sea (beard, missing dentures, etc.) Yes ( ) No ( )

I hereby certify that the subject employee has been tested according to procedures specified in the Thorad Project Respiratory Protection Program. The results of the test indicate that the subject employee is accepted ( ) rejected ( ) for work assignments requiring respiratory protective equipment.

Examiner's Name \_\_\_\_\_ Examiner's Signature \_\_\_\_\_ Date \_\_\_\_\_

Employee's Name \_\_\_\_\_ Employee's Signature \_\_\_\_\_ Date \_\_\_\_\_

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### 3.2 Preparation

The tasks below must be completed prior to starting fieldwork.

#### 3.2.1 Office

Review the RHSP, scope of work, and the related SOPs listed in Section 3.1 of this SOP. Contact emergency medical facilities with the work schedules and schedule a briefing date with these facilities prior to the commencement of work.

### 3.6 Documentation

The following documentation is required for all site work:

- Ensure that all emergency procedures are posted. All emergency procedure training, daily safety meetings, and briefings should be documented in the site health and safety (H&S) logbook;
- Data entry requirements in the site H&S logbook are as follows: the date, time, and person making entries should be recorded on each logbook page. All safety meetings, Radiation Work Permit (RWP) briefings, first aid kit inspections, health and safety observations, etc., should be documented in the H&S logbook;
- All contamination surveys should be documented according to the descriptions outlined in SOPs 1.2 and 1.7; and
- The site health physicists should also document in the H&S logbook all materials or people suspected to have come in contact with the potentially contaminated injured person or contaminated areas of the site.

### 3.7 Postings

Emergency procedures and phone numbers should be posted at the control area access point, in the administration building lunchroom, at the access control point into the potentially contaminated area (overhead door-north end of pole shed), at all contractor access control points, and at all contractor clean areas, including lunchrooms, inside the potentially contaminated area. The postings are as follows:

- A sign indicating location of the Emergency Radiological Response Kit;
- A sign indicating location of the first aid kits on the site; and
- A listing of emergency phone numbers for the site.

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### 3.3 Emergency Operations

The sections below describe Emergency Response Procedures.

#### 3.3.1 General

The following general procedures apply to all emergencies:

- If a serious injury occurs, apply first aid to stabilize the injured person. Only leave the injured person after he/she is stabilized or as a last resort. Contact the site manager so that he/she can take control and direct the emergency operations.
- Direct someone to contact emergency medical services (EMS). When contacting EMS be sure to give the site address (4868 E. Wilder Road, mention SC Johnson Wax or Dow Brands), site phone number, describe the nature of the injury, and indicate that the person is potentially contaminated with radioactive materials. After contacting EMS, someone should remain by the phone in case EMS needs to contact the site for further information.
- Another person, if available, should be sent to the East Guard Gate to meet and escort the emergency response personnel back to the site. If no one is available, the person that called EMS should contact the guard gate and inform the guard regarding the nature of the emergency.
- All life-threatening injuries are to be transported directly to the Bay Medical Center emergency room. The site manager or a designee should contact the emergency room personnel and describe the nature of the injuries and that the victim is potentially contaminated with radioactive materials.

Bay Medical Center  
1900 Columbus Avenue  
Bay City, MI  
(517) 894-3000

- If possible, transport the injured person to a clean area to meet the ambulance. If the injured person cannot be moved, the ambulance will be escorted into the potentially contaminated area by the site manager or a designee.
- The Radiation Safety Officer (RSO) should obtain the Emergency Radiological Response (ERR) kit and an alpha scintillator from the laboratory trailer. The ERR kit contains materials to be used to prevent and control the spread of

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contamination from the victim and response personnel to areas and equipment off-site **NOTE: THE ERR KIT DOES "NOT" CONTAIN FIRST AID SUPPLIES!!!** A First Responder first aid kit can be obtained at the control point entrance in the pole shed or at the other posted locations.

- After the ambulance arrives on-site, the stretcher should be covered with plastic from the ERR kit. The blanket in the kit should be used to wrap the victim before being placed on the stretcher or backboard. If possible, keep the stretcher and other emergency equipment from contacting the potentially contaminated ground.
- Monitoring of the injured person, the attending medical personnel, and the emergency vehicle will not occur at the control point in a life-threatening situation. However, response personnel will be required to don rubber booties, surgical gloves, and tyvek at the access control point prior to leaving the potentially contaminated area. This protective equipment may work in reverse of its intent to prevent the possible spread of contamination from the responders to the hospital and to the interior of the ambulance. While the response personnel are donning this equipment, a technician will perform a quick monitoring and a visual inspection of the ambulance tires. It is highly recommended that the injured person be transport to the clean area to meet the ambulance. If this is the case, all personnel accompanying the injured person to the hospital already should have been monitored and should be prepared to leave the control area immediately with the ambulances.
- The RSO will accompany the victim and response personnel to the hospital. He/she will take the ERR kit and the necessary monitoring instrumentation needed to perform contamination release surveys at the hospital.
- Upon arrival at the hospital, the emergency room (ER) personnel will be alerted that the victim may be potentially contaminated with radioactive materials. Concise instructions should be given to the ER personnel to prevent the spread of contamination. A control area will be established inside the hospital emergency room by the site health physicist. Anyone coming into contact with the victim must be monitored prior to leaving the control area.

### 3.4. Post Response

The sections below describe procedures required after the emergency is over.

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### 3.4.1. Hospital

After delivering the victim to the ER personnel, a control and decontamination area will be established by the site health physicist so the emergency response personnel can remove their protective clothing. All people, equipment, and areas that came into contact with the site or the victim must be surveyed according to SOPs 1.2 and 1.7 and be verified free of contamination before being released from the hospital control area. All areas of the ambulance (inside and outside) having come into contact with the site or the victim must also be surveyed before being put back into service. Once the victim's condition is stable, he/she must be surveyed before leaving the ER control area. If any contamination is found in or on any of the items surveyed, the contaminated areas will be isolated and then decontaminated. At this point, the incident should be reported to the NRC Region III.

In the case of all emergencies or injuries, contact the appropriate Radian International LLC (Radian) and Dow Chemical (Dow) personnel in a timely manner (not necessarily first). Unless trained, no attempt should be made to treat an injured person, as this may cause further injury.

### 3.4.2. Documentation

The following documentation is required for all emergencies:

- Complete logbook entries, verify the accuracy of entries, and sign/initial all pages; and
- Complete all forms that are required to document these procedures and verify that all areas, equipment, and people coming into contact with the victim or the site are free of contamination.

### 3.4.3. Office

Prepare all incident reports required by the corporations and the Michigan Department of Nuclear Safety.

## 4.0 SOURCES

None.

## 5.0 APPENDIX

### 5.1. Equipment and Supplies Checklist for the Emergency Radiological Response Kit

## SOP 1.12 – Appendix 5.1

### EQUIPMENT AND SUPPLIES CHECKLIST FOR THE EMERGENCY RADIOLOGICAL RESPONSE KIT

- \_\_\_\_\_ 1 box of 30 gallon garbage bags
- \_\_\_\_\_ plastic (four 10' x 10' sheets of visqueen)
- \_\_\_\_\_ duct tape
- \_\_\_\_\_ 1 dozen tyvek
- \_\_\_\_\_ 1 dozen rubber booties
- \_\_\_\_\_ 1 box of latex surgical gloves
- \_\_\_\_\_ 2 large blankets
- \_\_\_\_\_ "CAUTION" barrier tape
- \_\_\_\_\_ alpha scintillator/ratemeter (Ludlum 43-5/Model 3)
- \_\_\_\_\_ 1 box of paper smears or swipes
- \_\_\_\_\_ logbook and survey forms

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## 3.2 Preparation

The following sections describe procedures that must be completed prior to particulate sampling.

### 3.2.1 Equipment

Obtain a Hi-Vol air sampler (with shelter for protection) capable of pulling air through an open face 8"x10" glass fiber filter at a known rate greater than 20 lpm (GMW B/M 2000H Hi-Vol sampler or equivalent). This sampler may require AC power at the sampling location.

Obtain an alpha counting detector/scaler or combination capable of 60-minute counts (Ludlum Model 2221 scaler w/ Ludlum 43-90 detector or equivalent). Ensure that both have current calibrations, and the air samplers are equipped with a potentiometer to regulate sample flow and a pressure transducer recorder to measure and record airflow rate.

## 3.2 Documentation

Obtain a blank High Volume Radioactive Particulate Sampling Log sheet (Appendix 5.2) on which to record: sample number, date, start and stop times, flow rate, location, type of work being done. In addition, obtain filter envelopes to record sample number, date, start and stop times, and start and stop flow rates.

## 3.3 Field

In the field, the following steps must be performed to collect a sample:

1. Load an 8"x10" glass fiber filter into filter holder of a calibrated sampling pump with the rough-irregular pattern facing outward. The sampler should be placed at a location that is representative of the air that the workers are breathing.
2. With the pump on for several seconds, record the flow meter reading on the High Volume Radioactive Particulate Sampling Log (Appendix 5.2). Also record the sample #, sampler #, field tech, Radiation Work Permit (RWP) #, filter type, Hi-Vol calibration date, temperature, pressure, start time/date, location of sampler, and work activities. Leave the sampler running to collect the sample on the filter.

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3. Collect the sample for at least 4 hours. Record the pertinent sample information such as the stop time/date, pressure, temperature, and flow meter reading at the end of the sample collection. Remove the filter and place it in a filter envelope. (**Note:** Actual flow must be obtained from the pump calibration paper. The chart recorder on the pump is indicated flow and not actual flow.)
4. Determine and record the background of the Alpha counting instrument by counting a blank filter for at least 10 minutes (**Note:** Use of a longer time, such as overnight, is preferred.)
5. Obtain the counting efficiency for the alpha counting instrument (Ludlum 2221/ Ludlum 43-90) from the detector efficiency log. Record on High Volume Radioactive Particulate Sampling Log (Appendix 5.2).
6. Place the alpha probe on the geometrical center of the filter and count for 10 minutes. Enter this data on High Volume Radioactive Particulate Sampling Log (Appendix 5.2), as well as into the appropriate spreadsheet (see example in Appendix 5.3).
7. Give the High Volume Radioactive Particulate Sampling Form to the Radiation Safety Officer or his/her designee for review.
8. Retain High Volume Radioactive Particulate Sampling Log (Appendix 5.2) and filter in the records storage file.

#### 4.0 SOURCES

Operations Manual for Graseby Model GC 2310 Series: Total Suspended Particulate Sampling System Mass Flow Controlled. Graseby GMW, Village of Cleves, Ohio.

#### 5.0 APPENDICES

##### 5.1 Equipment and Supplies Checklist

##### 5.2 High Volume Radioactive Particulate Sampling Log

##### 5.3 Example Spreadsheet

SOP 1.18 – APPENDIX 5.1

**Equipment and Supplies Checklist**

- \_\_\_\_\_ Calibrated High Volume Air Sampler
- \_\_\_\_\_ 8" x 10" Glass Fiber Filters
- \_\_\_\_\_ Recorder Chart
- \_\_\_\_\_ High Volume Particulate Sampling Log (Appendix 5.2)
- \_\_\_\_\_ Calibrated Alpha Counting Detector/Scaler

**HIGH VOLUME RADIOACTIVE PARTICULATE SAMPLING LOG**

Sample No. \_\_\_\_\_  
 Sampler No \_\_\_\_\_  
 Cal Date \_\_\_\_\_

Field Tech: \_\_\_\_\_  
 RWP No. \_\_\_\_\_  
 Filter Type \_\_\_\_\_

Location/Assigned To: \_\_\_\_\_

Start					Stop				
Date	Time	Temp (degree F)	Pres. (in. Hg)	Flow (cfm)	Date	Time	Temp (degree F)	Pres. (in. Hg)	Flow (cfm)

Comments: \_\_\_\_\_  
 \_\_\_\_\_

**INITIAL COUNT**

LAB TECH \_\_\_\_\_

Counter: Serial No. \_\_\_\_\_  
 Date / Time \_\_\_\_\_  
 Alpha Counts \_\_\_\_\_  
 Bkg. Counts \_\_\_\_\_  
 Gross Alpha \_\_\_\_\_  $\mu\text{Ci/ml}$   
 % of DAC \_\_\_\_\_

Detector Serial No. \_\_\_\_\_  
 Efficiency \_\_\_\_\_ (E)  
 Count Time \_\_\_\_\_ 10 min (S)  
 Count Time \_\_\_\_\_ 10 min (B)

**FINAL COUNT**

LAB TECH \_\_\_\_\_

Counter: Serial No. \_\_\_\_\_  
 Date / Time \_\_\_\_\_  
 Alpha Counts \_\_\_\_\_  
 Bkg. Counts \_\_\_\_\_  
 Gross Alpha \_\_\_\_\_  $\mu\text{Ci/ml}$   
 % of DAC \_\_\_\_\_

Detector Serial No. \_\_\_\_\_  
 Efficiency \_\_\_\_\_ (E)  
 Count Time \_\_\_\_\_ 10 min (S)  
 Count Time \_\_\_\_\_ 10 min (B)

$FA = (\text{ratio of area of } 43 - 90 \text{ times filter absorption factor}) = 4.04$

$$\text{Gross Alpha activity, } \mu\text{Ci / ml} = \frac{[(Scpm) - (Bcpm)](FA) / \text{Count time}}{(2.22E + 6)(dpm / \mu\text{Ci}) \times E(\text{cpm / dpm}) \times V(\text{ml})}$$

Reviewed By: \_\_\_\_\_ Date: \_\_\_\_\_

SOP 1.18 - APPENDIX 5.3

EXAMPLE SPREADSHEET

$$\text{Gross Alpha activity} = \frac{(S \text{ cpm}) - (B \text{ cpm}) \times (FA)}{2.22 \text{ E}+6 \text{ (dpm/\mu Ci)} \times E \text{ (cpm/dpm)} \times V \text{ (ml)}} \quad \text{LLD, } \mu\text{Ci/ml} = \frac{4.66 \times (FA) \text{ Bkg count time (min)}}{2.22 \text{ E}+6 \text{ (dpm/\mu Ci)} \times E \text{ (cpm/dpm)} \times V \text{ (ml)}}$$

$FA = 4.04$        $S$  sample counts     $V$  volume     $E$  efficiency Bkg background

1997 Railhead Ramp Hivol Samples

Sample Number	Sampler Number	Cal Date	Start				Stop				Elapsed Time Min.	Calibration date		SAMPLING RATE			Volume ml	Count Date	Counter No.	Cl. Time Min.	Bkg counts	Gross counts	EFF	Gross Alpha Activity $\mu\text{Ci/ml}$	LLD $\mu\text{Ci/ml}$	Th-232 %	Rolling Average $\mu\text{Ci/ml}$	% Th Rolling Average		
			Date	Time	Temp	Pres.	Flow	Date	Time	Temp		Pres.	Flow	ro	b	start													stop	avg.
BCA-3110	HV3	12/05/96	01/08/97	09:00:00	26	30.36	41	01/08/97	16:45:00	28	30.27	42	465	0.7291	5.6753	37.32	37.98	37.65	4.96E+08	1/15/1997	126518	10	12	22	0.204	1.80E-14	2.90E-14	1.80	1.80E-14	1.80

**Appendix C**  
**OSHA Poster, Job Safety and Health Protection**

# JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Provisions of the Act include the following:

## EMPLOYERS

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employers must comply with occupational safety and health standards issued under the Act.

## EMPLOYEES

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

## INSPECTION

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

## COMPLAINT

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with the nearest OSHA office within 30 days of the alleged discriminatory action.

## CITATION

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected. The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

## PROPOSED PENALTY

The Act provides for mandatory civil penalties against employers of up to \$7,000 for each serious violation and for optional penalties of up to \$7,000 for each nonserious violation. Penalties of up to \$7,000 per day may be proposed for failure to correct violations within the proposed time period and for each day the violation continues beyond the prescribed abatement date. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to \$70,000 for each such violation. A minimum penalty of \$5,000 may be imposed for each willful violation. A violation of posting requirements can bring a penalty of up to \$7,000.

There are also provisions for criminal penalties. Any willful violation resulting in the death of any employee, upon conviction, is punishable by a fine of up to \$250,000 (or \$500,000 if the employer is a corporation), or by imprisonment for up to six months, or both. A second conviction of an employer doubles the possible term of imprisonment. Falsifying records, reports, or applications is punishable by a fine of \$10,000 or up to six months in jail or both.

## VOLUNTARY ACTIVITY

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

OSHA has published Safety and Health Program Management Guidelines to assist employers in establishing or perfecting programs to prevent or control employee exposure to workplace hazards. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

## CONSULTATION

Free assistance in identifying and correcting hazards and in improving safety and health management is available to employers, without citation or penalty, through OSHA-supported programs in each State. These programs are usually administered by the State Labor or Health department or a State university.

## POSTING INSTRUCTIONS

Employers in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

*Under provisions of Title 29, Code of Federal Regulations, Part 1903.2 (a) (1) employers must post this notice (or facsimile) in a conspicuous place where notices to employees are customarily posted.*

## More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta, GA	(404) 347-3573
Boston, MA	(617) 565-7164
Chicago, IL	(312) 353-2220
Dallas, TX	(214) 767-4731
Denver, CO	(303) 844-3061
Kansas City, MO	(816) 426-5861
New York, NY	(212) 337-2378
Philadelphia, PA	(215) 596-1201
San Francisco, CA	(415) 744-6670
Seattle, WA	(206) 442-5930

Robert B. Reich, Secretary of Labor

**U.S. Department of Labor**  
Occupational Safety and Health Administration

This information will be made available to sensory impaired individuals upon request. Voice phone: (202) 219-8615. TDD message relay: phone: 1-800-328-7577.

To report suspected fire hazards, imminent danger safety and health hazards in the workplace, or other job safety and health emergencies, such as toxic waste in the workplace, call OSHA's 24-hour hotline: 1-800-321-OSHA.

Washington, DC  
1992 (Reprinted)  
OSHA 2203



**Appendix D**  
**NRC Poster, Notice to Employees**



# NOTICE TO EMPLOYEES

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

## WHAT IS THE NUCLEAR REGULATORY COMMISSION?

The Nuclear Regulatory Commission is an independent Federal regulatory agency responsible for licensing and inspecting nuclear power plants and other commercial uses of radioactive materials.

## WHAT DOES THE NRC DO?

The NRC's primary responsibility is to ensure that workers and the public are protected from unnecessary or excessive exposure to radiation and that nuclear facilities, including power plants, are constructed to high quality standards and operated in a safe manner. The NRC does this by establishing requirements in Title 10 of the Code of Federal Regulations (10 CFR) and in licenses issued to nuclear users.

## WHAT RESPONSIBILITY DOES MY EMPLOYER HAVE?

Any company that conducts activities licensed by the NRC must comply with the NRC's requirements. If a company violates NRC requirements, it can be fined or have its license modified, suspended or revoked.

Your employer must tell you which NRC radiation requirements apply to your work and must post NRC Notices of Violation involving radiological working conditions.

## WHAT IS MY RESPONSIBILITY?

For your own protection and the protection of your co-workers, you should know how NRC requirements relate to your work and should obey them. If you observe violations of the requirements or have a safety concern, you should report them.

## WHAT IF I CAUSE A VIOLATION?

If you engaged in deliberate misconduct that may cause a violation of the NRC requirements, or would have caused a violation if it had not been detected, or deliberately provided inaccurate or incomplete information to either the NRC or to your employer, you may be subject to enforcement action. If you report such a violation, the NRC will consider the circumstances surrounding your reporting in determining the appropriate enforcement action, if any.

## HOW DO I REPORT VIOLATIONS AND SAFETY CONCERNS?

If you believe that violations of NRC rules or the terms of the license have occurred, or if you have a safety concern, you should report them immediately to your supervisor. You may report violations or safety concerns directly to the NRC. However, the NRC encourages you to raise

your concerns with the licensee since it is the licensee who has the primary responsibility for, and is most able to ensure, safe operation of nuclear facilities. If you choose to report your concern directly to the NRC, you may report this to an NRC inspector or call or write to the NRC Regional Office serving your area. If you send your concern in writing, it will assist the NRC in protecting your identity if you clearly state in the beginning of your letter that you have a safety concern or that you are submitting an allegation. The NRC's toll-free SAFETY HOTLINE for reporting safety concerns is listed below. The addresses for the NRC Regional Offices and the toll-free telephone numbers are also listed below.

## WHAT IF I WORK WITH RADIOACTIVE MATERIAL OR IN THE VICINITY OF A RADIOACTIVE SOURCE?

If you work with radioactive materials or near a radiation source, the amount of radiation exposure that you are permitted to receive may be limited by NRC regulations. The limits on your exposure are contained in sections 20.1201, 20.1207, and 20.1208 of Title 10 of the Code of Federal Regulations (10 CFR 20) depending on the part of the regulations to which your employer is subject. While these are the maximum allowable limits, your employer should also keep your radiation exposure as far below those limits as "reasonably achievable."

## MAY I GET A RECORD OF MY RADIATION EXPOSURE?

Yes. Your employer is required to advise you of your dose annually if you are exposed to radiation for which monitoring was required by NRC. In addition, you may request a written report of your exposure when you leave your job.

## HOW ARE VIOLATIONS OF NRC REQUIREMENTS IDENTIFIED?

NRC conducts regular inspections at licensed facilities to assure compliance with NRC requirements. In addition, your employer and site contractors conduct their own inspections to assure compliance. All inspectors are protected by Federal law. Interference with them may result in criminal prosecution for a Federal offense.

## MAY I TALK WITH AN NRC INSPECTOR?

Yes. NRC inspectors want to talk to you if you are worried about radiation safety or have other safety concerns about licensed activities, such as the quality of construction or operations at your facility. Your employer may not prevent you from talking with an inspector. The NRC will make all reasonable efforts to protect your identity where appropriate and possible.

## MAY I REQUEST AN INSPECTION?

Yes. If you believe that your employer has not corrected violations involving radiological working conditions, you may request an inspection.

Your request should be addressed to the nearest NRC Regional Office and must describe the alleged violation in detail. It must be signed by you or your representative.

## HOW DO I CONTACT THE NRC?

Talk to an NRC inspector on-site or call or write to the nearest NRC Regional Office in your geographical area (see map below). If you call the NRC's toll-free SAFETY HOTLINE during normal business hours, your call will automatically be directed to the NRC Regional Office for your geographical area. If you call after normal business hours, your call will be directed to the NRC's Headquarters Operations Center, which is manned 24 hours a day.

## CAN I BE FIRED FOR RAISING A SAFETY CONCERN?

Federal law prohibits an employer from firing or otherwise discriminating against you for bringing safety concerns to the attention of your employer or the NRC. You may not be fired or discriminated against because you:

- ask the NRC to enforce its rules against your employer;
- refuse to engage in activities which violate NRC requirements;
- provide information or are about to provide information to the NRC or your employer about violations of requirements or safety concerns;
- are about to ask for, or testify, help, or take part in an NRC, Congressional, or any Federal or State proceeding.

## WHAT FORMS OF DISCRIMINATION ARE PROHIBITED?

It is unlawful for an employer to fire you or discriminate against you with respect to pay, benefits, or working conditions because you help the NRC or raise a safety issue or otherwise discourage you from engaging in protected activities. Violations of Section 211 of the Energy Reorganization Act (ERA) of 1974 (42 U.S.C. 5851) include the harassment and intimidation by employers of (i) employees who bring safety concerns directly to their employers or to the NRC; (ii) employees who have refused to engage in an unlawful practice, provided that the employee has identified the illegality to the employer; (iii) employees who have testified or are about to testify before Congress or in any Federal or State proceeding regarding any provision (or proposed provision) of the ERA or the Atomic Energy Act (AEA) of 1954; (iv) employees who have commenced or caused to be commenced a proceeding for the administration or enforcement of any requirement imposed under the ERA or AEA or who have, or are about to, testify, assist, or participate in such a proceeding.

## HOW DO I FILE A DISCRIMINATION COMPLAINT?

If you believe that you have been discriminated against for bringing violations or safety concerns to the NRC or your employer, you may file a

complaint with the U.S. Department of Labor (DOL) pursuant to Section 211 of the ERA. Your complaint must describe the firing or discrimination and must be filed within 180 days of the occurrence. Filing an allegation, complaint, or request for action with the NRC does not extend the requirement to file a complaint with the DOL within 180 days. You must file the complaint with the DOL. The NRC cannot file the complaint for you.

## Send complaints to:

Office of the Administrator  
Wage and Hour Division, Room S3502  
Employment Standards Administration  
U.S. Department of Labor  
Constitution Avenue, NW  
Washington, DC 20210

or any local office of the DOL, Wage and Hour Division. Check your telephone directory under U.S. Government listings.

## WHAT CAN THE DEPARTMENT OF LABOR DO?

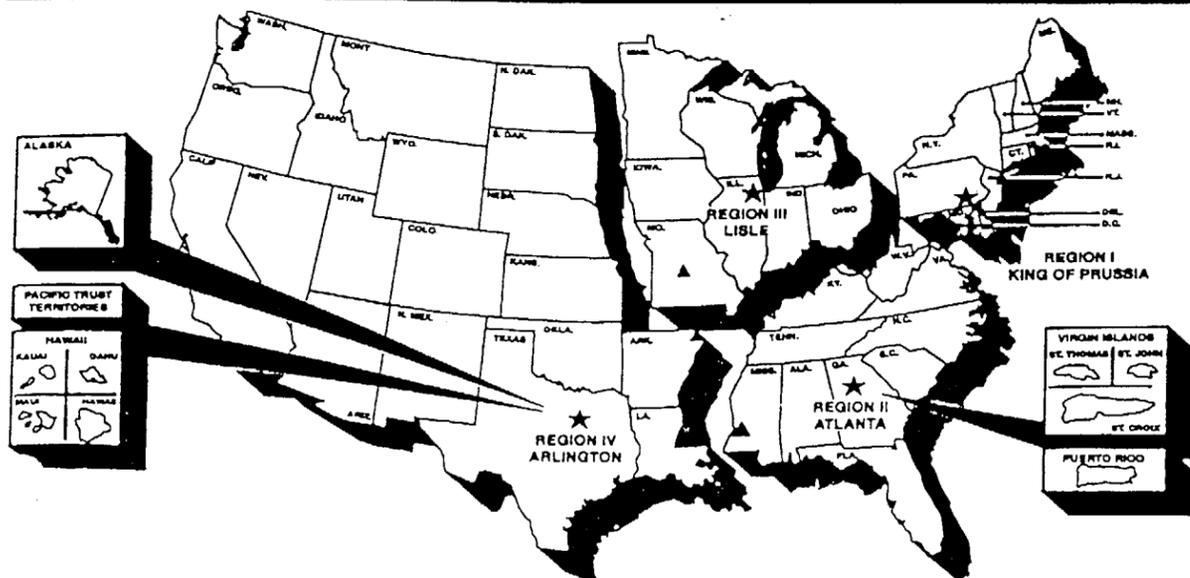
If your complaint involves a violation of Section 211 of the ERA by your employer, it is the DOL, NOT THE NRC, that provides the process for obtaining a personal remedy. The DOL will notify your employer that a complaint has been filed and will investigate your complaint.

If the DOL finds that your employer has unlawfully discriminated against you, it may order that you be reinstated, receive back pay, or be compensated for any injury suffered as a result of the discrimination.

## WHAT WILL THE NRC DO?

The NRC will evaluate each allegation of harassment, intimidation, or discrimination. Following this evaluation, an investigator from the NRC's Office of Investigations may interview you and review available documentation. Based on the evaluation, and, if applicable, the interview, the NRC will assign a priority and a decision will be made whether to pursue the matter further through an investigation. The assigned priority is based on the specifics of the case and its significance relative to other ongoing investigations. The NRC may not pursue an investigation to the point that a conclusion can be made whether the harassment, intimidation, or discrimination actually occurred. Even if NRC decides not to pursue an investigation, if you have filed a complaint with DOL, the NRC will monitor the results of the DOL investigation.

If the NRC or DOL finds that unlawful discrimination has occurred, the NRC may issue a Notice of Violation to your employer, impose a fine, or suspend, modify, or revoke your employer's NRC license.



▲ - Callaway Plant Site in Missouri and Grand Gulf Plant Site in Mississippi are under the purview of Region IV.

## UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICE LOCATIONS

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

### REGIONAL OFFICES

REGION	ADDRESS	TELEPHONE
I	U.S. Nuclear Regulatory Commission, Region I 475 Allendale Road King of Prussia, PA 19406-1415	(800) 432-1156
II	U.S. Nuclear Regulatory Commission, Region II 101 Marietta Street, N.W., Suite 2900 Atlanta GA 30323-0199	(800) 577-8510
III	U.S. Nuclear Regulatory Commission, Region III 801 Warrenville Road Lisle, IL 60532-4351	(800) 522-3025
IV	U.S. Nuclear Regulatory Commission, Region IV 611 Ryan Plaza Drive, Suite 400 Arlington, TX 76011-8064	(800) 952-9677
WALNUT CREEK CREEK FIELD OFFICE	U.S. Nuclear Regulatory Commission 1450 Maria Lane Walnut Creek, CA 94596-5368	(800) 882-4672

To report safety concerns or violations of NRC requirements by your employer,  
telephone:  
**NRC SAFETY HOTLINE**  
1-800-695-7403

To report incidents involving fraud, waste, or abuse by an NRC employee or NRC contractor,  
telephone:  
**OFFICE OF THE INSPECTOR GENERAL**  
HOTLINE  
1-800-233-3497

**Appendix E**  
**List of Field and Laboratory Instrumentation**

**List of Instrumentation for Dow THORAD Project**

Model Number	Serial Numbers	Intended Purpose	Probes	Serial Numbers	MDA μCi
Ludlum Model 1000	121249	Analytical	Ludlum 43-10	PR 127335	5.48E-08
Ludlum Model 1000	121256	Analytical	Ludlum 43-10	PR 127197	5.64E-08
Ludlum Model 1000	128285	Analytical	Ludlum 43-10	PR 132380	5.25E-07
Ludlum Model 1000	128300	Analytical	Ludlum 43-10-4	PR 132381	1.14E-06
Ludlum Model 1000	130040	Analytical	Ludlum 43-10	PR 131394	5.29E-07
Ludlum Model 1000	130041	Analytical	Ludlum 43-10	PR 135350	5.31E-08
Ludlum Model 12	125303	Scanning, Frisking	Ludlum 44-9	PR 128106	8.37E-05
Ludlum Model 12	128218	Scanning, Frisking	Ludlum 44-9	PR 132075	1.10E-04
Ludlum Model 12	128232	Scanning, Frisking	Ludlum 44-9	PR 130458	1.00E-04
Ludlum Model 177	124522	Scanning, Frisking	Ludlum 43-5	PR 131070	3.46E-05
Ludlum Model 177	128370	Scanning, Frisking	Ludlum 43-5	PR 131071	2.76E-05
Ludlum Model 177	128393	Scanning, Frisking	Ludlum 43-5	PR 127365	3.93E-05
Ludlum Model 177	128394	Scanning, Frisking	Ludlum 44-9	PR 132021	9.68E-05
Ludlum Model 19	123938	Static, Scanning			6.77E-01
Ludlum Model 19	127379	Static, Scanning			7.25E-01
Ludlum Model 2221	126502	Scanning	Ludlum 44-10	PR 128795	4.97E-03
Ludlum Model 2221	126518	Scanning, Static	Ludlum 43-90	PR 128800	1.10E-06
Ludlum Model 2221	126524	Scanning	Ludlum 44-10	PR 132143	5.12E-03
Ludlum Model 2221	126525	Scanning	Ludlum 44-10	PR 128794	6.06E-03
Ludlum Model 2221	127208	Scanning	Ludlum 44-10	PR 132150	5.98E-03
Ludlum Model 2221	127215	Scanning	Ludlum 44-10	PR 132151	5.68E-03
Ludlum Model 2221	127224	Scanning	Ludlum 44-10	PR 132152	5.48E-03
Ludlum Model 2221	127225	Scanning	Ludlum 44-10	PR 128453	5.42E-03
Ludlum Model 2221	127235	Scanning, Frisking	Ludlum 43-90	PR 132007	1.20E-06
Ludlum Model 2221	127250	Scanning, Frisking	Ludlum 43-90	PR 132353	1.07E-06
Ludlum Model 2221	127253	Analytical	Ludlum 43-10	PR 134281	4.22E-07
Ludlum Model 2221	127258	Scanning, Frisking	Ludlum 43-90	PR 128799	1.13E-06
Ludlum Model 500	121030	quipment Function Check			na
MCA #1	----	Analytical	Sodium Iodide	----	not in use
MCA #2	----	Analytical	Sodium Iodide	----	5.50E-06
MCA #3	----	Analytical	Sodium Iodide	----	5.34E-06

$$MDA = (2.71 + 4.65 * \sqrt{\text{background counts} / \text{background count time}^2}) * (1 / \text{Efficiency} * \text{Background Count})$$

**Unpaired Probes**

Ludlum 44-10	PR 128461		8 44-10 Shield	na
Ludlum 44-10	PR 131682		Ludlum 43-90	PR 131385
Ludlum 44-10	PR 132145		Ludlum 44-2	PR 130695
Ludlum 44-10	PR 132516	Used for Demonstration	Ludlum 44-2	PR 130741
Ludlum 44-10	PR 132151			

**Returned to Freeport**

Ludlum Model 12	125237	Ludlum 44-9	PR 131999
Ludlum Model 12	128251	Ludlum 44-9	PR 130457
Ludlum Model 12	128278	Ludlum 44-9	PR 132018
Ludlum Model 19	131244	Ludlum 44-9	021843
Ludlum Model 19	131292		
Ludlum Model 3	56541		
NRC Model ADM-300A	691033	NRC Model XP-100	690566
NRC Model ADM-300A	691034	NRC Model XP-100	690565
Ludlum Model 1000	128301	Ludlum 43-10	PR 131395