American Radiolabeled
Chemicals, Inc.

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Friday, 29 June 2012

Nuclear Materials licensing Section
U.S.Nuclear Regulatory Commission, Region III
2443 Warrenville Road, Suite 210
Lisle, IL 60532-4352

Reference: License No. 24-21362-01

ATTENTION: Kevin Null

American Radiolabeled Chemicals, Inc (ARC) requests that the attached documents be used to update the ARC License renewal request dated 31 August 2011.

The Policies, Program, and Procedures (PPP) transmitted as Attachment One of this letter should be substituted for those found in our renewal request dated 31 August 2011. This set of PPP are those in force after License Amendments 48, 47, 46, 45, and 44. This attachment is a complete replacement for Attachments A and B of the renewal request dated 31 August 2011.

Attachment Two to this letter is composed of a list of changes to the renewal application due to changes made by License Amendments 48, 47, 46, 45, and 44. These changes deal with possession limits and uses for various nuclides as well as changes to Authorized Users, staffing and nomenclature.

Attachment Three is a list of requested changes to the SOPs due to discrepancies, outdated equipment, and so on. These changes were found during our annual review of the PPP.

Attachment Four is composed of updates to floor plans and drawings that describe the facility. The changes to these items were made due to License Amendments 48, 47, 46, 45, and 44.

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Attachment Five is the updated Decommissioning Funding Plan (DFP) which was not sent as part of the renewal application. The DFP is updated every three years.

Attachment Six is the updated Environmental report which was not sent as part of the renewal application. The Environmental Report is updated every three years

These documents have been approved in various amendments to our license between submission of the renewal request and the present date.

If you have any questions, or need additional information, please contact Regis Greenwood, ARC RSO, directly.

Sincerely,

AMERICAN RADIOLABELED CHWEMICALS, INC

Surendra K. Gupta, PhD
President
American Radiolabelled Chemicals, Inc

CC: Regis A Greenwood, CHP
Radiation Safety Committee File
NRC Correspondence File

# ATTACHMENT ONE

This set of Policies, Program and Procedures are those in force after License Amendments 48, 47, 46, 45, and 44.

This Attachment is a complete replacement for Attachments A and B of the renewal request dated 31 August 2011.

## ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL RECORDS

It is the Policy of American Radiolabeled Chemicals, Inc (ARC) that every employee, may access his/her exposure and medical records. However, the request for these records must be in writing, signed by the requesting employee, and then sent to the Safety and Environmental Affairs Office.

It is ARC Policy that you not only have a right to access these records but that the company respects the confidential relationship that exists between physician and patient.

Additional information, copies of forms to request records, and copies of all regulations may be obtained from Regis A. Greenwood, CHP, Director, Safety and Environmental Affairs. Requests for information will be answered within fifteen (15) days pursuant to OSHA Regulations contained in 29 CFR 1910.20.

Surendra K. Gupta, PhD

President

American Radiolabeled Chemicals, Inc

# Health and Safety Policy

The purpose of this policy is to set forth our commitment and philosophy with respect to the prevention of accidents and occupational injury or illness.

Our underlying philosophy is that all injuries can be prevented. Management (which includes all supervisors) has the primary responsibility of preventing injuries, and the supervisor is directly responsible for safety in his/her area of control. We are committed to train and educate all employees to work safely and understand that it is to each employee's advantage, as well as the Company's, to work safely and that both the Company and the employees have a definite responsibility to do so. We will train and educate our employees on the safe practices of using protective equipment, enforcement of safety rules and practices which minimize exposure to toxic and stressful agents.

We recognize that each employee is responsible for 1) using and maintaining safe work practices and conditions at all times, 2) considering the consequences of his/her acts on the safety of his/her fellow employees, 3) reporting all unsafe work practices and conditions as a basic part of his/her job, and 4) wearing the protective equipment required by the company to prevent injuries or work-related illness.

An effective safety and occupational health program is an integral part of good management practices. Safety takes precedence over everything, and no subject is more important than safety as it involves our employees.

Surendra K. Gupta, PhD

President

American Radiolabeled
Chemicals, Inc.

# Limited Duty Policy

The American Radiolabeled Chemicals, Inc (ARC) workers' compensation program has several distinct goals:

- To provide employees with prompt, high-quality care for their work-related injuries.
- To compensate workers during the time they are disabled and unable to work.
- To return injured employees to full duty in the work force as soon as possible.
- To help us achieve these goals, we have instituted a modified-duty policy. Modified duty is temporary (usually no longer than 45 days). It is a process that provides wages for an injured employee during recovery.

Procedure:

If you are injured on the job, the following procedures will be used:

1. See your supervisor. If necessary, you will be sent to our medical provider for treatment.
2. The Accident Reporting and Treatment (ART) Form will be filled out; by signing the form promptly, you will ensure that there are no delays in payment of indemnity wages, if needed.
3. The medical provider will identify any injury-related restrictions:. for example, limits on the amount you can lift or pull, limits on motion, etc.
4. If work is available within the restrictions specified by the doctor, you will be offered an appropriate modified-duty position. Your physical restrictions will be reviewed weekly (or as required) to ensure progress toward return to full duty.

Surendra Gupta, Ph.D.
President, ARC, Inc
7 May 2004

# Radiation Safety Policy

It is hereby affirmed that ARC Officers, Management and the ARC Radiation Safety Committee are committed to the best possible Radiation Protection Program and to maintaining doses to ARC Personnel and the Public ALARA.

We are committed to train and educate all employees to work safely and understand that it is to each employee's advantage, as well as the Company's, to work safely and that both the Company and the employees have a definite responsibility to do so.

We will train and educate our employees on the safe practices of using protective equipment, enforcement of radiation safety rules and practices which minimize dose to the individual.

We recognize that each radiation worker is responsible for 1) using and maintaining safe radiation work practices at all times, 2) considering the consequences of his/her acts on the radiation safety of fellow employees and the public, 3) reporting all unsafe work practices and conditions as a basic part of his/her job, and 4) wearing the protective equipment required by the company to prevent personal contamination and the spread of contamination to the public.

An effective radiation safety program is an integral part of good management practices. Safety takes precedence over everything, and no subject is more important than safety as it involves our employees.

Surendra K. Gupta, PhD.
President
American Radiolabeled Chemicals, Inc.

# AMERICAN RADIOLABELED CHEMICALS

# RADIATION PROTECTION PROGRAM

**By: Regis A. Greenwood, CHP**
**Radiation Safety Officer**
**And**
**Kyle Gerard**
**Health Physicist**
**24 July 2010**

**Reviewed by Radiation Safety Committee**
**27 July 2010**

**Accepted by NRC**

**31 October2010**

**American Radiolabeled Chemicals**
**101 ARC Drive**
**St. Louis, MO 63146**

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SECTION 1.

# 1. RADIATION PROTECTION PROGRAM

## 1.1 Scope

The program, under the administration of the Radiation Safety Officer, is the primary means by which up-to-date standards or practices for radiation protection are defined and enforced.

An Authorized User (AU) is a person whose training and experience have been reviewed and approved by NRC, who is named on the license, and who uses or supervises the use of licensed material.

The AU's primary responsibility is to ensure that radioactive materials used in his or her particular lab or area is used safely and according to regulatory requirements The AU is also responsible to ensure that procedures and engineering controls are used to keep occupational doses and doses to members of the public ALARA.

Except where a definite procedure or technique is mandated by a specific regulation, this program specifies the application of those methods of radiation measurement or control that are best available for a given situation. In no instances does the program specify standards which are less stringent than the minimum standards for radiation control set forth by the U. S. Nuclear Regulatory Commission in Title 10, Code of Federal Regulations.

Selected parts of the regulations contained in 10 CFR Parts 19, 20 and 30 through 35 are paraphrased in Section 4.1 for brevity and ease of understanding. Section 4.1 is not meant to replace these regulations.

This program is the basic guide for all ARC personnel and contractors involved in the handling and use of licensed materials. A detailed description of the program comprises Sections 2 through 8.

It is hereby affirmed that ARC Officers, Management and the ARC Radiation Safety Committee are committed to the best possible Radiation Protection Program and to maintaining doses to ARC Personnel and the Public ALARA.

SECTION 2.

## 2. DEFINITIONS AND ACRONYMS

### 2.1 Definitions

(a) Unrestricted area - Unrestricted Areas are those which are not controlled or restricted in any manner by ARC. Example: Building 400, Building 400 parking areas, Building 400 Landscape areas, and ARC Drive.

(b) Restricted area - any area access to which is controlled for radiation protection purposes. These areas will be managed in accordance with the requirements and limitations of the License.

The entrances to these areas are posted with signs - such as**, but not limited to**:

RESTRICTED AREA;
RADIOACTIVE MATERIAL AREA;
CONTAMINATED AREA
AUTHORIZED PERSONNEL OR ESCORTED VISITORS ONLY.
AUTHORIZED PERSONNEL OR ESCORTED GUESTS ONLY

Restricted Areas are further sub-divided into:

(1) High Contamination Areas (HCA)
Areas such as, but not limited to, inside fume hoods, inside bench top trays, inside the compactor enclosure; other areas as designated by the RSO

(2) Contamination Areas (CA)
Areas inside the laboratories not listed as High contamination areas.

(3) Non contaminated areas.

(4) Radioactive Material Areas (RMA)

(c) Controlled area – Controlled area - any area, outside of restricted areas and within the site boundaries, access to which can be limited for any reason.

Offices and lunchrooms in the laboratory buildings, and areas of the property between and around the laboratorybuildings are examples of controlled areas.

These areas will be managed in accordance with the requirements and limitations of the License.

(d) Shall, must - these words denote a requirement

(e) Should, may - these words are used to denote a recommendation or permission

(f) Committee - the ARC Radiation Safety Committee

(g) Commission - The Nuclear Regulatory Commission or its representatives

(h) Finding - the discovery of an item of non-compliance with any applicable NRC or other Federal, State and local regulations or the conditions and provisions, including those incorporated by reference, of the ARC license.

(i) Observation - an observation is not an item of noncompliance but is a suggestion which may improve the quality of the radiation protection program.

(j) Authorized User - An Authorized User (AU) is a person whose training and experience have been reviewed and approved by NRC, who is named on the license, and who uses or directly supervises the use of, licensed material.

(k) Unfinished Form - An item is in finished form when it has been packaged for shipping and all applicable DOT labels have been affixed, that is, the item is ready for presentation to the carrier. Prior to this state, the radio nuclide is in unfinished form

2.2 Acronyms

(a) ALARA - As Low As Reasonably Achievable

(b) ALI - Annual Limit on Uptake

(c) ARC - American Radiolabeled Chemicals

(d) AU – Authorized User

(e) CDE – Committed Dose Equivalent

(f) CEDE - Committed Effective Dose Equivalent

(g) CFR - Code of Federal Regulations

(i) DAC - Derived Air Concentrations

(j) DOT - Department of Transportation

(k) DDE - Deep Dose Equivalent

(l) LDE – Lens Dose Equivalent (Same as Eye Dose Equivalent

(m) NRC - Nuclear Regulatory Commission

(n) RAM - Radioactive Materials

(o) RPP - Radiation Protection Program
(p) RSC - Radiation Safety Committee
(q) RSO - Radiation Safety Officer
(r) SDE – Shallow Dose Equivalent
(s) TEDE - Total effective dose equivalent
(t) TODE – Total Organ Dose Equivalent

SECTION 3.

# 3. RADIATION PROTECTION ORGANIZATION

## 3.1 President

### 3.1.1 Responsibility

The President is responsible for maintaining a Radiation Safety Committee and for hiring and retaining a fully qualified Radiation Safety Officer.

### 3.1.2 Duties

3.1.2.1 The President is responsible for establishing and retaining a well supervised Radiation Protection Organization which is approved by the NRC and which has well defined responsibilities.

3.1.2.2 The President is responsible for selecting, and submitting for approval to the NRC, those individuals who will be Authorized Users under the provisions of the ARC By-product Material License

## 3.2 Radiation Safety Committee

### 3.2.1 Function

The Radiation Safety Committee advises the President and the RSO on: (a) methods to control the procurement, use and disposition of radioactive materials; and, (b). proposed amendments to the License.

### 3.2.2 Composition

The Committee is composed of a Chairman, the Radiation Safety Officer (Vice Chair of the Committee), all of the Authorized Users, and a member from outside the Company who is trained and experienced in the safe use of By-product material. This individual should, at a minimum, be experienced in the administration of a large radiation safety program. A quorum consists of half of the membership (or a simple majority if there are an odd number of members) one of whom must be the Chairman and one of whom must be the RSO.

3.2.3 Responsibility

The Radiation Safety Committee is responsible for advising the President and the RSO on means of complying with applicable NRC, DOT, and other Federal, State, and local regulations.

The Radiation Safety Committee is administratively responsible to the President.

3.2.4 Duties

3.2.4.1 Evaluations of New Uses of RAM

The Radiation Safety Committee makes safety evaluations of proposed new uses of radioactive materials prior to submission to the NRC. The safety evaluations are documented and incorporated into the minutes of the meeting. Safety evaluations include the following considerations.

(a) The experience and qualifications of the individuals who will use the RAM

(b) The adequacy of the facilities including the containment systems and apparatus

(c) The methodology to be used

(d) The quantity of radioactivity to be used

(e) The chemical and physical form of the RAM

(f) The decay scheme and half-life of the radionuclide

(g) The biological fate of the radionuclide in the body

(h) After review by the RSC, a license amendment request will be prepared and submitted to the Commission. The new use shall not take effect until the amendment is issued by the NRC.

3.2.4.2 Evaluations of Written Protocols for Syntheses

The Committee reviews protocols for the syntheses of radiochemicals and related operations involving the handling of licensed material. The protocols and protocol reviews are incorporated into the minutes of the RSC.

Radiation and other safety considerations, as listed above, should be the basis for the evaluations.

After review by the RSC, a license amendment request will be prepared and submitted to the Commission. The new protocol shall not take effect until the amendment is issued by the NRC.

3.2.4.3 Evaluations of Facilities Modifications and Decommissioning Activities

The Committee reviews proposed modifications to existing facilities, engineering plans for new facilities, and any decommissioning activities prior to submission to the NRC

After review by the RSC, a license amendment request will be prepared and submitted to the Commission. The new modification shall not take effect until the amendment is issued by the NRC.

3.2.4.4 Evaluations of RPP and SOP Modifications

The RSC reviews modifications of the Radiation Protection Program and Standard Operating Procedures prior to submission to the NRC.

After review by the RSC, a license amendment request will be prepared and submitted to the Commission. The new revision shall not take effect until the amendment is issued by the NRC.

3.2.4.5 Personnel Classifications

Authorized User

An AU is a person whose training and experience have been reviewed and approved by NRC, who is named on the license, and who uses or supervises the use of licensed material.

After review by the RSC, a license amendment request will be prepared and submitted to the Commission. The individual shall not be considered an Authorized User until the amendment is issued by the NRC.

The AU's primary responsibility is to ensure that radioactive material used in his or her particular lab or area is used safely and according to regulatory requirements The AU is also responsible to ensure that procedures and engineering controls are used to keep occupational doses and doses to members of the public ALARA.

Workers

(a) Class 1 - Those individuals who may use, under the direction of an Authorized User radioactive materials within their area of responsibility. Direction by an AU does not require the physical presence of the AU, but responsibility remains with the AU.

(b) Class 2 - Those individuals who may use radioactive materials within their area of responsibility only under direct supervision by an AU, or by a Class 1 worker. This supervision requires the physical presence, on site, of the supervising individual.

The Committee may advise the upgrading of an individual from Class 2 to Class 1 under the following conditions:

a) The individual has been recommended for upgrade by the AU who has provided supervision.

b) The individual has demonstrated good radiation safety technique.

c) The individual has demonstrated good handling technique with RAM.

d) The individual has satisfactorily completed on-the-job training. The extent and content of the On the Job Training is at the discretion of the AU recommending upgrade.

3.2.4.6 Administrative Controls

The Committee advises in the establishment of a Radiation Protection Program by the Radiation Safety Officer to meet current Federal or State regulations. This program is then submitted to the NRC for approval and incorporation into the License

After review by the RSC, a license amendment request will be prepared and submitted to the Commission. The new use shall not take effect until the amendment is issued by the NRC.

3.2.4.7 Committee Guidelines and Goals

The RSC-recommends action levels, subject to NRC approval, to minimize the internal and external exposures of individuals in restricted areas and the release of RAM to unrestricted areas. These action levels, which may be more restrictive than applicable Federal or State regulations, are reviewed at least annually and reduced where possible to achieve the ALARA commitment.

3.2.4.8 Work Restrictions

The RSC or delegate shall restrict individuals from additional exposure when Committee action levels are reached. The RSC delegate is the Radiation Safety Officer.

The action levels may be temporarily modified by the RSC or delegate.

Under no circumstances however will any regulatory limit be exceeded.

3.2.4.9 Reports or Responses to the Commission

The Committee reviews and gathers information and data needed by the President to determine corrective actions to be taken for reports or responses to the NRC.

Determines the circumstances causing exposures or levels of radiation or concentrations which require a report to the Commission and any items of non-compliance noted during an inspection for determination of corrective actions.

Gathers information and data needed by the President to determine corrective actions to be taken for reports or responses to the NRC.

3.2.5 Meeting Frequency

A meeting of the Radiation Safety Committee is held at least quarterly and under any of the following circumstances:

(a) To fulfill the previously listed duties of the Committee

(b) Whenever any Committee member requests the Chairman or Vice Chairman to call a meeting at any time for any valid reason

3.2.6 ALARA Commitment

The Committee issues periodic advisory notices to make laboratory personnel aware of management's commitment to keep occupational exposures and exposures to other individuals within current ALARA guidelines.

3.2.7 Enforcement Actions

The Radiation Safety Committee has the authority and responsibility to enforce safe laboratory operation. Any operation which threatens the safety of ARC personnel, the Public, or the facility, is subject to curtailment.

Enforcement authority and responsibility is delegated to each member of the Radiation Safety Committee.

The Committee recommends disciplinary action when appropriate.

## 3.3 Radiation Safety Officer

### 3.3.1 Function

The Radiation Safety Officer is responsible for establishing and developing the overall Radiation Protection Program to meet applicable NRC, and other Federal, State and local regulations and the conditions and provisions of the ARC license. The Radiation Safety Officer administers and conducts the Radiation Safety Program

### 3.3.2 Responsibility

The Radiation Safety Officer report to the President and is-responsible administratively to the Radiation Safety Committee. If additional duties aside from what is listed in the RPP section 3.3.3 and 3.3.4 are added the NRC must be notified.

The RSO is on call by means of cell phone, or other similar means, 24/7 whether physically present on site or absent.

### 3.3.3 Administrative Duties

The Radiation Safety Officer is responsible for the administrative functions of the Radiation Protection Program. The NRC will be informed if new duties are added. The RSO:

3.3.3.1 Is the primary contact with NRC licensing and enforcement personnel.

3.3.3.2 Prepares and submits NRC license applications and amendments.

3.3.3.3 Prepares or modifies Standard Operating Procedures for submission to the NRC

3.3.3.4 Meets periodically with the Radiation Safety Committee (RSC) and production chemists to review doses received and radiation levels and concentrations.

3.3.3.5 Annually reviews, and submits updates for NRC approval, as necessary, the Radiation Protection Program to assure compliance with established

standards and procedures.

This review will be, whenever possible, accomplished by the use of a third party auditor. The minimum qualification for the auditor is Certification by the American Board of Health Physics and experience as RSO or RPM of a large license.

The lack of availability or difficulty in obtaining the services of an appropriate auditor does not remove the requirement for a review or audit.

If necessary, the review or audit may be carried out by the RSC or delegate using the format given in attachment A

3.3.3.6 Reviews radiation safety records periodically to assure compliance with the provisions of the Radiation Protection Program

3.3.3.7 Presents summary reports to the President specifying the primary sources of exposure to radiation or radioactive materials with possible recommendations for exposure reduction.

3.3.3.8 Makes safety evaluations of proposed new synthesis methods for presentation to the RSC, including modification of equipment and procedures.

New uses of RAM, rather than new methods of synthesis requires a license amendment, as does modification of the facility and/or new authorized users.

3.3.3.9 Gathers information and data needed by the President to determine corrective actions to be taken for reports or responses to the NRC.

3.3.3.10 Reviews and updates Decommissioning Funding Plan on a frequency set by applicable regulations and guides

3.3.4 Supervisory Duties

The RSO:

3.3.4.1 Conducts the Radiation Protection Program to maintain compliance with established standards and procedures.

3.3.4.2 Issues and enforces work restrictions when necessary.

3.3.4.3 Periodically reviews shipping documents to ensure compliance with DOT or IATA regulations.

3.3.4.4 Develops and conducts radiation safety indoctrination and training programs to ensure that personnel receive sufficient information for their respective jobs.

3.3.4.5 Observes production chemists and provides on-the-job radiation safety training.

3.3.4.6 Observes the shipping clerk(s) and provides on-the-job DOT and IATA training.

3.3.4.7 Performs radiation safety surveys in accordance with Standard Operating Procedures and reviews the results (bioassay data, air concentration data, etc.) to ensure compliance with NRC regulations.

3.3.4.8 Maintains records pertaining to the Radiation Protection Program.

3.3.4.9 Responds to all incidents involving RAM, on-site and off-site, as necessary to maintain regulatory compliance.

3.3.4.10 curtails any operation involving RAM, which threatens the safety of ARC personnel, the public, or the facility.

3.3.4.11 curtails and corrects any operation which is not in compliance with applicable NRC and other Federal, State and local regulations and the conditions and provisions of the ARC license.

3.3.5 Assistant RSO

ARC shall maintain the position of assistant RSO. This individual will act as the RSO during any absence of the RSO.

The qualifications and experience level of this individual are subject to review by the RSC.

As a minimum, the individual should have an associate degree (or equivalent) in Nuclear Technology.

The assistant shall act as the RSO during periods of vacation, ill health or similar occurrences.

The assistant shall have the ability to consult with the RSO during this period. The RSO is available by cell phone on a 24/7 basis.

The assistant shall, in the absence of the RSO, have stop work authority for occurrences such as, but not limited to, unplanned releases and /or spills of licensed material

3.3.6 Alternate RSO

When the RSO is not available for reasons such as illness or vacation, and the assistant RSO is also not available, then the Radiation Safety Committee Chair shall function as the Alternate RSO. Routine radiation safety duties will be performed by an individual trained by the RSO.

3.3.6 Outside Health Physics Consultants

The Radiation Safety Officer may utilize outside consultants to perform, or assist in performance of, any of the listed duties. The responsibility remains with the RSO.

SECTION 4.

# 4. ARC STANDARDS

## 4.1 Regulatory Standards

Except where a definite procedure or technique is mandated by a specific regulation, this program specifies the application of those methods of radiation measurement or control that are best available for a given situation. In no instances does the program specify standards which are less stringent than the minimum standards for radiation control set forth by the U. S. Nuclear Regulatory Commission in Title 10, Code of Federal Regulations.

Selected parts of the regulations contained in 10 CFR Parts 19, 20 and 30 through 35 are paraphrased in this Section for brevity and ease of understanding. Section 4.1 is not meant to replace these regulations.

### 4.1.1 Occupational dose limits

#### 4.1.1.1 Occupational Dose Limits for Adults

The annual dose to an adult is limited as follows:

(a) 5 rem - The total effective dose equivalent, TEDE, or

(b) 50 rem - The Total Organ Dose Equivalent, TODE, to the highest exposed organ or tissue

(c) 15 rem - eye dose equivalent, LDE, to the lens of the eye

(d) 50 rem - shallow dose equivalent, SDE, to the skin or to each of the extremities.

(e) Derived air concentrations (DAC) and annual limits on intake (ALI) may be used to determine the individual's dose and to determine compliance with occupational dose limits.

f) The dose an individual may receive in the current year must be reduced by the amount received in the current year while employed by any other person.

#### 4.1.1.2 Determination of internal exposure.

For the purpose of assessing dose, any one or more of the following measurements may be used.

(a) Measurement of air concentrations

(b) *In vivo* bioassay measurements

(c) *In vitro* bioassay measurements

4.1.1.3 Occupational dose limits for minors

The annual occupational dose limits for minors are 10% of the annual occupational dose limits for adults.

4.1.1.4 Dose to an embryo/fetus

The exposure of a declared pregnant woman shall be controlled such that the dose to the embryo/fetus shall not exceed 500 mrem.

4.1.2 Radiation Dose Limits for Individual Members of the Public

4.1.2.1 Dose limits for individual members of the public

(a) The TEDE limit for members of the public is 100 mrem in a year, not more than 50 mrem of this from airborne effluents.

(b) The external dose limit in unrestricted or controlled areas is 2 mrem/hour

4.1.2.2 Compliance with dose limits for individual members of the public

(a) Appropriate surveys shall be made to demonstrate that individual members of the public do not receive more than 100 mrem in a year.

(b) Compliance shall be demonstrated by measurement or calculation that

(1) The TEDE does not exceed 100 mrem/year, or

(2) The annual average air and water effluent concentrations do not exceed the limits in Table 2 of Appendix B, and that an individual would not receive more than 2 mrem in an hour and 50 mrem in a year if the individual were continuously present in an unrestricted area.

4.1.3 Surveys and Monitoring

4.1.3.1 General

(a) Surveys shall be made as necessary to -

(1) Comply with regulations and

(2) are reasonable to evaluate radiation levels, concentrations or quantities of RAM, and radiological hazards.

(b) Instrumentation and equipment used for quantitative measuring radiation or contamination shall be calibrated periodically.

4.1.3.2 Conditions requiring individual monitoring of external and internal occupational dose.

Occupational exposures to radiation and radioactive materials shall be monitored to demonstrate compliance with regulations. As a minimum -

(a) Dosimeters shall be provided and used for the following individuals:

(1) Adults likely to receive an external dose >500 mrem in 1 year

(2) Minors and declared pregnant women likely to receive an external dose >50 mrem in 1 year

(b) Bioassays shall be performed and analyzed for the following individuals:

1) Adults likely to receive an internal dose >500 mrem in 1 year

(2) Minors and declared pregnant women likely to receive an internal dose >50 mrem in 1 year

4.1.4 Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas

4.1.4.1 Use of process or other engineering controls
Process or other engineering controls shall be used to control air concentrations of RAM.

4.1.4.2 Use of other controls

When it is not practicable to use process or other engineering controls in airborne radioactivity areas, monitoring should be increased and intakes limited by one or more of the following

(a) Control of access

(b) Limitation of exposure times

(c) Use of respiratory equipment (not applicable)

(d) Other controls

4.1.5 Precautionary Procedures

4.1.5.1 Caution signs

The prescribed three-bladed radiation symbol shall use magenta, purple, or black on a yellow background.

4.1.5.2 Posting requirements

(a) Posting of radiation areas

Each radiation area shall be posted with a sign bearing the radiation symbol and the following words

CAUTION RADIATION AREA

(b) Posting of airborne radioactivity areas

Each airborne radioactivity area shall be posted with a sign bearing the radiation symbol and the following words

CAUTION (OR DANGER) AIRBORNE RADIOACTIVITY AREA

4.1.5.3 Labeling containers

(a) Each container of RAM bears a label with the radiation symbol and the following words

CAUTION RADIOACTIVE MATERIALS

These labels shall have sufficient additional information to permit individuals who are working with or around the RAM to take precautions to minimize exposures (e.g. radionuclide, activity.

(b) Radioactive materials labels shall be removed or defaced prior to disposal of uncontaminated containers to an unrestricted area.

4.1.5.4 Exemptions to labeling requirements

RAM labels are not required on containers providing -

(a) The activity is less than the quantity listed in Appendix C, and

The concentration is less than the quantity listed in Table 3, Appendix B. Or

(b) The containers are packaged and labeled in compliance with the DOT regulations.

4.1.5.5 Procedures for receiving and opening packages

(a) Radiation level and contamination surveys shall be performed on RAM packages if the package -

(1) Is labeled with DOT or IATA RAM labels

(2) Is crushed, wet or damaged

(b) The above surveys shall be performed as soon as practicable within 3 hours after delivery during normal working hours and within 3 hours from the start of the next working day if delivered after normal working hours.

(c) The final delivering carrier and the NRC RIII office shall be notified immediately when-

(1) Contamination levels exceed 6,600 dpm/300 $cm^2$, or

(2) The TI exceeds 10; or when the surface exceeds 200 mR/hr.

4.1.6 Waste Disposal

4.1.61 General requirements

RAM shall be disposed of only -

(a) By transfer to an authorized recipient, or

(b) By decay in storage, or

(c) By release in airborne effluents within limits for the public, or

(d) As authorized for release into sanitary sewerage.

4.1.6.2 Disposal by release into sanitary sewerage

RAM may be discharged to the sanitary sewer providing-

(a) It is readily water soluble and

(b) The average monthly concentration does not exceed limits

(c) When more than one radionuclide is present, the sum of the ratios of the concentration of each radionuclide divided by its respective Effluent Limit (EL) should be less than or equal to unity.

$$C_1/EL_1 + C_2/EL_2 + \ldots\ldots\ldots\ldots + C_n/EL_n <= 1$$

(d) The yearly total does not exceed the following

| | |
|---|---|
| Tritium | 5 Ci |
| Carbon-14 | 1 Ci |
| All others | 1 Ci |

4.1.6.3 Disposal of specific waste

The following RAM may be disposed of as if it were not radioactive:
0.05 microcurie of C-14 or H-3 per gram of scintillation media

4.1.6.4 Transfer for disposal and manifests

(a) Each shipment of radioactive waste shall be accompanied by a shipment manifest. (Section I, Appendix F, 10CFR20)

(b) Each shipment manifest shall include a certification by the waste generator. (Section II, Appendix F, 10CFR20)

(c) Anyone involved in the transfer shall comply with regulations. (Section III, Appendix F, 10CFR20)

4.1.6.5 Compliance with environmental and health protection regulations

Licensees must comply with all other regulations governing other toxic or hazardous properties of the radioactive waste.

4.1.7 Records

4.1.7.1 General Provisions

(a) The units curie, rad and rem (and multiples and subdivisions) shall be used and shown on records

(b) The quantities on records (TEDE, $H_D$, $H_{E,50}$, etc.,) shall be clearly indicated.

4.1.7.2 Records of radiation protection programs

(a) The following records of the radiation protection program shall be maintained.

(1) The provisions of the program

(2) Audits and other reviews of the program content

(b) The records in (1) above shall be retained indefinitely and the records in (2) above shall be retained for 3 years

4.1.7.3 Records of surveys

(a) Survey instrument calibration records shall be retained for 3 years

(b) The following records shall be retained until license termination

(1) Records of individual dose from external sources in lieu of or in combination with personnel monitoring records

(2) Records and calculations to determine intakes used in assessments of internal dose

(3) Records of air sampling, surveys, and bioassays

(4) Records of effluent release to the environment

4.1.7.4 Determination of prior occupational dose

(a) For individuals in restricted or controlled areas who are likely to receive 500 mrem per year, the licensee shall

(1) Determine the dose received during the current year

(2) Attempt to obtain lifetime cumulative occupational exposures

(b) For determining the dose received during the current year, the licensee may -

(1) Accept a signed statement by the individual or previous employer

(2) Accept a completed NRC-4 signed by the individual and employer

(3) Accept a report from the most recent previous employer of the dose equivalent by telephone, telegram, electronic media or letter.

(d) Exposure histories shall be recorded on form NRC-4

(e) Forms NRC-4 shall be retained until termination of the license. Records used to prepare the NRC-4 forms shall be retained for 3 years

4.1.7.5 Records of individual monitoring results

(a) Records shall be maintained for doses to individuals when required to be monitored and for accidents and emergency conditions. When applicable, the records shall include--

(1) The whole body deep-dose equivalent, eye-dose equivalent, shallow-dose equivalent to the skin, and the shallow-dose equivalent to the extremities.

(2) The intake or body burden of radionuclides

(3) The committed effective dose equivalent assigned to the intake or body burden of radionuclides

(4) The information used to calculate the committed dose equivalent.

(5) The TEDE when required

(6) The total of the deep-dose equivalent and the committed dose to the organ receiving the highest total dose.

(b) Records of dose to an embryo/fetus shall be kept with the dose to the declared pregnant woman. The declaration of pregnancy may be maintained with the dose records.

(c) Records shall be retained until termination of the license

4.1.7.6 Records of dose to individual members of the public

(a) Records shall be maintained to demonstrate compliance with the dose limit for individual members of the public.

(b) Records shall be retained until termination of the license

4.1.7.7 Records of waste disposal

(a) Records shall be maintained of the disposal of RAM.

(b) Records shall be retained until termination of the license

4.1.8 Reports

4.1.8.1 Records of theft or loss of licensed materials

(a) Telephone reports -

Report by telephone as follows:

Immediately after it is known, report lost, stolen or missing RAM 1000 times the quantity in appendix C if individuals in unrestricted areas could be exposed.

Within 30 days after it is known, report lost, stolen or missing RAM 10 times the quantity in appendix C

(b) Written reports -

(1) Within 30 days of required telephone reports, make written reports including the following information:

A description of the RAM
A description of the circumstances
A statement of the disposition of the RAM
Exposures to individuals in unrestricted areas
Actions taken or planned to recover the RAM
Actions taken to prevent a recurrence

(2) Make reports to the Administrator, USNRC Region III

4.1.8.2 Notification of incidents

(1) Exposures to individuals

A TEDE >= 5 rem
An eye dose equivalent >= 15 rem
A shallow-dose equivalent to the skin or extremities >= 50 rem

(2) Airborne concentrations of RAM which would result in 1 ALI had an individual been present for 24 hours.

(c) State the names of individuals who were exposed on a separate page.

(d) Make reports as follows:

(1) Telephone reports - NRC Operations Center

(2) FAX reports - Administrator, USNRC Region III

4.1.8.3 Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the limits

In accordance with 10CFR20

4.2 ARC Guidelines and Goals

In order to maintain doses to ARC personnel below regulatory limits, and as a major component of ARC's commitment to the ALARA principle, guidelines and goals have been set at levels substantially below those in 10CFR20.

4.2.1 Dose Levels and Concentrations

The goal for yearly TEDE or CEDE for an individual is established by the-RSC and reviewed during periodic meetings of the RSC. Should an individual's annual dose reach or exceed this level, the individual is restricted from work which would result in additional dose. The individual may petition the RSC for relief from the restriction. Depending upon the circumstances, the RSC may or may not lift the restriction.

As actions are taken to improve operational procedures, facilities, and equipment, the dose goal will be reduced accordingly. The purpose of establishing a dose goal is twofold:

(a) To prevent an individual from exceeding regulatory limits

(b) To minimize the dose to an individual to achieve the Company ALARA commitment

4.2.2 At present the annual goal for TEDE is 1250 mrem.

4.2.1.1 Requirements for Limiting External Exposures of Individuals

At present, the nuclide mix licensed for ARC use does not cause measurable external dose.

4.2.1.2 Exposure of Individuals to Concentrations of Radioactive Material in Restricted Areas

The maintenance of TEDE at or below the 1250 mrem mark is positive evidence that DACs and ALIs are being maintained below 25 % of the regulatory limits.

(a) The ALIs and yearly DAC-hrs should be controlled to the extent practicable to 25 percent of the regulatory limits. THESE LIMITS ARE LISTED BELOW

Nuclides Chemically Processed at ARC

| | | *Inhalation* | *Ingestion* | | |
|---|---|---|---|---|---|
| **Radionuclide** | **Class** | **ALI uCi** | **ALI uCi** | **DAC uCi/ml** | |
| **$^{3}H$** | **Water** | **8E+4** | **8E+4** | **2E-5** | |
| | **Gas** | **8E+4** | **8E+4** | **2E-5** | |
| **$^{14}C$** | | **monoxide** | **NA** | **2E+6** | **7E-4** |
| | **dioxide** | **NA** | **2E+5** | **9E-5** | |
| | **compounds** | **2E+3** | **2E+3** | **1E-6** | |
| **$^{32}P$** | **D, all compounds except phosphates given for W** | **6E+2** | **9E+2** | **4E-7** | |
| | **W, phosphates (see list)** | **NA** | **4E+2** | **2E-7** | |
| **$^{35}S$** | | **Vapor** | **NA** | **1E+4** | **6E-6** |
| | **D, sulfides and sulfates except those given for W** | **1E+4** | **2E+4** | **7E-6** | |
| | **W, elemental sulfur** | **6E+3** | | | |
| | **W, sulfides and sulfates** | **NA** | **2E+3** | **9E-7** | |
| **$^{125}I$** | **D, all compounds** | **4E+1 thyroid** | **6E+1 thyroid** | **3E-8** | |
| | | **(1E+2)** | **2E+2** | | |

$$H_D/5 + I_1/ALI_1 + I_2/ALI_2 + \ldots\ldots + I_n/ALI_n <= 0.25, \text{ or}$$

$$H_D/5 + (DAC_1\text{-hrs} + DAC_2\text{-hrs} + \quad + DAC_n\text{-hrs})/\ 2000 <= 0.25$$

(b) Air sampling is conducted continuously, with sample change approximately weekly

4.2.1.3 Radioactivity in Effluents to Unrestricted Areas

(a) The yearly average airborne concentrations of RAM at the unrestricted area boundary should be controlled as far below the following limits as practicable.

| Radionuclide | Class | DAC uCi/ml |
|---|---|---|
| $^{14}C$ | monoxide | 2E-6 |
| | dioxide | 3E-7 |
| | compounds | 3E-9 |
| $^{3}H$ | Water | 1E-7 |
| | Gas | 1E-7 |
| $^{32}P$ | D, all compounds except phosphates given for W | 1E-9 |
| | W, phosphates (see list) | 5E-10 |
| $^{35}S$ | Vapor | 2E-8 |
| | D, sulfides and sulfates except those given for W | 2E-8 |
| | W, sulfides and sulfates | 3E-9 |
| $^{125}I$ | D, all compounds | 3E-10 |

$$C_1/DAC_1 + C_2/DAC_2 + \ldots\ldots\ldots\ldots + C_n/DAC_n << = 1$$

(b) Air sampling is conducted continuously, with sample change approximately weekly

4.2.1.4 Internal Exposures of Individuals to RAM

(a) The maximum permissible average yearly critical organ burdens of an individual, based upon a chronic uptake model, to preclude exceeding the ALI are as follows:

| Radionuclide | Critical Organ | Microcuries |
|---|---|---|
| $^{14}C$ | Total body | 400 |
| $^{3}H$ | Total body | 3400 |
| $^{32}P$ | Total body | 30 |
| $^{35}S$ | Total body | 400 |
| $^{125}I$ | Thyroid | 3 |

(b) The frequency for recorded bioassay analyses is weekly

(c) Bioassays are required for those individuals who are likely to receive a committed effective dose equivalent of 500 mrem/year or a committed dose equivalent to the thyroid of 5 rem/year. This includes all individuals who work in restricted areas and who process or handle the above radionuclides in unfinished forms.

(d) An item is in finished form when it has been packaged for shipping and all applicable DOT labels have been affixed, that is, the item is ready for presentation to the carrier.

Prior to this state, the radionuclide is in unfinished form

4.2.1.5 Permissible Levels of Surface Contamination

Any surface which has readily removable contamination in excess of permissible levels shall be decontaminated until reduced below the applicable levels.

4.2.1.6 ACTION LEVEL

At this level, areas and equipment are decontaminated at the next practical time if contamination is above the following levels.

NOTE:

For Contaminated Restricted Areas, this would be at the time of weekend cleaning.

For all others, decontamination will take place immediately, if possible, but not more than 24 hours shall elapse

Access to the area or item will be restricted during the cleaning. If the area or item cannot be cleaned immediately, it shall be posted commensurate with the level of contamination.

(a) Contaminated Restricted Areas

Tritium – 50,000 dpm/100 $cm^2$
Carbon-14 – 10,000 dpm/100 $cm^2$
Other $\beta$–$\gamma$ - 10,000 dpm/100 $cm^2$

(b) Non contaminated Restricted Areas and Controlled Areas

Total- 5,000 dpm/100 $cm^2$ average, not to exceed 10,000 for a single point , of which the Removable component is less than 1000 dpm/100 $cm^2$ total

Goal – less than 1000 dpm/100 $cm^2$ total

(c) Unrestricted Areas

Total- 1000 dpm/100 $cm^2$ average, not to exceed 5,000 for a single point, of which the removable component is less than 500 dpm/100 $cm^2$

Goal – 100 dpm/100 $cm^2$ each, fixed and removable

4.2.1.6 INVESTIGATIVE LEVEL

At this level, areas and equipment are decontaminated immediately upon discovery if contamination is above the following levels.

(a) If initial contamination levels exceed 10 times the action levels, attempt to determine the source and cause.

(b) Document the results of the investigation and file the report in the Off-normal Occurrence File.

(c) Decontaminate the area or equipment immediately.

4.2.1.7 STOP WORK LEVEL

This is the upper limit for contamination in ARC facilities. If any Investigation Level listed above is exceeded by a factor of 200, (NOTE: This is 2000 times the Action Level) all work in that lab building will stop until

(a) The extent and cause of the contamination has been determined

(b) All individuals have been shown to be non-contaminated

(c) The contamination levels have been reduced to below the investigative level,

(d) And the RSO has given permission to resume work

4.2.2 Precautionary Procedures

4.2.2.1 Requirements for Protective Outer Garments

(a) Lab Coat – required for entering CAs

(b) Safety glasses – required for entering CAs

(c) Disposable gloves – required for entering CAs

(d) Lab shoes – required for all work in CAs; see (i) and (j) below.

(e) Rubber shoe covers – required for all work in CAs

(f) Aprons – worn under lab coats whenever brushing against, or leaning on benches or hood ledges is likely to occur.

(g) Sleeve Protectors – worn whenever reaching into HCAs is likely.

(h) Trouser protectors – worn in laboratories when seated work is likely.

(i) Cloth Booties – worn only for inspections and tours. The floor (or other walking surface) must be dry.

(j) Tyvek or vinyl booties – worn only for inspections or tours.

(k) Rubber or nitrile gloves – worn when high specific activity work is done, or when (in the judgment of the AU), they are required by the chemical hazard.

4.2.2.2 Requirements for Limiting Internal Exposures of Individuals

An individual shall be restricted from further exposure to any radionuclide or radionuclides if it is determined by *in vitro* or *in vivo* bioassay measurements that the individual has received a significant committed effective dose equivalent, or significant committed dose equivalent to the thyroid. The action levels are as follows:

(a) For an annual committed effective dose equivalent of 5 Rem

(1) Acute exposures – Short-term (abrupt increase in exposure)

>100 mrem in a week – (100% AL) the individual is restricted from further work with radio nuclides which could result in an additional uptake. This weekly dose rate is the sum of the dose rates for each radionuclide identified.

The individual shall remain restricted until two consecutive samples are below 100 mrem or a single sample falls below 50 mrem in a week (50% AL). See section 3.2.4.8 above.

The RSO shall attempt to determine the cause of the uptake and to propose corrective actions to minimize a recurrence.

(2) Chronic exposures – Long-term (relatively steady exposure)

>50 mrem/week – (50% AL) the individual is restricted from any area within which air concentrations in excess of 20 DAC-hrs/week for the applicable radionuclide. See section 3.2.4.8 above.

The RSO shall attempt to determine the cause of the uptake and to propose corrective actions to minimize a recurrence.

(3) Annual exposures – Chronic or acute (yearly mrem)

>1,250 mrem/year – the RSC reviews summary reports for the internal exposures of each individual and identifies the primary sources of exposure in order to take corrective action to reduce exposures.

(b) For an annual committed dose equivalent of 50 rem to the thyroid

(1) Acute exposures – Short-term (abrupt increase in thyroid burden)

>1000 mrem/week to the thyroid--the individual is restricted from further work with $^{125}I$ .

Daily samples shall be taken to determine the $T_{bio}$ until the dose rate falls below 250 mrem/week.

The individual shall remain restricted until the dose rate falls below 250 mrem/week.

The RSO shall attempt to determine the cause of the uptake and to propose corrective actions to minimize a recurrence.

(2) Chronic exposures – Long-term (relatively steady exposure)

>500 mrem/week to the thyroid – the individual is restricted from any area within which air concentrations in excess of 20 DAC-hrs/week for $^{125}I$

The RSO shall attempt to determine the cause of the uptake and to propose corrective actions to minimize a recurrence.

(3) Annual exposures – Chronic or acute (yearly mrem)

>12,500 mrem/year – the RSC reviews reports summarizing the thyroid exposures of each individual and identifies the primary sources of exposure in order to take corrective action to reduce exposures.

(c) The frequency for recorded bioassay analyses is weekly

4.2.2.3 Requirements for Assignment and Wearing of TLDs

All individuals with the potential to receive Deep Dose Equivalent in excess of 500 mrem in a year shall be issued, and wear, TLD (or approved equivalent) dosimetry devices.

(a) Individuals processing $^{32}P$ compounds shall be assigned and wear TLD (or approved equivalent) body and extremity badges

(b) Individuals subdividing and / or repackaging purchased quantities of $^{32}P$ compounds are not likely to exceed the guideline listed above.

(c) The normal TLD wearing frequency is quarterly

4.2.3 Precautionary Signs and Labels

In addition to the signs, labels and marks required by 10CFR20, ARC will use signs in the standard radiation warning colors to denote various levels of contamination and associated protective equipment.

4.2.4 Records Reports and Notifications

As required by 10CFR19 and 20

SECTION 5

# 5. GOOD RADIATION PROTECTION PRACTICES

## 5.1 Preface

The degree of success of the Radiation Protection Program is dependent upon the cooperation of individuals under its guidance. The following radiation protection practices are a basis for radiation safety in daily operations for all individuals at all levels of responsibility.

## 5.2 Practices in Contaminated Areas

### 5.2.1 Personal habits

5.2.1.1 Individuals should be conscious of and avoid such habits as biting their fingernails, or placing objects in their mouth such as pens or eyeglass temples.

5.2.1.2 The application of cosmetics is prohibited in contaminated areas.

5.2.1.3 Mouth pipetting is prohibited

5.2.1.4 Habits such as nose rubbing and head scratching should be curbed

### 5.2.2 Precautions

5.2.4.1 Eating and drinking is permitted only in office and lunchroom areas.

5.2.2.2 All individuals shall report any break in the skin such as a cut or abrasion to the RSO for appropriate action.

5.2.2.3 Individuals shall wash their hands upon exiting the laboratory

### 5.2.3 Personal Contamination Surveys

Any contamination detectable above background indicates excessive loose contamination and shall be reported to the RSO.

5.2.3.1 Individuals shall survey their hands every time they exit the laboratory. At the end of the workday a full body frisk with the survey meter is required.

5.2.3.2 Individuals shall survey items being taken from the laboratory to prevent the transfer of contamination to non-Contaminated areas.

### 5.2.4 Personnel Dosimetry (if issued).

5.2.4.1 Individuals shall wear assigned TLDs in the laboratory restricted area.

5.2.4.2 TLDs shall be stored in a low background controlled area along with a control badge at the end of the workday.

5.2.5 Protective Clothing

5.2.5.1 Lab Coat – required for entering CAs

5.2.5.2 Safety glasses – required for entering CAs

5.2.5.3 Disposable gloves – required for entering CAs

5.2.5.4 Lab shoes – required for all work in CAs; see 5.2.5.9 and 5.2.5.10 below.

5.2.5.5 Rubber shoe covers – required for all work in CA

5.2.5.6 Aprons – worn under lab coats whenever brushing against, or leaning on benches or hood ledges is likely to occur.

5.2.5.7 Sleeve Protectors – worn whenever reaching into HCAs is likely.

5.2.5.8 Trouser protectors – worn in laboratories when seated work is likely.

5.2.5.9 Cloth Booties – worn only for inspections and tours. The floor (or other walking surface) must be dry.

5.2.52.10 Tyvek or vinyl booties – worn only for inspections or tours.

5.2.5.11 Rubber or nitrile gloves – worn when high specific activity work is done, or when (in the judgment of the AU), they are required by the chemical hazard.

5.2.6 Work Area Surveys

Individuals shall be aware of locations where RAM is processed and of the applicable radiation and contamination levels in their working area.

5.2.7 Handling RAM

5.2.7.1 Operations involving volatile forms of RAM shall be performed in ventilated enclosures under negative pressure.

5.2.7.2 Work with RAM shall be performed on a laboratory work surface covered with a disposable material to prevent contamination of the surface.

5.2.7.3 Work with high energy beta emitters shall be performed behind beta shields provided for this purpose.

5.2.7.4 RAM being transferred between buildings must be packaged in a suitable secondary containment system provided for this purpose. A glass bottle inside a sealed Ziploc-type bag inside a Tupperware-type container is considered to be a suitable system. Any other systems must be approved by the RSO.

5.2.7.5 Containers of RAM in liquid form must be sealed or stoppered before they are removed from a fume hood.

5.2.7.6 RAM in liquid form shall not be handled in a fume hood while sitting down.

5.2.7.7 Finished inventory items must be transported in a secondary container.

5.2.7.8 Round-bottomed flasks and other containers must be in a secondary container while being moved from location to location.

5.2.8 Radioactive Waste Handling

Radioactive waste must be handled carefully to prevent elevated air concentrations or contamination levels.

5.2.8.1 Non-aqueous radioactive liquid waste is transferred to containers stored in ventilated enclosures and is solidified by evaporation.

5.2.8.2) After assay, aqueous radioactive liquid waste is transferred to the sanitary sewer system.

5.2.8.3 Dry solid waste is transferred to waste containers for that purpose.

5.2.9 Accidents

5.2.9.1 Any puncture or cut of the skin by a sharp object potentially contaminated with RAM shall be washed thoroughly and reported to the RSO immediately.

5.2.9.2 If a spill occurs, follow the instructions posted throughout the laboratories.

**SPILLS**

**<u>WHAT THE CHEMIST MUST DO IN CASE OF A SPILL</u>**

**COVER THE SPILL WITH AN ABSORBENT (I.E. PAPER TOWELS).**

**INFORM COWORKERS AND THE RSO THAT A SPILL OCCURRED.**

**KEEP COWORKERS AWAY FROM THE SPILL AREA.**

**REMAIN IN THE AREA UNTIL THE RSO ARRIVES.**

**PROVIDE THE RSO ALL RELEVANT INFORMATION.**

**DO NOT LEAVE THE FACILITY UNTIL RELEASED BY THE RSO.**

**WHAT THE RSO MUST DO IN CASE OF A SPILL**

**SURVEY THE CHEMIST'S PROTECTIVE CLOTHING, PERSONAL CLOTHING, AND EXPOSED SKIN AREAS.**

**REMOVE ANY CONTAMINATED CLOTHING AND DECON ANY CONTAMINATED SKIN AREAS.**

**IF NECESSARY, USE THE BUILDING 300 SHOWER. PROVIDE SOAP, HAND BRUSH, SHAMPOO, TOWELS, BOOTIES & JUMPSUIT.**

**SUPERVISE THE WORKERS INVOLVED IN DECON.**

**SURVEY THE AREA FOR RESIDUAL CONTAMINATION.**

**EVALUATE THE SKIN DOSE IF STILL CONTAMINATED.**

**RECORD THE EVENTS AND THE SURVEY RESULTS.**

# 6. RADIATION SAFETY TRAINING

## 6.1 Requirement

All new individuals shall receive a radiation safety indoctrination before beginning work with RAM. All individuals who use or supervise the use of RAM shall attend a training session specific to their duties and responsibilities, as outlined below. They are issued a copy of the Radiation Protection Program. The extent of training is dependent upon their experience and training with RAM and their educational background. An example would be an individual coming from a background in radiation safety could elect to not take the basic radiation safety portion of the training as well as the meter test since he/she is already familiar with principals like ALARA and time distance and shielding as well as reading a GM counter. In this case the individual would only need to participate in the site specific training involving ARC procedures. Another example would be a new maintenance employee with no radiation safety background. This individual would need to participate in all of our training including but not limited to basic radiation safety, GM meter test, and site specific training. These sessions shall be augmented by on-the-job training.

## 6.2 Formal Training Sessions

6.2.1 Training shall be provided by the Radiation Safety Officer.

6.2.2 The individuals attending formal training sessions shall be given written or oral examinations to determine their competency level. An oral exam consists of asking the questions from a written exam aloud if it makes the testing process easier on the individual in training. The passing rate for oral and written exams is 70%. The results of the exams shall be maintained for review.

6.2.3 Individuals will be tested at least every year on their understanding of how radiation protection relates to their jobs.

6.2.4 Radiation workers are provided a review of radiation protection once every year

## 6.3 On-the-job Training

On-the-job training is provided by the **RSO,** Assistant RSO, Authorized User or by designated personnel as determined by need. This applies to new radiation workers and to experienced workers on new job assignments or who may have received an unusual internal or external exposure.

## 6.4 Training Outline

### 6.4.1 Ionizing Radiation

6.4.1.1 Beta, gamma, and x-ray

6.4.1.2 Interaction with matter

6.4.2 Units of Measure

6.4.3.1 Curie, millicurie, microcurie

6.4.3.2 Concentration

6.4.3.3 Specific activity

6.4.3 Personnel Exposure

6.4.3.1 External Exposure

(a) TLDs

(b) Regulatory limits, Company goals

6.4.3.2 Internal Exposure

(a) Whole body, critical organ

(b) Uptake measurements, urinalyses

(c) Regulatory limits, Company goals

6.4.4 Protection Against Radiation

6.4.4.1 External Exposure

(a) Time - dose rate

(b) Distance - inverse square law

(c) Shielding - half value layers

6.4.4.2 Internal Exposure

(a) Ventilated enclosures

(b) Lab coats, gloves, shoe covers

6.4.4.3 Monitoring and surveys

(a) Loose contamination levels

(b) Personal contamination levels

(c) Airborne radioactivity levels

(d) Survey meters, radiation monitors

(e) Fixed contamination levels.

6.5 Additional Training Subjects

6.5.1 The ARC Radiation Protection Program

6.5.2 Form NRC-3, "Notice to Employees"

6.5.3 Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Exposures As Low As is Reasonably Achievable"

6.5.4 Regulatory Guide 8.13, "Instruction Concerning Prenatal Exposure"

6.5.5 Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Exposure"

6.5.6 10 CFR 19, "Notices, Instructions and Reports to Workers; Inspections"

6.5.7 10 CFR 20, "Standards for Protection Against Radiation"

6.5.8 Location in restricted areas where RAM are handled or stored.

6.5.9 Employee responsibility to report unsafe conditions.

6.5.10 Responses to emergency situations involving RAM.

6.5.11 Employee rights to access of personal exposure reports

6.5.12 Location and availability of notices, copies of regulations, the license, notices of violations, audit findings, and inspection findings.

SECTION 7

# 7. INSTRUMENT CALIBRATION

## 7.1 Survey Meters and Monitors for Radiation Safety Purposes

### 7.1.1 Description

These are portable survey meters and line-operated monitors equipped with thin end window or thin window pancake G.M. detectors. Portable survey meters using a thin crystal gamma scinti0llator are used for low energy gamma and x-ray measurements

### 7.1.2 Responsibility

The RSO is responsible for assuring that these instruments are calibrated and maintained in good working condition

### 7.1.3 Frequency and Procedure

These survey instruments are calibrated yearly at 2 points separated by at least 50% of each linear scale. An instrument is considered calibrated when the observed readings are within +-10% of the known or calculated values.

## 7.2 Liquid Scintillation Spectrometers

### 7.2.1 Description

These instruments are manufactured by Packard or Beckman

### 7.2.2 Responsibility

The RSO is responsible for assuring that these instruments are calibrated and maintained in good working condition under a maintenance contract with the vendor.

### 7.2.3 Frequency and Procedure

The calibration of these instruments is checked routinely (when in service) against standards prepared by the vendor.

## 7.3 Gamma Scintillation Spectrometers

### 7.3.1 Description

These instruments are NaI gamma spectrometers manufactured by Ludlum.

7.3.2 Responsibility

The RSO is responsible for assuring that these instruments are calibrated and maintained in good working condition.

7.3.3 Frequency and Procedure

The calibration of these instruments is checked routinely (when in service) against I-125 or I-129 standards.

7.4 Radiation Detection Instruments used in Chemical Syntheses.

Instruments used solely to detect the presence or absence of radioactivity (for example to locate activity on a chromatogram), and not required to be quantitative, do not require periodic calibration. These instruments are checker electronically, using a pulser, annually. This check is not a calibration and is not required to be such.

SECTION 8

# 8. EMERGENCY PROCEDURES

## 8.1 Outside Emergency Services

### 8.1.1 **Hospitals and Medical Offices**

Provisions have been made for treatment of occupational injuries by appropriately trained physicians in the St. Louis County area.

**Barnes Care -- 993-3014**

**Barnes West County Hospital -- 434-0600**

For minor injuries not involving radioactive material.

**St. Johns Mercy Hospital Emergency Room -- 569-6090**

For major injuries or injuries involving radioactive material.

### 8.1.2 **Ambulance -- 911**

For major injuries or to obtain paramedics.

### 8.1.3 **Fire Fighting and Ancillary Services**

Phone numbers for the local fire department, police department and utilities companies are posted in the office area. In addition, the fire department and police department are summoned by automatic alarm signals as noted below.

## 8.2 Building Security

### 8.2.1 Electronic Systems

All buildings are equipped with motion detectors and entry point monitors which trigger an audible alarm and send a signal to the security company upon intrusion. The alarms may be deactivated by entry of a 4 digit code number at the alarm deactivation stations within 30 seconds of entry.

### 8.2.2 Sprinkler Systems

Both buildings are equipped with sprinkler systems which send alarm signals upon a drop in water pressure when sprinkler heads activate.

## 8.3 Radioactive Materials Spills

### 8.3.1 Spill not involving contamination of individuals)

Cover the spill with an absorbent material (i.e. paper towels) to prevent spreading the radionuclide. Notify the RSO or alternate RSO and other individuals in the area that a spill has occurred. Keep coworkers away from the spill area. Don't try to clean the spill yourself.

Remain in the area until the RSO arrives. Provide the RSO all relevant information. The RSO will survey the individual's protective clothing, personal clothing, and exposed skin areas and will release the individual if not contaminated

Individuals under the direction of the RSO perform area decontamination and surveys. Use gloves, absorbent materials, plastic bags and decontamination cleaners as appropriate to clean the area. Survey and wipe test the area to verify the effectiveness of the cleanup operation.

### 8.3.2 Spill involving contamination of individuals

Cover the spill with an absorbent material (i.e. paper towels) to prevent spreading the radionuclide. Notify the RSO or alternate RSO and other individuals in the area that a spill has occurred. Keep coworkers away from the spill area. Don't try to clean the spill yourself.

Remain in the area until the RSO arrives. Provide the RSO all relevant information. The RSO will survey the individual's protective clothing, personal clothing, and exposed skin areas.

The RSO will remove any contaminated clothing and decontaminate any contaminated skin areas. If necessary, the RSO will direct the individual to use the building 300 shower stall. The RSO will provide soap, a hand brush, shampoo, towels, booties and a jumpsuit. If skin areas are still contaminated, the RSO will evaluate the skin dose. Do not leave the facility until released by the RSO.

Individuals under the direction of the RSO perform area decontamination and surveys. Use gloves, absorbent materials, plastic bags and decontamination cleaners as appropriate to clean the area. Survey and wipe test the area to verify the effectiveness of the cleanup operation

## 9.0 Radioactive Waste Program

**References SOPs 01,07,08,17,18,19,29, and 32**

This program provides a means to safely:

- Collect and compact dry solid waste.
- Measure the pH and radioactivity of aqueous wastewater before discharge to the sanitary sewer.
- A means to safely reduce non-aqueous liquid waste to dry solid waste.
- Assure that materials released to sanitary landfills have radiation levels indistinguishable from background
- As long as there are DAW processors open, Long Term Storage of DAW is not utilized by ARC. Should this change, a license amendment will be obtained prior to instituting long term storage

### 9.1 Dry Active Waste (DAW)

#### 9.1.1 Prerequisites

- Individual dry solid waste containers are provided to the chemists as needed.
- "Sharps" containers are provided to the chemists as needed.
- Hot waste containers are labeled appropriately.
- Hot waste containers are lined with appropriate sized plastic bags.
- Labeled transport containers are present in each laboratory building.
- A Bulk "sharps" container is available at the compactor location

#### 9.1.2 Training

Individuals using the compactor are provided training in its operation and associated radiation protection principles.

9.1.3 Operation

9.1.3.1 Chemists

Responsible for placing generated DAW in the proper container

9.1.3.2 Lab Technician

Responsible for:

- Collecting DAW
- Transferring DAW to Building 200
- Compacting DAW
- Labeling DAW
- Clean-up

## 9.2 Aqueous Liquid Waste

9.2.1 Radioactive aqueous liquid waste may be generated from the following operations:

- Dishwashers
- Washing machines
- Scintillation vials
- Floor scrubbers
- Normal Chemical Operation

9.2.2 Wastewater must be assayed and the pH must be determined before discharge to the sanitary sewer

9.2.3 Radioactive liquid waste is sampled on an as-needed basis.

9.2.4 Sampling, assay, and record keeping is the responsibility of the Radiation Safety Staff.

9.2.5 Normal Discharge Pathways

9.2.5.1 Gravity drain from the hold up tank in Bldg 300 – waste from the sink in 300; dishwasher; washing machine.

9.2.5.2 Janitor sink in 300 Lab – Floor washing and rinse water; Aqueous HPLC waste.

9.2.5.3 Pump to drain from hold up tanks in Bldg 100 – waste from front and rear sinks in 100.

9.2.5.4 Pump to drain from Decon sinks in Bldg 100/200 – waste water from steam cleaner, pressure washer etc. (this path is not yet in service 7/25/10)

9.2.6 Other Pathways

**ANY OTHER PATHWAY MUST BE APPROVED BY THE RSO AND DIRECTLY SUPERVISED BY THE RSO (OR DESIGNEE) IN PERSON AND PHYSICALLY PRESENT.**

**9.2.7** Discharge Criteria

9.2.7.1 If <u>at any time during the month</u> the sum total monthly percent permissible would exceed the 100% monthly limit, all or part of the radioactive liquid waste must be stored for future disposition.

9.2.7.2 If <u>at any time during the month</u> the sum total monthly percent permissible would not exceed the 100% monthly limit, all of the radioactive liquid waste may be discharged to the sanitary sewer.

9.2.7.3 If <u>at the end of the year</u> the running yearly percent permissible would exceed the 100% yearly limits, all or part of the radioactive liquid waste must be stored for future disposition.

9.2.7.4 If at the end of the year the running yearly percent permissible would not exceed the 100% yearly limits and the sum total monthly percent permissible would not exceed the 100% monthly limit, all of the radioactive liquid waste may be discharged to the sanitary sewer.

## 9.3 Decay in Storage

### 9.3.1 Requirements

9.3.1.1 Waste must be segregated by physical form (e.g. solid, liquid or gas)

9.3.1.2 Waste must be segregated by radionuclide (e.g. $^{131}I$, $^{32}P$, $^{125}I$, $^{35}S$)

9.3.1.3 Waste containers must be properly labeled (e.g. nuclide, activity and date)

9.3.1.4 Maintain records of the location and contents of waste containers.

9.3.1.5 Waste must be held for decay for a minimum of 10 half-lives.

9.3.1.6 Waste must be surveyed before release to a sanitary landfill.

### 9.3.2 Operation

9.3.2.1 Survey of stored waste shall be in a low background area

9.3.2.2 A survey meter or monitor equipped with a thin end-window G.M. detector shall be used for beta emitting waste.

9.3.2.3 A survey meter or monitor equipped with a gamma scintillation detector shall be used for for waste which does not emit a beta.

9.3.2.4 The detector window shall be within one (1) centimeter, but not touching, of the exposed waste.

9.3.2.5 The waste may be released only if levels are indistinguishable from background.

***Note: Indistinguishable from Background may be understood to mean a gross count rate that is not more than two times the standard deviation of the background count above the background count.***

## 9.4 Non-aqueous Liquid Waste

### 9.4.1 Precautions and Limitations

9.4.1.1 Liquid waste shall be evaporated inside fume hoods under negative pressure.

9.4.1.2 Effluent air released to an unrestricted area shall be monitored.

9.4.1.3 Liquid waste shall be transferred between buildings in a container system that has been approved by the RSO.

9.4.1.4 Waste evaporation shall be performed in designated hoods in Building 200.

9.4.1.5 Lab coats, aprons, and heavy-duty rubber gloves must be worn by the individual performing liquid waste evaporation operations.

***Note: This is minimum PPE and may be augmented on a case by case basis.***

9.4.1.6 A personal contamination survey is required after an individual performs liquid waste evaporation operations and before he exits building 200.

9.4.2 Responsibilities

9.4.2.1 Chemists

- Chemists are responsible for segregation of liquid waste to minimize the volume to be evaporated.
- Prevent liquid waste from being diluted.
- Segregate aqueous phase from non-aqueous phase.

9.4.2.2 Radiation Safety Officer (RSO)

The RSO (or designee) is responsible for assay of low level aqueous waste to determine if it may be discharged to the sanitary sewer (See 9.2 Above). Liquid waste should be evaporated whenever possible to keep the activity discharged to the sanitary sewer as low as reasonably achievable.

9.4.2.3 Laboratory Technician

Whenever transporting a liquid waste container system (LWCS) between buildings, a disposable glove must be worn on the hand used to carry the LWCS. Keep the other hand ungloved for opening doors, etc. Do not allow the transfer container to come in contact with surfaces outside of restricted areas since the LWCS could be externally contaminated.

9.5 Records

Records generated as part of the Radioactive Waste Program shall be dispositioned as follows:

9.5.1 Dose Related

Records used to list, calculate or substantiate dose to the workers or to the public shall be retained indefinitely.

9.5.2 Other

Other records generated by the Radioactive Waste program shall be retained for five (5) years.

9.5.3 LSC

Records of all Calibration runs, daily checks, and quench curves shall be maintained by the RSO.

9.5.4 Format

Records will be retained in hard copy form OR electronic form OR in both forms.

## 9.6 Calibration

9.6.1 Quality Control

Calibration is performed daily when the LSC is in service using $^{14}C$ and $^{3}H$ quenched standards for efficiency determination.
Scintillation Cocktail blanks are used to determine system background.

9. 6.2 Quality assurance.

Quality assurance is performed by counting $^{14}C$ and $^{3}H$ quenched standards with each sample group, Results must be +-20% of the standard values.

## 10.0 Corrective Action Program (SOP 35)

This program provides a means to assure safety concerns raised by individuals at ARC are reviewed, dispositioned and corrected in a timely manner. And to ensure that there is no retaliation for raising the concern

10.1 A safety concern may be raised directly with any Company Officer, Member of the RSC, Authorized User, or any member of the Radiation Safety Organization.(RSO)

10.1.1 The individual raising the concern shall remain anonymous at all times.

10.1.2 It is against ARC policy and contrary to Federal Regulations to permit any form of retaliation for raising safety concerns.

10.2 Concerns may be made using anonymous suggestion boxes

10.3 Printed forms shall be used for submitting concerns; the individual uses the first space on the form.

10.4 Disposition

The RSC shall:

10.4.1 Discuss the concern, assign the concern to an individual by name and assign a due date

10.4.2 Ensure that the assigned individual makes such corrective actions (both short term and long term), as are necessary.

10.4.3 Ensure that a root cause is determined, if possible.

10.4.4 Review the corrective actions and the apparent and root causes.

10.4.5 Ensure that the completed form is posted for a minimum of 30 days in order that all may see that actions were taken.

Supersedes: 7/27/10 
Reviewed by RSC: 2/21/11

SUBJECT: DRY SOLID RADIOACTIVE WASTE COMPACTION PROGRAM

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**OBJECTIVE:** This program provides a means to safely collect and compact dry solid waste.

**RESPONSIBILITY**: Radiation Safety Officer

**REFERENCES:** SOP 16; SOP 20; SOP 21; SOP 33; SOP 35; and SOP 38

**PROGRAM**

## 1.0 Prerequisites

1.1 Individual dry solid waste containers are provided to the chemists as needed.

1.2 "Sharps" containers are provided to the chemists as needed.

1.3 Hot waste containers are labeled as Hot Waste Only (or similar wording)

1.4 Hot waste containers are lined with appropriate sized plastic bags.

1.5 Transport containers with Radioactive Material Labels are present in each laboratory building.

1.6 A Bulk "sharps" container is available at the compactor location

## 2.0 Training

Individuals using the compactor are provided training in its operation and associated radiation protection principles. This training includes:

2.1 All normal training given to employees.

2.2 Use of compactor bags

2.3 Use of mechanical shield door.

2.4 Use of switches and controls

2.5 Action level for contamination control.

2.6 Instruction to inform the Radiation Protection Staff of any non-routine or abnormal occurrence.

## 3.0 Procedure

3.1 Chemists

3.1.1 Place dry solid waste in the hot waste containers provided for this purpose.

3.1.2 Place "sharps" (i.e. Pasteur pipettes, syringes, etc.) in the containers provided for this purpose.

3.2 Technician

3.2.1 Collect the dry solid waste from the individual waste containers and transfer the waste bags to the transport containers.

3.2.2 Collect the individual "sharps" containers from the chemists and place these containers in the transport container.

3.2.3 Transfer the waste (in the transfer container) to the waste processing facility.

3.2.4 Don normal contaminated area protective clothing. (SOP 33)

3.2.5 Place the contents of the individual "sharps" containers in the bulk sharps container. Return the individual containers to the chemists

3.2.6 Before compacting, spread a plastic sheet or plastic-backed bench- paper on the floor in front of the compactor and tape in place.

3.2.7 If required, construct the appropriate number of fiberboard waste containers.

3.2.8 Don additional PCE coveralls, booties, gloves, eye protection and head covering.

3.2.9 Compact the bags only when the enclosure doors are shut.

3.2.10 Place the compacted bags in the fiberboard waste container.

3.2.11 After compacting, remove the plastic sheet or bench-paper from the floor and place it in a compactor bag.

3.2.12 After compacting, remove the additional PCE and place it in the compactor bag.

3.2.13 Survey the floor area and clean as may be required. Action level is 50,000 dpm H-3 and 10,000 dpm C-14. Inform the RSO if Action Level is exceeded.

3.2.14 When full, seal the waste container and transfer it to the waste storage area.

3.2.15 Mark the container with the next sequential number and the date the container is closed.

3.2.16 Place a temporary RAM label on the container. Fill in the label with the date and <10 mCi $^{14}C$ and <10 mCi $^{3}H$.

3.2.17 Inform the RSO of the box number (the date the box was sealed) and the weight.

3.2.18 Return the transfer containers to the appropriate laboratory building.

Supersedes: 7/27/2010
Reviewed by RSC: 2/21/2011



SUBJECT: IN-VITRO BIOASSAY PROGRAM

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**OBJECTIVE:** The *in-vitro* bioassay program provides a means to estimate the committed effective dose equivalent received by ARC employees

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** General Reference Only: NRC Regulatory Guide 8.32
General Reference Only: NUREG-0938

**PROGRAM**

**1.0 Maximum permissible burdens**

The maximum permissible average yearly critical organ burdens of an individual may be based upon a chronic uptake model as follows:

| Radionuclide | Critical Organ | Microcuries |
|---|---|---|
| Carbon-14 | Total body | 395 |
| Tritium | Total body | 3430 |

***Note:*** *As the critical organ listed above is the total body, calculation of dose to the critical organ is identical to calculating dose to the whole body*

**2.0 Sampling frequency**

The frequency for recorded bioassay analyses is weekly. Additional samples may be required at the direction of the Radiation Safety Officer.

**3.0 Requirement**

Urinalyses are required for those individuals who are likely to receive an annual TEDE of 500 mrem. This includes all individuals who have processed or handled $^{14}C$ or $^{3}H$ in unfinished forms.

*(**Note:** Unfinished form includes handling By-product Material in any fashion from receipt of raw material until the product is labeled for shipment.)*

**4.0 Procedure**

4.1 ARC employees shall provide a urine sample on Monday, or the first workday after the weekend, prior to entering any area containing unfinished RAM.

4.2 A 1 ml aliquot of the urine sample is assayed by liquid scintillation counting using Counting Protocol 3 – Bioassay, see attached).

4.3 A 15 ml blank is assayed with each group of samples

4.4 The Liquid Scintillation Counter automatically makes corrections for quench, overlap, efficiency and background to obtain results in net dpm/ml and percent permissible body burden for each radionuclide. The print outs are retained for record and review.

4.5 For each occupationally exposed individual, the results are entered in his or her spreadsheet, which provides the average weekly mrem, the quarterly mrem and the running yearly mrem for each radionuclide. These spreadsheets, when printed, contain information equivalent to NRC Form 5.

4.6 The annual dose reports are given to each occupationally exposed individual in January of each year.

## 5.0 Action Levels

5.1 Acute exposures - Short-term, >100 mrem/week

The individual is restricted from further work with radionuclides, which could result in an additional uptake. This weekly dose rate is the sum of the dose rates for each radionuclide identified.

5.1.1 The individual shall remain restricted until the dose rate falls below 100 mrem/week, based on two consecutive samples; or below 50 mrem/wk on any sample.

5.1.2. The RSO, or designee, see RPP Section 3.3.4.12, shall attempt to determine the cause of the uptake and to propose corrective actions to minimize the potential for recurrence. This determination shall be documented, including any corrective actions.

5.1.3. A copy of the documentation shall be given to the individual concerned, and the original placed in the individual's radiation protection file.

5.2 Chronic exposures - Long-term exceeding 50 mrem/week (4 consecutive weeks or longer

The individual is restricted from any area within which air concentrations exist in excess of 50% of permissible.

5.2.1 The individual shall remain restricted until the dose rate falls below 50 mrem/week.

5.2.2 The RSO, or designee, see RPP Section 3.3.4.12, shall attempt to determine the cause of the uptake and to propose corrective actions to minimize the potential for recurrence.

5.3 Annual exposures - Chronic or acute, >1250 mrem/year

The Radiation Safety Committee (RSC) reviews summary reports for the internal exposures of each individual and identifies the primary sources of exposure in order to take possible corrective action to reduce exposures.

## 6.0 Calibration

6.1 Quality Control

Calibration is performed daily when the LSC is in service using $^{14}C$ and $^{3}H$ quenched standards for efficiency determination. Scintillation Cocktail blanks are used to determine system background.

6.2 Quality assurance.

Quality assurance is performed by counting $^{14}C$ and $^{3}H$ quenched standards with each sample group, Results must be +-20% of the standard values.

6.3 Records

Records of all Calibration runs, daily checks, quench curves are maintained by the RSO.

## 7.0 Maintenance

The LSC performance is ensured through a service agreement with Beckman-Coulter

Supersedes: 7/27/2010 
Reviewed by RSC: 2/21/2011

SUBJECT: $^{14}C$ and $^{3}H$ AIR MONITORING PROGRAM

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**OBJECTIVE:** This program provides a means to assure that airborne concentrations of radioactive materials are maintained within regulatory limits

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** Regulatory Guide 8.25

**PROGRAM**

## 1.0 Equipment

1.1 An air sampling "bubbler train" consists of a rotameter followed by 1 or 2 gas-washing bottles containing 0.1 molar sodium hydroxide, an entrainment eliminator, a second rotameter, and a limiting orifice all connected in series to a vacuum source.

1.2 Stack sampling for Building 100 use models MRB500C14 and MRB200H3; for Building 300 the units in use are MRB200C14 and MRB200H3. These units use Ethylene Glycol and Ethanolamine for Tritium and C-14, respectively, and have an efficiency of greater than 99%. Each sampling unit has a built in pump and will sample the stack air on parallel lines. Note: The manuals for each sampling unit will be on file with the RSO.

1.3 Air sampling may be performed at any of the following points of interest in restricted and unrestricted areas. For example:

- In close proximity to radioactive fume hoods;
- In close proximity to waste compactors;
- At the point of discharge from a stack to the atmosphere;
- At other locations selected by the radiation safety officer.

## 2.0 Requirement

2.1 Air sampling is required in areas within which air concentrations normally exist in concentrations in excess of 10% of permissible limits. Air sampling stations are checked daily and the results documented.

## 3.0 Sampling frequency

3.1 Air sampling is performed at frequencies sufficient to provide reliable estimates of the air concentrations

3.2 Continuous air samples typically are run 24 hours per day except for sample changing and servicing of the system.

3.3 Intermittent samples may be collected at intervals ranging from a few hours to approximately one week depending upon the area being measured and the DAC limits.

**4.0** **Procedure** (assumes the sample train has been running normally for the required time).

4.1 End the sampling period and prepare samples from each gas-washing bottle for assay in the liquid scintillation counter (LSC).

4.2 Prepare a NaOH blank from each sampling station for background purposes.

4.3 Clean and rinse gas-washing bottles.

4.4 Laboratory Air Sampling

4.4.1 Fill collection bottles with approimately 150 ml of NaOH, and begin sampling period

4.5 Stack Air Sampling

4.5.1 Using Ethylene Glycol for Tritium sampling and Ethanolamine for C-14 sampling, fill 4 scintillation vials with 10mL Ethylene Glycol and 6 scintillation vials with 10mL ethanolamine.

4.5.2 Record the time and volume passed through for each individual machine, then turn off the machine.

4.5.3 Remove all vials from left to right per machine, then replace them from right to left. This will prevent any liquid uptake into the sampling lines.

4.5.4 Reset the sampling period and volume passed through before starting the next sampling period.

4.6 Record the data on the pre-printed data sheets.

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4.7 An aliquot of each sample, including the blanks, is added to 15 ml of scintillation cocktail. The resulting samples are batch counted using Counting Protocol 7 Air Sampling, Counting Protocol 4 – H-3 Stack or Counting Protocol 9 – C-14 Stack ~~Building 400 Air~~, as appropriate.

4.8 The data from the counting print out and the sample data sheets are entered in a spreadsheet and converted to concentrations and % permissible for each radionuclide. The worksheets are retained for record and review.

4.9 Input/output data for laboratory spreadsheet worksheets

4.9.1 Input data

Date Started

Time Started

Date Finished

Time Finished

Initial ml/min

Final ml/min

1st Bottle NaOH ml

2nd Bottle NaOH ml

4.9.2 C-14 Assay Data

1st NaOH dpm/ml

2nd NaOH dpm/ml

4.9.3 H-3 Assay Data

1st NaOH dpm/ml

2nd NaOH dpm/ml

4.9.4 Output data

Sample minutes

Average ml/min

Air Sample ml

4.9.5 C-14 Output Data

Collection Eff.

Conc. µCi/ml

% Permissible

mCi Discharged

4.9.6 H-3 Output Data

Collection Eff.

Conc. µCi/ml

% Permissible

mCi Discharged

4.9.7 Total % Permissible.

4.10 Input/output data for stack spreadsheet worksheets

4.10.1 Input data

Date

Days

Hours

Minutes

Volume passed through

1st Bottle NaOH ml

2nd Bottle NaOH ml

4.10.2 C-14 Assay Data (if applicable)

1st NaOH dpm/ml

2nd NaOH dpm/ml

4.10.3 H-3 Assay Data (if applicable)

1st NaOH dpm/ml

2nd NaOH dpm/ml

4.10.4 Output data

Sample minutes

Average ml/min

Air Sample ml

4.10.5 C-14 Output Data

Collection Eff.

Conc. µCi/ml

% Permissible

mCi Discharged

4.10.6 H-3 Output Data

Collection Eff.

Conc. µCi/ml

% Permissible

mCi Discharged

4.10.7 Total % Permissible.

## 5.0 Calibration

5.1 Quality Control

Calibration is performed daily when the LSC is in service using $^{14}C$ and $^{3}H$ quenched standards for efficiency determination. Scintillation Cocktail blanks are used to determine system background.

5.2 Quality assurance.

Quality assurance is performed by counting $^{14}C$ and $^{3}H$ quenched standards with each sample group, Results must be +-20% of the standard values.

5.3 Records

Records of all Calibration runs, daily checks, quench curves are maintained by the RSO.

## 6.0 Maintenance

The LSC performance is ensured through a service agreement with Beckman-Coulter

Supersedes:
Reviewed by RSC: 7/27/2010



SUBJECT: HEPA AND PRE-FILTER EXCHANGE PROGRAM

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**This SOP has been suspended from use as being no longer applicable.**

**In the event that ARC begins processing of significant amounts of nuclides other than H-3 or C-14, or begins processing significant amounts of particulate forms of C-14 or H-3, this Standard Operating Procedure will be updated and reinstated.**

Supersedes: 7/27/2010 
Reviewed by RSC: 2/21/2011

SUBJECT: INSTRUMENT CALIBRATION PROGRAM

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**OBJECTIVE:** To assure meters that will be used to monitor radiation and/or contamination levels are calibrated annually for the proper radiation that will be measured.

**RESPONSIBILITY**: Radiation Safety Officer

**REFERENCES:** R. M. Wester & Associates, Inc. - NRC License No. 24-20091-01
Ludlum Measurements, Inc. - Texas License No. LO-1936
Packard Instrument Company
Beckman-Coulter Instrument Company

## 1.0 Calibration frequency

1.1 The normal calibration frequency for instruments in use is annually and after any repair.

1.2 Instruments that are not in service, either awaiting repair, or not needed are exempt from normal calibration.

## 2.0 Requirement

Calibration is required for instrumentation utilized for radiation protection purposes including monitoring, surveying, and assaying. ***Radiation measuring instruments for production purposes are not included in this program. These instruments are response checked in accordance with Section 3.4 and following.***

## 3.0 Procedure

3.1 Dose Rate survey instruments and the pulser are calibrated by one of the above referenced companies in accordance with procedures contained in their license.

3.2 Packard and Beckman liquid scintillation counters are calibrated by health physics personnel in accordance with manufacturer's procedure.

3.3 When in service, the Ludlum gamma scintillation system is calibrated by health physics personnel in accordance with manufacturer's procedure.

3.4 Surface Contamination Instruments not used for measuring dose to individuals are response checked by health physics personnel in accordance with the following

procedure. Any instrument used for dose or dose rate to an individual is calibrated by the third party listed above.

3.4.1 Check the batteries in the meter. If the batteries are not performing properly, verify that the contacts are not dirty. If the problem is not resolved, replace the old batteries.

3.4.2 Print out a blank meter calibration report for the instrument to be response checked

3.4.3 Enter all required data on the Calibration Report and efficiency Report.

3.4.4 Ensure the Amplitude & Multiplier on the pulsar are turned all the way down.

3.4.5 Connect the meter to the pulsar using an appropriate cable, and then turn the pulsar on.

3.4.6 Fill out the information on the top part of the "Electronic Calibration Certificate."

3.4.7 Take a high voltage recording of the pulser, using the kilovolt scale located to the left of the counts/min digital window.

3.4.8 Record this reading on the Meter Efficiency Report.

3.4.9 Perform a sensitivity response test on the meter being checked. For this you will be using both the Pulser and the meter you are checking. On the pulser you will be determining the amplitude required to meet the threshold of counts that the meter can detect. Thus on the pulser you will be adjusting the amplitude and at the same time you will be viewing the counts/min scale as well as listening to audio response of the meter.

- Set the following parameters on the pulser.

  Ensure that the amplitude is at 50Mv

  Amplitude range is turned counter clockwise so that you will be starting at the lowest range.

  The multiplier on the pulser is at x 1.

- Slowly increase the amplitude range knob from low to high.

- As you slowly increase the amplitude, view the counts/min scale on the meter as well as listen to the audio response. You will notice that the counts on the meter begin to increase as you increase the amplitude range at the 50 mV setting on the Pulser. You will also distinguish a more steady audio response as the meter approaches the threshold. After you know the meter has reached the threshold, slightly increase the amplitude on the pulser to ensure no counts will fall below the threshold

3.4.10 Check the linearity of the meter by setting the pulsar approximately 20% and 80% of that particular meter's count per minute scale (this must be to the nearest major division. Ensure that the Pulser counts/minute multiplier is set at 1 and the counts registering at 110.

- The Meter Calibration Report has a table with the linearity series that will be checked for each specific meter. (A new meter will require a new spreadsheet to be created.) Make any corrections to the cpm of the meter in the "Meter Reading CPM" column. The table shows the appropriate meter scale and desired setting of the pulsar.

- If the meter cpm are off by more than + / - 10% adjustments to the meter being checked must occur.

- Make first adjustment for the 80% scale reading for all the ranges, then do the same for the 20% of scale readings.

3.5 Efficiency Calculations:

3.5.1 Obtain a current decay correction list for the standard used for this isotope. This is accomplished automatically when the efficiency report is opened.

3.5.2 Reattach the probe to the survey meter box. Record the count rate from direct reading of the standard. Enter this count rate on the Efficiency form.

3.5.3 The efficiencies are then transferred onto the tag or sticker to be placed on the meter.

3.5.4 If the survey meter has a check source attached to it, take a reading of this source and record results on the EFF form.

3.6 Records & Attachments:

3.6.1 Attach a calibration sticker/tag to the response-checked meter. This sticker will provide:

- the date of response checking
- the initials of who checked it.
- the C-14 efficiency.
- the count rate of the Cs-137 check source
- the new due date

3.6.2 Print out the forms for review and archiving

3.6.3 The completed form is given to the RSO who will then review and sign the report.

3.6.4 File the completed reports

3.7 Return the Meter to the Lab

## 4.0 Operational Checks

4.1 Check to ensure the survey meter has a current calibration date or response check date, as appropriate.

4.2 Put the meter function switch on BAT, meter should read within the battery test zone shown on the meter scale.

4.3 Set the meter on the proper scale to read the check source value shown on the calibration or response check, as appropriate sticker/tag.

4.4 Place the probe over the Cs-137 check source yellow side, dated 1/28/92.

4.5 The survey meter should show within +/- 10% of the check source value shown on the calibration or response check, as appropriate sticker/tag.

Supersedes: 7/27/2010 
Reviewed by RSC: 2/21/2011

SUBJECT: PROGRAM FOR PICKING UP, RECEIVING, AND OPENING OF INCOMING RADIOACTIVE MATERIALS.

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**OBJECTIVE:** The program provides a means to safely open incoming packages of radioactive materials.

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** General Reference Only: NUREG-1556 Volume 12, para 8.10.3

**PROGRAM**

**1.0 Requirements**

1.1 For packages containing RAM in excess of a Type A quantity listed in Appendix A of 10CFR71, arrangements shall be made to receive the package either –

1.1.1 When the carrier offers it for delivery, or

1.1.2 Upon notification of the arrival and shall take possession of the package expeditiously.

For all other RAM packages, see 1.5

1.2 Radiation level and contamination surveys shall be performed on any RAM package if the package either –

1.2.1 Is labeled with DOT RAM labels, or

1.2.2 Is crushed, wet or damaged

1.3 Radiation level surveys shall be performed using an instrument calibrated to read mR/hr.

1.4 Loose contamination surveys shall be performed on each package by wiping at least a 300cm$^2$ area. Wipes shall be assayed in an instrument calibrated to output CPM (Counting Protocol # 18 - Shipping/Receiving).

1.5 The above surveys shall be performed as soon as practicable (within 3 hours after delivery during normal working hours) or within 3 hours from the start of the next working day if delivered after normal working hours.

1.6 Levels on the exterior of a package in excess of the following are indicative of leakage:

| | |
|---|---|
| Removable contamination | >1000 cpm/100 $cm^2$ |
| Radiation levels at the surface | >200 mr/hr |
| Radiation levels at 1 meter | >10 mr/hr |

1.7 If leakage is indicated, immediate notification shall be made first to the final delivering carrier by telephone and then by telephone and facsimile to the NRC Operations Center (301-816-5100), by telephone.

## 2.0 Procedure

This procedure shall be followed for all incoming packages labeled as RAM, or otherwise indicating that the contents are radioactive.

Prepare an "Incoming Package Survey" form (Copy attached). Enter date and time of receipt of the package at ARC.

2.1 Put on gloves to prevent hand contamination.

2.2 Visually inspect the package for any sign of damage (e.g. wet or crushed). If damage is noted, stop the procedure and notify the RSO.

2.3 Loose contamination surveys shall be performed on each package by wiping at least a 300 $cm^2$ area.

2.4 Wipes shall be assayed in an instrument calibrated to output CPM (Counting Protocol #18 - Shipping/Receiving). Attach the print out from the LSC to the form

2.5 If the shipment is Dangerous Goods, attach a copy of the Dangerous goods declaration to the form.

2.6 Measure the dose rate on the surface of the package and at 1 meter from the surface.

2.6.1 Enter the highest contact reading and its' location on the form.

2.6.2 Enter the dose rate at 1 meter on the form

---

2.7 If radiation level surveys or contamination level surveys on the outside of the package are higher than expected, stop the procedure and notify the RSO.

2.8 Open the outer package following the supplier's instructions if provided.

2.9 Remove the packing slip. Make a copy of the packing slip and attach the copy to the form

2.10 Open the inner package and determine whether the contents agree with the packing slip.

2.11 Check the integrity of the final source container(s). Look for broken seals or vials, loss of liquid, condensation, or discoloration of the packing material.

2.12 Take and count a wipe sample of each final source container. Attach the LSC print out to the form

2.13 If anything is other than expected, stop the procedure and notify the RSO.

2.14 Verify that the material received is the material that was ordered.

2.15 Monitor the packing material and the empty packaging for contamination with a survey meter before discarding.

2.15.1 If contaminated, treat the materials as radioactive waste.

2.15.2 If not contaminated, remove or obliterate the radiation labels before discarding the packaging materials as non-radioactive waste.

2.16 Make a record of the receipt and retain the record for review by the NRC.

2.17 Office personnel will then enter the amount of the radionuclide(s) into the RAM inventory.

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# Attachment one

# Incoming Package Survey.

Supersedes: 7/27/2010
Reviewed by RSC: 2/21/2011



SUBJECT: LIQUID WASTE DISPOSAL PROGRAM

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**OBJECTIVE:** The liquid waste disposal program provides a means to measure the pH and radioactivity of wastewater before discharge to the sanitary sewer

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** RPP Section 9
SOPs 8, 16, 20, 21, 33, 35, and 38

## 1.0 Radioactive liquid waste retention system

Radioactive liquid waste is collected in containers such as tanks, beakers, or flasks. In the following procedure, these collectively shall be referred to as waste containers.

Radioactive liquid waste may be generated from the following operations:

- Dishwashers
- Washing machines
- Scintillation vials
- Floor scrubbers
- Normal Chemical Operation

## 2.0 Requirement

Wastewater must be assayed and the pH must be determined before discharge to the sanitary sewer.

## 3.0 Sampling frequency

Radioactive liquid waste is sampled when the tank or container is full.

## 4.0 Procedure

**NOTE: Maintenance personnel may sample hold up tanks and mop buckets as directed by the RSO or designee, see RPP Section 3.3.4.12. Maintenance personnel will perform only items 4.1, 4.2, 4.3 and 4.8 below. When discharging maintenance personnel must check the net µCi/L for each isotope, seeing that it is under the daily discharge limits as outlined by the RSO.**

4.1 Measure the wastewater volume in gallons or liters.

4.2 Stir the wastewater thoroughly, collect a 1 ml aliquot, and measure the pH.

Assay the sample in the liquid scintillation counter (LSC) using Counting Protocol #6 – Liquid waste

4.3 The LSC automatically makes corrections for quench, overlap, efficiency and background to yield results in net μCi/l.

4.4 Enter the initial data in the liquid waste spreadsheet.

4.4.1 Date in Column A

4.4.2 pH in column B

4.4.3 Source Building in Column C

4.4.4 Volume in column G or H as appropriate

4.4.5 Sample size, usually 1 ml, in Column F

4.5 Enter the μCi/l in columns D & E of the liquid waste spreadsheet which computes the following:

4.5.1 The volume of the wastewater in liters

4.5.2 The activity in mCi

4.5.3 The concentration in μCi/ml based on the dilution water flow

4.5.4 The running yearly total in curies

4.5.5 The running yearly percent permissible

4.5.6 The percent of the yearly discharge rate

4.6 The following information is calculated and provided in the shaded areas.

4.6.1 The running monthly totals in millicuries for tritium and for $^{14}C$

4.6.2 The running monthly percent permissible for tritium and for $^{14}C$

4.6.3 The sum total monthly percent permissible for tritium plus $^{14}C$.

4.7 Wastewater will be discharged by or under supervision of the Radiation Protection Staff.

## 5.0 Discharge Criteria

**Note: The normal discharge pathways are as follows:**

**Gravity drain from the hold up tank in Bldg 300 – waste from the sink in 300; dishwasher; washing machine.**

**Janitor sink in 300 Lab – Floor washing and rinse water; Aqueous HPLC waste.**

**Pump to drain from hold up tanks in Bldg 100 – waste from front and rear sinks in 100.**

**Darkroom sink in Bldg 100 – assayed liquid waste**

**Pump to drain from Decon sinks in Bldg 100/200 – wastewater from steam cleaner, pressure washer etc. (this path is not yet in service 2/22/08)**

**ANY OTHER PATHWAY MUST BE APPROVED BY THE RSO, AND DIRECTLY SUPERVISED BY THE RSO (OR DESIGNEE, SEE RPP SECTION 3.3.4.12) IN PERSON AND PHYSICALLY PRESENT.**

5.1 If at any time during the month the sum total monthly percent permissible would exceed the 100% monthly limit, all or part of the radioactive liquid waste must be stored for future disposition.

5.2 If at any time during the month the sum total monthly percent permissible would not exceed the 100% monthly limit, all of the radioactive liquid waste may be discharged to the sanitary sewer.

5.3 If at the end of the year the running yearly percent permissible would exceed the 100% yearly limits, all or part of the radioactive liquid waste must be stored for future disposition.

5.4 If at the end of the year the running yearly percent permissible would not exceed the 100% yearly limits and the sum total monthly percent permissible would not exceed the 100% monthly limit, all of the radioactive liquid waste may be discharged to the sanitary sewer.

## 6.0 Records

6.1 File the records for permanent retention.

## 7.0 Calibration

7.1 Quality Control

Calibration is performed daily when the LSC is in service using $^{14}C$ and $^{3}H$ quenched standards for efficiency determination. Scintillation Cocktail blanks are used to determine system background.

7.2 Quality assurance.

Quality assurance is performed by counting $^{14}C$ and $^{3}H$ quenched standards with each sample group, Results must be +-20% of the standard values.

7.3 Records

Records of all Calibration runs, daily checks, and quench curves are maintained by the RSO.

## 8.0 Maintenance

The LSC performance is ensured through a service agreement with Beckman-Coulter.

Supersedes: 7/27/2010 
Reviewed by RSC: 2/21/2011

SUBJECT: RADIOACTIVE WASTE PROGRAM

---

**OBJECTIVE**: This program provides a means to safely:

- Collect and compact dry solid waste.
- Measure the pH and radioactivity of wastewater before discharge to the sanitary sewer.
- The liquid waste evaporation program provides a means to safely reduce liquid waste to dry solid waste.
- Assure that materials released to sanitary landfills have radiation levels indistinguishable from background.
- Safely reduce liquid waste to dry solid waste.
- As long as there are DAW processors open, Long Term Storage of DAW not utilized by ARC. Should this change, a license amendment will be obtained prior to instituting long term storage.

**RESPONSIBILITY:** Radiation Safety Officer (or designee, see RPP Section 3.3.4.12)

**REFERENCES:** RPP Section 9;

SOPs 8, 16, 20, 21, 33, 35, and 38

## 1.0 PROCEDURE:

**Dry Active Waste (DAW)**

1.1. Prerequisites

1.1.1. Individual dry solid waste containers are provided to the chemists as needed.

1.1.2. "Sharps" containers are provided to the chemists as needed.

1.1.3. Hot waste containers are labeled appropriately.

1.1.4. Hot waste containers are lined with appropriate sized plastic bags.

1.1.5. Labeled transport containers are present in each laboratory building.

1.1.6. A Bulk "sharps" container is available at the compactor location

1.2. Training

1.2.1. Individuals using the compactor are provided training in its operation and associated radiation protection principles.

1.3. Operation

1.3.1. Chemists

1.3.1.1. Place dry solid waste in the hot waste containers provided for this purpose.

1.3.1.2. Place "sharps" (i.e. Pasteur pipettes, syringes, etc.) in the containers provided for this purpose

1.3.2. Technician

1.3.2.1. Collect the dry solid waste from the individual waste containers and transfer the waste bags to the transport containers.

1.3.2.2. Collect the individual "sharps" containers from the chemists and place these containers in the transport container.

1.3.2.3. Transfer the waste (in the transfer container) to the waste processing facility.

1.3.2.4. Place the contents of the individual "sharps" containers in the bulk sharps container. Return the individual containers to the chemists

1.3.2.5. Before compacting, spread a plastic sheet or plastic-backed bench- paper on the floor in front of the compactor and tape in place.

1.3.2.6. If required, construct the appropriate number of fiberboard waste containers.

1.3.2.7. Compact the bags only when the enclosure doors are shut.

1.3.2.8. Place the compacted bags in the fiberboard waste container.

1.3.2.9. After compacting, remove the plastic sheet or bench-paper from the floor and place it in a compactor bag.

1.3.2.10. Survey the floor area according to the weekly schedule.

1.3.2.11. When full, seal the waste container and transfer it to the waste storage area.

1.3.2.12. Mark the container with the next sequential number, the date the container is closed, and the weight of the container.

1.3.2.13. Place a temporary RAM label on the container. Fill in the label with the date and <10 mCi $^{14}C$ and <10 mCi $^{3}H$.

1.3.2.14. Record the data of 1.3.2.12 above on the Shipment Tally Sheet.

1.3.2.15. Return the transfer containers to the appropriate laboratory building.

## 2.0 Aqueous Liquid Waste

2.1. Radioactive liquid waste is collected in containers such as tanks, beakers, or flasks. In the following procedure, these collectively shall be referred to as waste containers.

2.2. Radioactive aqueous liquid waste may be generated from the following operations:

- Dishwashers
- Washing machines
- Scintillation vials
- Floor scrubbers
- Normal Chemical Operation

2.3. Wastewater must be assayed and the pH must be determined before discharge to the sanitary sewer.

2.4. Radioactive liquid waste is sampled on an as-needed basis.

2.5. Procedure

2.5.1. Measure the wastewater volume in gallons or liters.

2.5.2. Stir the wastewater thoroughly, collect a 1 ml aliquot, and measure the pH. *For retention tanks with installed pumps, recirculate the tank contents for 5 minutes will serve as sufficient stirring*

2.5.3. If the average monthly pH is not in the 5.5 to 11.5 range, adjust the wastewater pH, and repeat step 2.5.2.

*Proceed to step 2.5.4 if the pH is within limits.*

2.5.4. Enter the initial data in the liquid waste spreadsheet.

2.5.4.1. Date in Column A

2.5.4.2. pH in column B

2.5.4.3. Source Building in Column C

2.5.4.4. Volume in column G or H as appropriate

2.5.4.5. Sample size, usually 1 ml, in Column F

2.5.5. Assay the sample in the liquid scintillation counter (LSC) using the Counting Protocol for liquid waste. The LSC automatically makes corrections for quench, overlap, efficiency and background to yield results in net μCi/l.

2.5.6. Enter the μCi/l in columns D & E of the liquid waste spreadsheet which computes the following:

2.5.6.1. The volume of the wastewater in liters

2.5.6.2. The activity in mCi

2.5.6.3. The concentration in μCi/ml based on the facility water consumption

2.5.6.4. The running yearly total in curies

2.5.6.5. The running yearly percent permissible

2.5.6.6. The percent of the yearly discharge rate

2.5.7. The following information is calculated and provided in the shaded areas.

2.5.7.1. The running monthly totals in millicuries for tritium and for $^{14}C$

2.5.7.2. The running monthly percent permissible for tritium and for $^{14}C$

2.5.7.3. The sum total concentration monthly percent permissible for tritium plus $^{14}C$.

2.5.8. Normal Discharge Pathways

2.5.8.1. Gravity drain from the hold up tank in Bldg 300 – waste from the sink in 300; dishwasher; washing machine.

2.5.8.2. Janitor sink in 300 Lab – Floor washing and rinse water; Aqueous HPLC waste.

2.5.8.3. Pump to drain from hold up tanks in Bldg 100 - waste from front and rear sinks in 100.

2.5.8.4. Pump to drain from Decon sinks in Bldg 100/200 – waste water from steam cleaner, pressure washer etc. (this path is not yet in service 12/10)

**ANY OTHER PATHWAY MUST BE APPROVED BY THE RSO AND DIRECTLY SUPERVISED BY THE RSO, OR DESIGNEE, SEE RPP SECTION 3.3.4.12, IN PERSON AND PHYSICALLY PRESENT.**

2.5.9. Discharge Criteria

2.5.9.1. If at any time during the month the sum total monthly percent permissible would exceed the 100% monthly limit, all or part of the radioactive liquid waste must be stored for future disposition.

2.5.9.2. If at any time during the month the sum total monthly percent permissible would not exceed the 100% monthly limit, all of the radioactive liquid waste may be discharged to the sanitary sewer.

2.5.9.3. If at the end of the year the running yearly percent permissible would exceed the 100% yearly limits, all or part of the radioactive liquid waste must be stored for future disposition.

2.5.9.4. If at the end of the year the running yearly percent permissible would not exceed the 100% yearly limits and the sum total monthly percent permissible would not exceed the 100% monthly limit, all of the radioactive liquid waste may be discharged to the sanitary sewer.

## 3.0 Decay in Storage

### 3.1. Requirements

3.1.1. Waste must be segregated by physical form (e.g. solid, liquid or gas)

3.1.2. Waste must be segregated by radionuclide (e.g. $^{131}I$, $^{32}P$, $^{125}I$, $^{35}S$)

3.1.3. Waste containers must be properly labeled (e.g. nuclide, activity and date)

3.1.4. Maintain records of the location and contents of waste containers.

3.1.5. Waste must be held for decay for a minimum of 10 half-lives.

3.1.6. Waste must be surveyed before release to a sanitary landfill.

### 3.2. Procedure

3.2.1. Survey stored waste in a low background area

3.2.2. Use a survey meter or monitor equipped with a thin end-window G.M. detector for beta emitting waste.

3.2.3. Use a gamma scintillation detector for waste that does not emit a beta.

3.2.4. Hold the detector within one (1) centimeter of the exposed waste.

3.2.5. Release the waste only if levels are indistinguishable from background.

***Note: Indistinguishable from Background may be understood to mean a gross count rate that is not more than two times the standard deviation of the background count above the background count.***

## 4.0 Non-aqueous Liquid Waste

### 4.1. Precautions and Limitations

4.1.1. Liquid waste shall be evaporated inside fume hoods under negative pressure.

4.1.2. Effluent air released to an unrestricted area is monitored.

4.1.3. Liquid waste shall be transferred between buildings in a container system that has been approved by the RSO.

4.1.4. Waste evaporation shall be performed in designated hoods in Building 200.

4.1.5. Lab coats, aprons, and heavy-duty rubber gloves must be worn by the individual performing liquid waste evaporation operations. Note: This is minimum PPE and may be augmented on a case by case basis.

4.1.6. A personal contamination survey is required after an individual performs liquid waste evaporation operations and before they exit Building 200.

### 4.2. Procedure

4.2.1. Chemists

4.2.1.1. Chemists are responsible for segregation of liquid waste to minimize the volume to be evaporated.

4.2.1.2. Prevent liquid waste from being diluted.

4.2.1.3. Segregate aqueous phase from non-aqueous phase.

4.2.2. Radiation Safety Officer (RSO)

The RSO (or designee, see RPP Section 3.3.4.12) is responsible for assay of low-level aqueous waste to determine if it may be discharged to the sanitary sewer (See Above). Liquid waste should be evaporated whenever possible to keep the activity discharged to the sanitary sewer as low as reasonably achievable.

4.2.3. Laboratory Technician

Whenever transporting a liquid waste container system (LWCS) between buildings, a disposable glove must be worn on the hand used to carry the LWCS. Keep the other hand ungloved for opening doors, etc. Do not allow the transfer container to come in contact with surfaces outside of restricted areas since the LWCS could be externally contaminated.

4.2.3.1. Whenever transporting a LWCS to building 200, exit buildings 100 or 300 through the respective change area.

4.2.3.2. Place the LWCS on the transfer cart in building 200.

4.2.3.3. Pour the liquid waste into an open pan containing absorbent sponges or paper. Fill the liquid to a depth of 1 inch or less.

4.2.3.4. Close the hood panels while evaporating to maximize air flow over the pan surfaces.

4.2.3.5. Return an empty LWCS to buildings 100 or 300 through its change area.

## 5.0 Records

Records generated as part of the Radioactive Waste Program shall be dispositioned as follows:

### 5.1. Dose Related

Records used to list, calculate or substantiate dose to the workers or to the public shall be retained indefinitely.

### 5.2. Other

Other records generated by the Radioactive Waste program shall be retained for five (5) years.

### 5.3. LSC

Records of all Calibration runs, daily checks, and quench curves are maintained by the RSO.

### 5.4. Format

Records will be retained in hard copy form OR electronic form OR in both forms.

## 6.0 Calibration

### 6.1. Quality Control

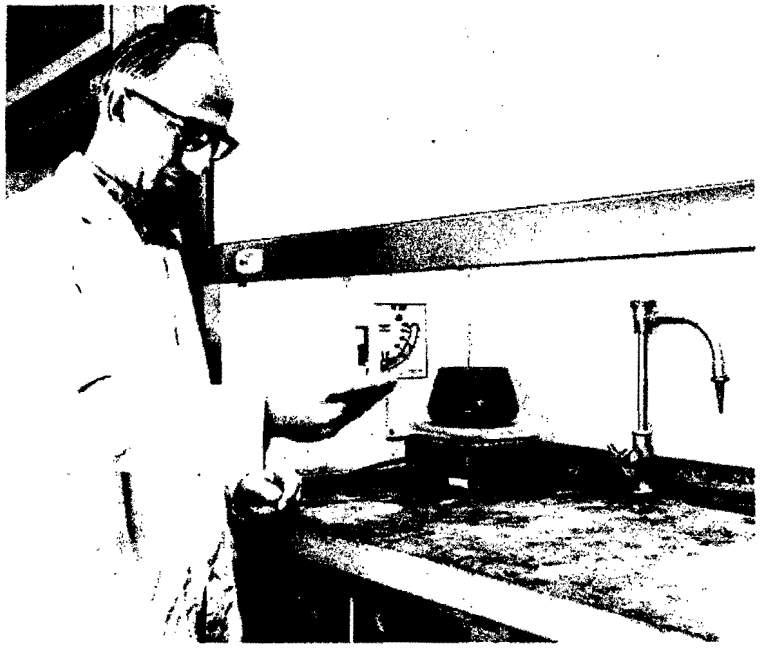
Calibration is performed daily when the LSC is in service using $^{14}C$ and $^{3}H$ quenched standards for efficiency determination. Scintillation Cocktail blanks are used to determine system background.

### 6.2. Quality assurance

Quality assurance is performed by counting $^{14}C$ and $^{3}H$ quenched standards with each sample group, Results must be +-20% of the standard values.

## 7.0 Maintenance

LSC performance is ensured through a service agreement with Beckman-Coulter.



Bulletin II-14

# INSTRUCTIONS for No. 480 VANEOMETER' AIR VELOCITY METER

Use a Vaneometer to measure velocity of air flow into laboratory fume hoods and...

...at paint spray booths to determine when to change filters. Or wherever needed to meet OSHA standards of ventilation for smoke, dust or fume removal.

## Use this sensitive new Dwyer VaneometerTm to measure low air velocities-at low cost.

THE PROBLEM: How can you insure that OSHA, EPA and other safety ventilation requirements are met —at paint spray booths and at fume, smoke and dust exhaust hoods—in the plant, laboratory or restaurant? To do this, you need to measure low air velocities—from 25 to 400 feet per ridnute.+

Until now, instruments for this purpose have been complex and costly—from four to ten times the modest price of unit.

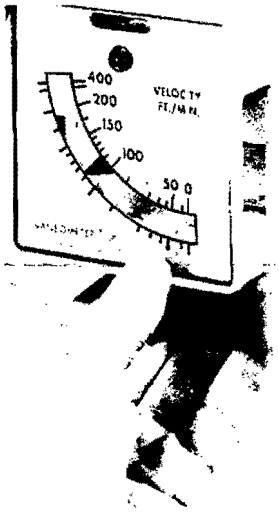
SOLUTION: The new Dwyer Vaneometer™. It's pocket-size and light in weight --only four ounces. So it's handy to carry from one work station to another to make spot checks of air flow.* And it's easy to use—for untrained personnel. Just hold meter parallel to air flow—the pendulum vane/pointer indicates air velocity in feet per minute on a large, easy-to-read scale.

It can be hand held—or permanently mounted if continuous monitoring of face velocity is desired. A versatile steel mounting bracket and operating instructions are included. It's sensitive and accurate to ± 10% of full scale. The Vaneometer has a bubble level and scale visible on both sides.

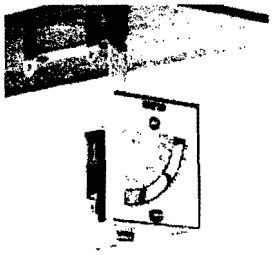
With housing of tough ABS plastic, it is durable and easy to clean with soap and water. The polyester vane can be cleaned with lacquer thinner. A spare vane is provided.

The Vaneometer is a tested, practical instrument for daily use—sensibly designed by Dwyer—"The Low Pressure People". Try one—and judge for yourself.

*For horizontal air flows only at this time. +Metric scales are avalable. Range: 0 to 2.0 meters per second.

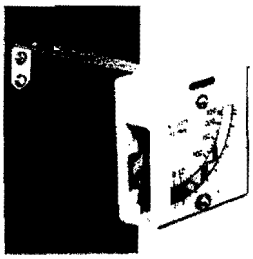



The Vaneometer's large scales are easy to read. Both sides have factory calibrated scales. Recessed bubble level at top helps insure accurate readings.



A versatile steel mounting bracket is included.

Left— Shows overhead mounting of Vaneometer for continuous monitoring.



The same bracket permits wall mounting. Bolts, nuts and screws are included.

## How to Operate Meter

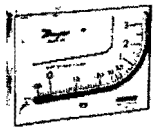
To install vane, pull vane holder from end of Vaneometer. Carefully remove vane from plastic bag and cardboard envelope. (Two vanes are enclosed, one is a spare.) Hang the vane by the wire in the two slots provided in the vane holder, then re-install the vane holder in the meter. Either side of vane may face the air flow. The meter is now ready to take readings. It is precalibrated. If vane becomes damaged, it is easily replaced with spare vane.

The Vaneometer is accurate to ±5% of full scale from bottom of scale to 100 FPM and ±10% from 100 FPM to top of scale.

For permanent mounting with bracket, Vaneometer should be located at least 6 inches from wall or side of duct. For accurate readings be sure to keep meter level at all times.

To determine face velocity, take the average of six readings. Readings should be taken at the center of six equal sections, three across top and three across the bottom.

When conditions are such that the Vaneometer cannot be permanently mounted, it may be more practical to install a Dwyer Mark II differential pressure manometer and calibrate it to indicate a dirty filter condition. To calibrate a Dwyer Mark II No. 25 Manometer with the Vaneometer, first follow Mark II installation instructions, (Bulletin 0.58 included with the gage). Install new filters, start spray booth fan, note and record manometer reading and face velocity. Block-off filter media until face velocity reaches 100 feet per minute or conforms to OSHA, EPA or governing agency. Record and mark this point on the manometer, then replace filters at this point.



For replacement Vanes, order • Part No. A390, package of two.

MARK II MANOMETER

DWYER INSTRUMENTS, IN1,., P.O. BOX 373, MICHIGAN CITY, INDIANA 46360, U.S,A Phone: 219/879-8000



FR 69-441 I

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Supersedes: 12/17/2004
Reviewed by RSC: 7/27/2010



SUBJECT: HOOD FACE VELOCITY MAINTENANCE PROGRAM

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**OBJECTIVE:** This program provides a means to measure hood face velocities and maintain them within acceptable standards.

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** SOP-03, 16, 28, 33

## PROCEDURE

### 1.0 As Found Measurements

1.1. Measure the total width of all openings of the Hood. Record on the data sheet.

1.2. Measure the linear feet per minute velocity at the center of the hood face opening and record the values.

### 2.0 As Left Measurements

2.1. Adjust the hood opening to the recommended value for that hood from the data sheet

2.2. Measure the linear feet per minute velocity at the center of the hood face opening and record the values.

### 3.0 Action Levels

3.1. The action level is 100 ft/minute. No hood may be used with less than 100 ft/min face velocity.

### 4.0 Corrective Action

4.1. Corrective action should be taken if the face velocity falls below 100 ft/min. These actions may range from reducing the recommended opening through tightening a loose belt to modifying the air handling system.

### 5.0 Frequency

5.1. The frequency for hood face velocity measurements is weekly.

---

## BUILDING 100 HOODS

Performed by: Date

| Hood number/user | | Width | Height | Area | LFM | CFM | COMMENTS |
|---|---|---|---|---|---|---|---|
| 100N1 | As found | | 25 | | | | |
| Kamal Das | Normal | 14 | 25 | 2.4 | | | |
| 100N2 | As found | | 19 | | | | |
| Dunlong Jian-left | Normal | 14 | 19 | 1.8 | | | |
| 100N3 | As found | | 19 | | | | |
| Dunong Jian-right | Normal | 14 | 19 | 1.8 | | | |
| 100NW1 | As found | | 28 | | | | |
| Unassigned | Normal | 28 | 28 | 5.4 | | | |
| 100NW2 | As found | | 27 | | | | |
| Vora | Normal | 16 | 27 | 3.0 | | | |
| 100W1 | As found | | 21 | | | | |
| Kajal Das | Normal | 20 | 21 | 2.9 | | | |
| 100W2 | As found | | 27 | | | | |
| Jason Yu | Normal | 50 | 27 | 9.4 | | | |
| 100S1 | As found | | 29.5 | | | | |
| waste | Normal | 12 | 29.5 | 2.5 | | | |
| 100S2 | As found | | 22 | | | | |
| shaker | Normal | 28 | 22 | 4.3 | | | |
| 100S3 | As found | | 13 | | | | |
| Phil Korb–left | Normal | 32 | 13 | 2.9 | | | |
| 100S4 | As found | | 13 | | | | |
| Phil Korb–right | Normal | 21 | 13 | 1.9 | | | |
| 100E1 | As found | | 26 | | | | |
| rotovap | Normal | 45 | 26 | 8.1 | | | |
| 100E2 | As found | | 14 | | | | |
| rotovap | Normal | 60 | 14 | 5.8 | | | |
| 100DR | As found | | 10 | | | | |
| darkroom | Normal | 8 | 10 | 0.6 | | | |
| | | | | | | | |
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| Performed by: | | | | | | Date | |
|---|---|---|---|---|---|---|---|
| Hood number/user | | Width | Height | Area | LFM | CFM | COMMENTS |
| 200LW1 | As found | | 30.75 | | | | |
| Liquid evapo | Normal | 8 | 30.75 | 1.7 | | | |
| 200LW2 | As found | | 26 | | | | |
| Liquid evapo | Normal | 6 | 26 | 1.1 | | | |
| 200LW3 | As found | | 33 | | | | |
| Liquid evapo | Normal | 6 | 33 | 1.4 | | | |
| 200LW4 | As found | | 33 | | | | |
| Liquid evapo | Normal | 6 | 33 | 1.4 | | | |

## BUILDING 200 300 HOODS

Performed by: Date

| Hood number/user | | Width | Height | Area | LFM | CFM | COMMENTS |
|---|---|---|---|---|---|---|---|
| 300SW1 | As found | | 24 | | | | |
| | Normal | 35 | 24 | 5.8 | | | |
| 300SW2 | As found | | 24 | | | | |
| | Normal | 40 | 24 | 6.7 | | | |
| 300NW1 | As found | | 24 | | | | |
| | Normal | 36 | 24 | 6.0 | | | |
| 300NW2 | As found | | 24 | | | | |
| | Normal | 6 | 24 | 1.0 | | | |
| 300N1 | As found | | 24 | | | | |
| Rotovap | Normal | 16 | 24 | 2.7 | | | |
| 300N2 | As found | | 31.5 | | | | |
| Kajal Das - right | Normal | 12 | 31.5 | 2.6 | | | |
| 300N3 | As found | | 20 | | | | |
| Ashok - right | Normal | 25 | 20 | 3.5 | | | |
| 300N4 | As found | | 26.5 | | | | |
| Janard - left | Normal | 12 | 26.5 | 2.2 | | | |
| 300C1 | As found | | 14 | | | | |
| Ganeshraj - left | Normal | 12 | 14 | 1.2 | | | |
| 300C2 | As found | | 30.5 | | | | |
| Tian - right | Normal | 12 | 30.5 | 2.5 | | | |
| 300C3 | As found | | 24 | | | | |
| Janard - far right | Normal | 12 | 24 | 2.0 | | | |
| 300S1 | As found | | 24 | | | | |
| Larry/Janard - left | Normal | 12 | 24 | 2.0 | | | |
| 300S2 | As found | | 24 | | | | |
| Larry/Janard - center | Normal | 12 | 24 | 2.0 | | | |
| 300S3 | As found | | 24 | | | | |
| Larry/Janard - right | Normal | 13 | 24 | 2.2 | | | |
| 300DR1 | As found | | 27 | | | | |
| Darkroom - left | Normal | 12 | 27 | 2.3 | | | |
| 300DR2 | As found | | 27 | | | | |
| Darkroon - right | Normal | 12 | 27 | 2.3 | | | |
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# IATA Dangerous Goods Check List

**Each Item of this check list will be verified as correct. The individual verifying the item will certify by initialing the appropriate entry.**

**Non conforming items will be brought to the attention of the appropriate person, for example, errors in Content will be referred to Shipping; errors in the Declaration will be referred to the sales office.**

**The RSO (or Assistant RSO in the absence of the RSO) shall sign verifying completeness of the check.**

## Package Content

Content on Label matches Invoice _____

Content on Label matches Data Sheet _____

## Dangerous Goods Declaration

There are at least two copies in English _____

Shipper complete name & address are present _____

Addressee complete name & address are present _____
**And match with invoice "Ship To"**

Page of Pages is listed correctly _____

"Non Radioactive" obliterated _____

Proper type of Aircraft chosen _____

**The following 3 items are not required if using a Forwarder Such as FedEx or DHL etc mark as N/A if not required**

Air Way Bill Number _____
Airport of Departure _____
Destination Airport _____

**For each item in the "Nature and Quantity" Section**

Column 1 contains **UN2915** _____

Column 2 contains **Radioactive Material Type A Package** _____

Column 3 contains the numeral 7 _____

Column 4 should be blank _____

Column 5 description of package EXAMPLE *Carbon 14 liquid Labeled compound 65000 MBq.* _____

Note Column 5 will contain additional information (see below)

Column 6 contains the label (White I or Yellow II) and the Transport Index (if yellow II) _____

Column 7 is blank _____

**IF DRY ICE IS IN THE PACKAGE The following additional entries will Be made**

Column 1 contains **UN1845** _____

Column 2 contains **Dry Ice** _____

Column 3 contains the numeral **9** _____

Column 4 contains is blank _____

Column 5 contains **net weight of ice** EXAMPLE 4 kg. _____

Note Column 5 will contain additional information (see below)

Column 6 contains **954** _____

Column 7 is blank _____

Column **5 below all other entries** contains the statement

Packed in 1 Type a Package
Lists the **total** Activity in Bq or multiples
Lists the package dimensions in cm. **(if Yellow II)**

If more than one line item, the state will read "All packed in 1...) _____

Verify that the total activity is correct _____

**Additional Handling Information**

Following statements are present

"Radioactive Materials for use in medical research. ICAO/IATA used" _____

"24 hour emergency Contact Tel No (314) 991-4545" _____

Place, date and signature are present and valid _____

## Air Waybill

Does Handling instruction box contain one of the following

"Dangerous goods as per attached Shipper's Declaration" or "Dangerous Goods as per attached DGD";

_____

## Package Marking and Labeling

Box states "UN2915 Radioactive Material Type A Container" _____

Box has Biomedical Research statement _____

**For Dry ICE** does weight on the box match the weight on the DG _____

Are Hazard labels on opposite sides of the box _____

Is Package Survey Form Complete _____

Is Transport Index (TI) as measured in agreement with label and with the dangerous goods declaration _____

Are Hazard labels unobscured _____

Are orientation arrows unobscured _____

Is the DG Declaration signed _____

The package is certified as ready for transport to the best knowledge and understanding of the Undersigned

Signature_____Date_____

Print Name_____

Supersedes: 12/17/2004 
Approved by RSC: 4/30/08

SUBJECT: ARC SHIPPING PROGRAM

---

**OBJECTIVE:** This program provides a means to ship radioactive materials in compliance with DOT or IATA regulations

**RESPONSIBILITY**: As specified below in this procedure

**REFERENCES:** 10CFR71; 49CFR100 – 49CFR185; IATA Air International Regulations

**PROGRAM**

**1.0 Chemists**

1.1 Production chemists assay finished products and provide all information necessary to identify the contents.

1.2 Finished vials are cleaned by packaging chemists to assure that they are within the permissible level for handling without gloves. This permissible level is 1000 dpm/100 $cm^2$ (or 100dpm/vial) for any beta or gamma emitting radionuclide.

1.3 The packaging chemist then provides sufficient information for the office personnel to update the bulk inventory.

**2.0 Secretary**

2.1 The secretary takes customer telephone orders, reviews faxes, emails, and web orders, and checks them against both the prepackaged and bulk inventory.

2.2 The secretary gives all shipping labels and shipping documents to the shipping clerk.

2.3 The secretary coordinates with other office personnel and the shipping clerk to make all necessary changes to the computerized inventory system.

2.4 The secretary determines the sum total for each radionuclide in each of the solid, liquid or gas categories and enters the totals in a chart. **For example:**

| Millicuries | Solid | Liquid | Gas |
|---|---|---|---|
| Carbon-14 | 10 | 4 | |
| Calcium-45 | | | |
| Chlorine-36 | | | |
| Hydrogen-3 | | 10 | |
| Iodine-125 | | | |
| Iodine-131 | | | |
| Phosphorous-32 | | | |
| Phosphorous-33 | | | |
| Sulfur-35 | | 0.1 | |
| Iron-59 | | | |
| Strontium-89 | | | |

The secretary then divides each total by the respective value in the below table and sums the fractions as follows:

$$\frac{10}{81} + \frac{4}{8.1} + \frac{10}{110} + \frac{0.1}{8.1} = 0.12354 + 0.4938 +$$

0.0909 + 0.0123 = 0.7205 which is less than 1, there fore this package would meet the criteria for a limited quantity.

| Millicuries | Solid | Liquid | Gas |
|---|---|---|---|
| Carbon-14 | 81 | 8.1 | 81 |
| Calcium-45 | 27 | 2.7 | 27 |
| Chlorine-36 | 13.5 | 1.35 | 13.5 |
| H-3 (other than HTO) | 1100 | 110 | 1100 |
| Iodine-125 | 81 | 8.1 | 81 |
| Iodine-131 | 19 | 1.9 | 19 |
| Phosphorous-32 | 14 | 1.4 | 14 |
| Phosphorous-33 | 27 | 2.7 | 27 |
| Sulfur-35 | 81 | 8.1 | 81 |
| Iron-59 | 24 | 2.4 | 24 |
| Strontium-89 | 13.5 | 1.35 | 13.5 |
| Chromium – 51 | 810 | 81 | 810 |
| Iron – 55 | 1100 | 110 | 1100 |

Tritium as HTO (tritiated water)

| | |
|---|---|
| <0.1 Ci/L | 1000 Ci |
| >0.1 Ci/L but <1.0 Ci/L | 100Ci |
| >1 Ci/L | 1Ci |

The secretary then applies the sum of fractions rule to determine the proper shipping name.

**If the sum of the fractions equals 1 or less, the shipping name is:**
**"UN 2910, radioactive material, excepted package--limited quantity of material"**

**If the sum of the fractions is greater than 1, the shipping name is:**
**"UN 2915, radioactive material, Type A package, *non-special form, non-fissile or fissile excepted"***

**Note: UN 2915 packages, require DG paperwork, and appropriate Radioactive material label**

2.5 The secretary converts millicuries to megabequerels as follows:

N mCi * 37 MBq / mCi = 37 * N MBq

2.6 The secretary types a shipper's declaration for dangerous goods, air bills, address labels, packing lists, and shipper's instructions as appropriate.

2.7 The secretary gives all labels and shipping documents to the shipping clerk.

## 3.0 Shipping Clerk

3.1 The shipping clerk checks to see if the product is available in prepackaged inventory. If not, the shipping clerk notifies one of the packaging personnel who will review the packing slip to ensure it includes all pertinent product information and the quantity to be packaged.

3.2 The packaging personnel will make any necessary adjustments to the slip and returns the slips to the shipping clerk.

3.3 The shipping clerk transmits a copy of the slips to the office personnel for review before printing the product's radioactive materials labels.

3.4 The shipping clerk prepares the radioactive materials labels for the vial and the plastic container using the information from the slip.

3.5 The shipping clerk returns the slips along with the product labels to the packaging personnel for packaging.

3.6 The packaging personnel packages the products from bulk inventory and seals the vial in a plastic bag with the slip and labels and returns to the shipping clerk.

3.7 The shipping clerk cleans the vials received from the packaging personnel, attaches the labels to the vials, and seals the vials in a plastic bag. All screw-cap vials are taped to prevent loosening during shipment.

3.8 The shipping clerk wraps the plastic bag containing the vial with absorbent paper, seals it in a plastic container, and labels the container with a duplicate radioactive materials label. Absorbent paper must be adequate enough to absorb twice the amount of liquid shipped.

3.9 The shipping clerk double checks customer orders against the packaged product.

3.10 The shipping clerk enters all customer information and product data into the computerized log and fills out the data sheets accordingly. NOTE: At the end of the day, the shipping clerk prints the daily log out and places in the logbook.

3.11 The shipping clerk packs the product in appropriate fiberboard box, labels the box, and inserts the data sheet.

3.12 The shipping clerk attaches the packing list and shipping papers on the box.

3.13 The shipping clerk labels any extra vials prepared and places them in prepackaged inventory.

3.14 The shipping clerk inspects each package of radioactive materials and reviews its associated shipping papers.

3.15 The shipping clerk coordinates with the office personnel to make all necessary changes to the computerized inventory system.

## 4.0 Shipping surveys

4.1 Wipe Survey

4.1.1 The shipping clerk groups the prepared packages into groups of not more than five packages.

4.1.2 The Radiation Safety Officer (or the shipping clerk as designee for the RSO, see RPP Section 3.3.4.12) wipe tests all of the boxes in a group with one wipe. Each box is wiped over a 300 $cm^2$ area. Wipes are assayed using an instrument calibrated to output cpm/300 $cm^2$ (Counting Protocol #18–Shipping/Receiving,). It is assumed that any activity found on the wipe originated from only one box. Boxes are released for shipment if the composite wipe is less than the DOT limit of 1000 cpm/300 $cm^2$.

4.1.3 The shipping clerk files the wipe survey results for review by the NRC.

4.1.4 In the unlikely event that the composite wipe exceeds 1000 cpm/300 $cm^2$, each box in the group is wipe tested separately to determine which box is contaminated.

4.1.5 The contaminated box is disposed of, replaced with a new one and retested for loose contamination before release.

4.1.6 If a shipping package is found to be contaminated, area surveys are performed to determine the extent of the contamination. After cleanup, the RSO, or designee, see RPP Section 3.3.4.12, attempts to determine the cause and to take corrective actions to prevent a recurrence.

4.2 Radiation Levels

4.2.1 Radiation level surveys shall be performed using an instrument calibrated to read mr/hr. The Radiation Safety Officer, or designee, see RPP Section 3.3.4.12, measures the dose rate on the package surfaces to assure that Excepted and White I packages do not exceed 0.5 mrem/hour.

*4.2.2* If the surface dose rate exceeds 0.5 mrem/hr, The Radiation Safety Officer, or designee, see RPP Section 3.3.4.12, measures the Transport Index (TI) and writes this number in the box provided on a Yellow II label. The TI is recorded to the nearest one tenth of a millirem/hour. The minimum TI to be entered on a label is 0.1. *NOTE: The TI (transport index) is the net mrem/hr at 1 meter from the package surfaces. Very rarely does a package require a Yellow III label.*

| Millirem/hour | Excepted | White I | Yellow II | Yellow III |
|---|---|---|---|---|
| Surface | <=0.5 | <= 0.5 | 0.5 - 50 | 50 - 200 |
| Transport Index | NA | (TI=0*) | 0.1 – 1.0 | 1.1 – 10 |

*(On shipping papers, not on label)

4.2.3 As required, the shipping supervisor places White I or Yellow II labels on two opposite sides of the package.

## 5.0 Radiation Safety Officer

5.1 The RSO or designee, see RPP Section 3.3.4.12 certifies each package of radioactive material as required by 49 CFR § 172.204 *Shipper's certification* by his signature or facsimile on one of the following statements on the *Shipper's Declaration for Dangerous Goods*:

5.1.1 DOT

"This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation."

5.1.2 DOT and IATA

"I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national government regulations."

5.2 The RSO or designee, see RPP Section 3.3.4.12 fills out the "Package Survey" form (see attached) for each Outgoing Dangerous Goods shipment (Radioactive White I or Radioactive Yellow II).

**5.3 ARC does not ship packages that require a Radioactive Yellow III label.**

**5.4** The RSO or designee, see RPP Section 3.3.4.12 uses the IATA Checklist (see attached) to ensure that all Dangerous Goods shipment traveling by air meet all IATA an d DOT requirements.

## Appendix One Step-by-step radiation level survey

1.0 All reading will use the mrem/hr scale of the meter

2.0 At the start of package surveys, turn on the shipping meter and allow time for background to stabilize. Note the background in mr/hr without packages present.

3.0 Measure the maximum surface dose rate on the package. Check all six sides

4.0 Subtract background from the surface reading

5.0 Net dose rate

5.1 If the net dose rate is <= 0.5 mr/hr at the surface, the package requires either no label (excepted package) or a White I label. (No TI for a White I label) Note: some carriers require a TI=0 entry on the paperwork.

5.2 If the contact dose rate is less than 0.5 mrem/hr, then

5.2.1 If the package is going as UN2910, no further measurements are necessary.

5.2.2 If the package is going as White I, measure the highest dose rate at 1 meter.

5.3 If the net dose rate is > 0.5 mr/hr at the surface, the package requires a Yellow II label.

6.0 Measure the TI for a package requiring a Yellow II label.

By definition, a TI is the mr/hr at 1 meter from a package.

6.1 Place the package 1 meter from the detector.

6.2 Measure the dose rate in mr/hr.

6.3 Subtract the background dose rate.

6.4 The net rate is the TI for the package.

6.5 If the count rate is indistinguishable from background, enter TI = 0.1 on the label and on the paperwork.

7.0 For White I and Yellow II Complete the Package Survey form and the IATA check list.

8.0 If no other packages require survey, Turn off the shipping survey meter.

# Attachment One

# Package Survey Form

# Attachment Two

# IATA/DOT Check List

Supersedes:1/7/2005 
Approved by RSC: 3/7/2008

SUBJECT: ARC SHIPPING PACKAGE TESTING PROGRAM

---

**OBJECTIVE:** This program provides a means to test packages against the USA DOT 7A TYPE A performance standards.

**RESPONSIBILITY:** Radiation Safety Officer

**PROGRAM**

**1.0 General performance requirements**

When subjected to the tests in this SOP, the package will prevent

1.1 loss or dispersal of the radioactive contents and

1.2 any significant increase in the radiation levels at the external surfaces of the package.

**2.0 Demonstration of compliance with tests**

Compliance with the test requirements shall be shown

2.1 by performance of tests with prototype packages the contents of which will simulate the expected radioactive contents. Non-radioactive substitute contents should be used providing the radioactive characteristics are taken into account.

2.2 by reference to a previous satisfactory series of tests on a similar package.

**3.0 Type A packaging tests**

3.1 Water spray

Spray a package simultaneously from 4 different directions at a rate of 2 inches per hour for a period of 1 hour. A shower stall may be used for this test. Perform the following Section 3 tests 2 hours after a spray test.

Note: The following tests may be performed on individual packages or on the same package in sequence with the exception of the 1 foot free-drop test. Tests shall be conducted to cause maximum damage to the package.

3.2 Free-drop (4 foot) - all packages

Corner-drop the package (1 corner) onto a flat, horizontal, concrete or steel surface through a distance of 4 feet (1.2 meters).

3.3 Free-drop (1 foot) - rectangular, fiberboard packages.

Corner-drop a separate package (each corner) onto a flat, horizontal, concrete or steel surface through a distance of 1 foot (0.3 meters).

3.4 Compression

For a period of 24 hours, apply to the top of a package a compressive load equal to the greater of 5 times the weight of the package or 1.9 pounds per square inch.

3.5 Penetration

Place the package on a flat, horizontal, concrete or steel surface. Suspend the special testing rod 3.3 feet (1 meter) above the package and free-drop the rod.

## 4.0 Additional tests for packages containing liquids or gases

4.1 Free-drop (30 foot)

Free-drop the package through a distance of 30 feet (9 meters) onto a flat, horizontal, concrete or steel surface striking the surface in a position to maximize any damage.

4.2 Penetration

Place the package on a flat, horizontal, concrete or steel surface. Suspend the special testing rod 5.5 feet (1.7 meters) above the package and free-drop the rod.

## 5.0 Documentation of package testing

Complete Section 6 which describes the component parts of the package being tested and the results of the testing. Retain this document and any photographs which may have been taken for review by the NRC or DOT.

NOTE: Italicized portions of the section following are for example purposes only. Section Six should be completed for each package type tested.

## 6.0 Shipping package testing report number - i.e., 931126

6.1 Package component parts (from inside out)

Product container(s) - *round bottom flask with break-seal and side-arm*

Absorbent/cushioning material - *2 inch foam rubber on bottom, side and top with 2 inch foam rubber vertical separator to form 2 compartments*

Secondary container(s) - *none*

Number of above units in package - *2*

Bracing - *held in place by foam rubber.*

Outer container - *Air and water tight 3 1/2 gallon HDPE pail by Plastican Inc 12" diameter x 15" high.*

Special - *none*

6.2 Testing results - Passed

| | | | | |
|---|---|---|---|---|
| 3.1 | Water spray | Performed | [ ] | Not applicable [X] |
| 3.2 | Free-drop (4 foot) | Passed [X] | | |
| 3.3 | Free-drop (1 foot) | Passed [ ] | | Not applicable [X] |
| 3.4 | Compression | Passed [X] | | |
| 3.5 | Penetration (3.3 feet) | Passed [X] | | |
| 4.1 | Free-drop (30 foot) | Passed [X] | | Not applicable [ ] |
| 4.2 | Penetration (5.5 feet) | Passed [X] | | Not applicable [ ] |

Performed By: *Joe Technician*

Date Completed: *01/01/2001*

Supersedes: 12/17/2004
Reviewed by RSC: 7/27/2010



SUBJECT: INVIVO BIOASSAY PROGRAM

**This SOP has been suspended from use as being no longer applicable.**

**In the event that ARC begins processing of significant amounts of radio-iodines, this Standard Operating Procedure will be updated and reinstated.**

Supersedes: 12/17/2004
Reviewed by RSC: 7/27/2010



SUBJECT: $^{125}$I AIR MONITORING PROGRAM

---

**This SOP has been suspended from use as being no longer applicable.**

**In the event that ARC begins processing of significant amounts of radio-iodines, this Standard Operating Procedure will be updated and reinstated.**

Supersedes: 12/17/2004
Reviewed by RSC: 7/27/2010



SUBJECT: $^{32}P$ AIR MONITORING PROGRAM

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**This SOP has been suspended from use as being no longer applicable.**

**In the event that ARC begins processing of significant amounts of P-32, this Standard Operating Procedure will be updated and reinstated.**

Supersedes: 1/7/2005
Reviewed by RSC: 7/27/2010



SUBJECT: PROCUREMENT AND USE OF RADIOACTIVE MATERIALS

---

**OBJECTIVE:** This procedure provides a means to assure that possession limits are not exceeded and that radioactive materials are used safely.

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** RPP Sections 1 and 3

**PROCEDURE:**

## 1.0 Procurement of Radioactive Materials

1.1. The procurement of radioactive materials is limited to the Company President or to an individual under his direction.

1.2. Prior to ordering, the activity to be ordered is checked against the computer inventory and compared to possession limits to assure compliance.

1.3. The activity received is added to the computer inventory and compared to possession limits to assure compliance.

## 2.0 Use of Radioactive Materials

2.1. New Uses of RAM

The Radiation Safety Committee (RSC) shall complete safety evaluations of proposed new uses of radioactive materials prior to the new use. If it is indeed a new USE, then a license amendment will be prepared and submitted. Records (minutes) of the safety evaluation shall be kept. The new use shall not take place until the amendment is approved.

2.2. Standard Production Protocols

The RSC shall complete safety evaluations of new protocols for the syntheses of radiochemicals prior to production of the radiochemicals. Records (minutes) of the safety evaluation shall be kept. If this involves a new USE, see 2.1 above.

2.3. Existing Facilities Modifications

The RSC shall complete safety evaluations of proposed modifications to existing facilities required for the new use prior to the modifications. Any

such modifications must improve or maintain the level of radiation safety. Records (minutes) of the safety evaluation shall be kept. A license amendment will be prepared and submitted. The modification shall not take place until the amendment is approved.

2.4. Radiation Protection Program and Standard Operating Procedure Modifications

2.5. The RSC shall complete safety evaluations of proposed modifications of the RPP or SOP's required for the new use prior to incorporation of the modifications. Any such modifications must improve or maintain the level of radiation safety. Records (minutes) of the safety evaluation shall be kept. A license amendment will be prepared and submitted. The new use shall not take place until the amendment is approved.

**AMERICAN RADIOLABELED CHEMICALS, INC.**
**STANDARD OPERATING PROCEDURE - SOP-16**

Supersedes: 7/27/2010 
Reviewed by RSC: 2/21/2011

SUBJECT: RADIOACTIVE CONTAMINATION CONTROL PROGRAM

---

**OBJECTIVE:** The radioactive contamination control program provides a means to measure and control removable radioactive contamination.

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** General Reference Only: Reg Guide 8.21, Section C, para 1.4 – 1.8; Reg Guide 1.86, Table 1;

Nureg-1556 Vol. 12 appendix P
**This reference is used for guidance only and not for any specific quantity or use.**

SOP-33;
SOP-21;
SOP-38

**PROCEDURE:**

**1.0 Requirement**

Representative total and removable contamination surveys are required in Restricted Areas and Unrestricted areas.

1.1. Unrestricted areas.

Unrestricted Areas are those that are not controlled or restricted in any manner by ARC. Example: Building 400, Building 400 parking areas, Building 400 Landscape areas, ARC Drive, and all off site areas.

1.2. Controlled Areas

Controlled area - any area, outside of restricted areas and within the site boundaries, access to which can be limited for any reason. Offices and lunchrooms in the laboratory buildings, and areas of the property between and around the laboratory buildings are examples of controlled areas.

1.3. Restricted Areas

Restricted Areas are further sub-divided into:

1.3.1. High Contamination Areas

Areas such as, but not limited to, inside fume hoods, inside bench top trays, inside the compactor enclosure; other areas as designated by the RSO.

1.3.2. Contamination Areas

1.3.2.1. Areas inside the laboratories not listed as High contamination areas.

1.3.2.2. Any area, no matter where located, where the following limits are exceeded:

Total – 5000 dpm/100 $cm^2$ average, not to exceed 15,000 for a single point

Removable – 1000 dpm/ 100 $cm^2$

1.3.3. Non-contaminated Restricted areas

Areas such as, but not limited to, change areas, the shipping area, the building 300 garage or other areas designated by the RSO.

**2.0 <u>Action level</u>**

At this level, areas and equipment are decontaminated by maintenance personnel under supervision of the Radiation protection staff at the next practical (usually immediately, but in all cases within 24 hours time if contamination is above the following levels.)

2.1. Contaminated Restricted Areas

Tritium – 50,000 dpm/100 $cm^2$

Carbon-14 – 10,000 dpm/100 $cm^2$

Other $\beta$–$\gamma$ - 10,000 dpm/100 $cm^2$

2.2. Non-contaminated Restricted Areas

Total- 5000 dpm/100 $cm^2$ average, not to exceed 15,000 for a single point

Removable – 1000 dpm/ 100 $cm^2$

2.3. Controlled Areas

Total- 5000 dpm/100 $cm^2$ average, not to exceed 15,000 for a single point

Removable – 1000 dpm/ 100 $cm^2$

2.4. Unrestricted Areas

The **goal** for these areas is 100 total dpm above background for wipe samples and 100 cpm above background for direct survey. The action level is:

Total- 5000 dpm/100 $cm^2$ average, not to exceed 15,000 for a single point

Removable – 1000 dpm/ 100 $cm^2$

2.5. Routine surveys should include areas most likely to be contaminated such as the floors and doorknobs on the "clean" side of the laboratory exits.

2.6. Any area exceeding the action level shall be restricted

2.6.1. Affected personnel shall be informed of the elevated levels;

2.6.2. Affected personnel shall be advised of interim actions and/or restrictions to be followed.

## 3.0 Investigation Level

At this level, areas and equipment are decontaminated immediately by maintenance personnel under supervision of the Radiation protection staff upon discovery if contamination is above the following levels.

3.1. If initial contamination levels exceed 10 times the action levels, attempt to determine the source and cause.

3.2. Document the results of the investigation and file the report in the Off-normal Occurrence File.

3.3. Decontaminate the area or equipment immediately.

## 4.0 Stop Work Level

This is the upper limit for contamination in ARC facilities. If any Investigation Level listed above is exceeded by a factor of 200, (NOTE: This is 2000 times the Action Level) all work in that lab building or exterior location will stop until the following conditions are met simultaneously. Note: the RSO will be contacted prior to any sort of cleanup, 4.4 denotes that the RSO has given approval to lift the stop work order.

4.1. The extent and cause of the contamination has been determined

4.2. All individuals have been shown to be non-contaminated

4.3. The contamination levels have been reduced to below the investigative level,

4.4. The RSO (by telephone, if necessary) has given permission to resume work

## 5.0 Survey frequency

5.1. The routine frequency for removable contamination surveys of each type (direct frisk and wipe) is twice weekly. Materials or equipment removed from restricted areas are surveyed prior to removal.

5.2. Surveys are performed to determine the "worst case" conditions in both restricted and unrestricted areas.

5.3. Direct frisk surveys, those made with a survey meter, are taken in Controlled areas, non-contaminated restricted areas and unrestricted areas to determine total activity, these surveys are taken weekly.

5.4. Wipe surveys are taken in Controlled areas, non-contaminated restricted areas, and unrestricted areas to assure that activity has been contained within restricted areas.

5.5. Contamination is not to be expected in unrestricted areas and indicates that containment has been breached

5.6. High Contamination Areas

These areas are inside hoods and inside working tray on bench tops, not routinely surveyed.

5.7. Contamination Areas

5.7.1. End of Week prior to cleaning – Last workday of the week, usually Friday

5.7.2. Start of Week, after cleaning – Usually Monday morning.

5.8. Controlled and Non-contaminated Restricted Areas

5.8.1. Same frequency as above, with

5.8.2. Daily surveys performed as conditions and manpower permit.

5.9. Unrestricted Areas

5.9.1. Areas within Building 400 - Weekly

5.9.2. Other areas (Private vehicles, driveways, sidewalks, street shoes, street clothing and other similar areas/objects) -- Monthly, time and manpower permitting.

## 6.0 Procedure

6.1. Use dry wipes and number them consecutively.

6.2. Wipe approximately 100 $cm^2$ of the surface being surveyed. A 16 square inch area is approximately 100 $cm^2$ (i.e. 4 x 4, 2 x 8, etc.). If the surface being surveyed is less than 100 $cm^2$, wipe the entire surface.

6.3. For weekly required restricted area surveys, enter the number of the wipe on a diagram of the area being surveyed.

6.4. Assay the wipes in a liquid scintillation counter (LSC) that automatically converts the count rate to net dpm/100 $cm^2$.

6.5. Decontaminate and rewipe any surface areas above the action levels defined in 2.0 above.

6.6. Repeat the above step as necessary.

6.7. Use a survey meter calibrated for C-14 cpm and record the total for the area being surveyed. This is normally the same area as the wipe survey

6.8. If required, compute the fixed/loose ratio.

## 7.0 Calibration of LSC

7.1. The LSC performance is ensured through a service agreement with the equipment vendor.

7.2. Calibration is accomplished through the use of available quenched standards.

## 8.0 Quality assurance.

8.1. Quality assurance is performed by counting available quenched standards for $^{14}C$ and tritium. Results must be +-15% of the standard value.

8.2. Efficiency and Background are determined daily when the LS is in Service.

SUBJECT: DECAY-IN-STORAGE PROGRAM

---

**OBJECTIVE:** The decay-in-storage program provides a means to assure that materials released to sanitary landfills have radiation levels indistinguishable from background

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** SOPs 16, 20, 21, 33, 35, and 38

## PROGRAM

### 1.0 Applicability

Decay-in-storage applies only to radionuclides with a half-life less than 120 days.

### 2.0 Requirements

2.1. Waste must be segregated by physical form (e.g. solid, liquid or gas)

2.2. Waste must be segregated by radionuclide (e.g. $^{131}I$, $^{32}P$, $^{125}I$, $^{35}S$)

2.3. Waste containers must be properly labeled (e.g. nuclide, activity and date)

2.4. Maintain records of the location and contents of waste containers.

2.5. Waste must be held for decay for a minimum of 10 half-lives.

2.6. Waste must be surveyed before release to a sanitary landfill.

### 3.0 Procedure

**DIS** waste will be stored in the Radiation Safety workroom, Bldg 300.

3.1. Survey stored waste in a low background area

3.2. Use a survey meter or monitor equipped with a thin end-window G.M. detector for beta emitting waste.

3.3. Use a gamma scintillation detector for waste that does not emit a beta.

3.4. Hold the detector within one (1) centimeter of the exposed waste.

---

3.5. Release the waste only if levels are indistinguishable from background.

***Note: Indistinguishable from Background may be understood to mean a gross count rate that is not more than two times the standard deviation of the background count above the background count.***

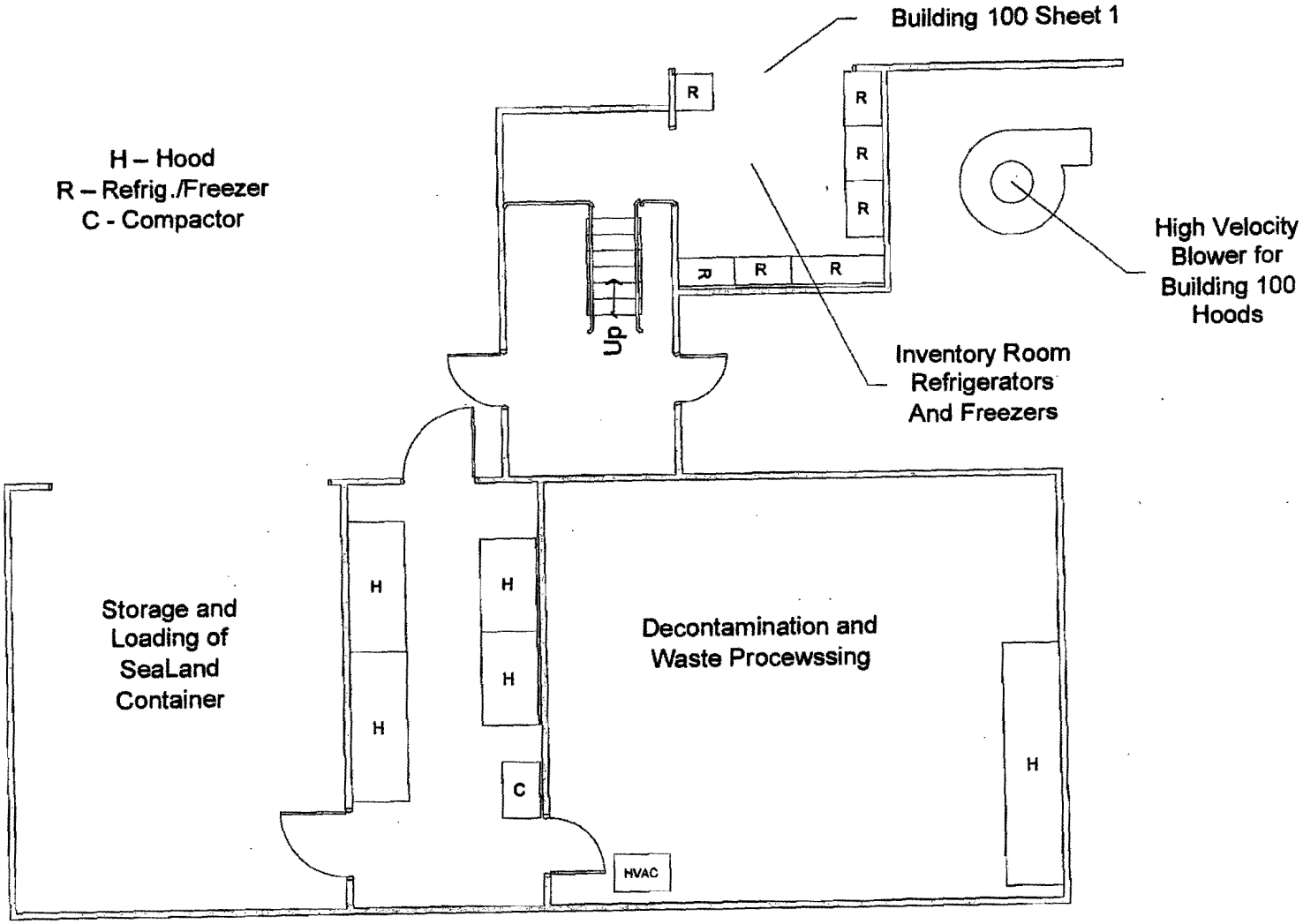
**3.6. ALL labels or other indication of Radioactive material shall be removed prior to discarding**

## 4.0 Calibration

Calibration is maintained by the use of Standard Operating Procedure - SOP-05, *Instrument Calibration Program*

## 5.0 Quality assurance.

Quality assurance is performed by the use of beta or gamma check sources. Results must be +-10% of the expected reading.




100 Laboratories -
Sheet 2

Do Not Scale
Approx. 1/8 in to 1 foot

Supersedes: 2/23/2005
Reviewed by RSC: 7/27/2010



SUBJECT: LIQUID WASTE EVAPORATION PROGRAM

---

**OBJECTIVE:** The liquid waste evaporation program provides a means to safely reduce liquid waste to dry solid waste.

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** RPP Section 9
SOP's 3, 8, 16, 20, 21, 33, 35, 38
Emergency Instructions and Procedure

## PROCEDURE

### 1.0 Precautions and Limitations

1.1. Liquid waste shall be evaporated inside fume hoods under negative pressure.

1.2. Effluent air released to an unrestricted area is monitored.

1.3. Liquid waste shall be transferred between buildings in a container system that has been approved by the RSO.

1.4. Waste evaporation shall be performed in designated hoods in Building 200.

1.5. Laboratory clothing must be worn by the individual performing liquid waste evaporation operations.

1.6. A personal contamination survey is required after an individual performs liquid waste evaporation operations and before he exits building 200.

### 2.0 Procedure

2.1. Chemists

Chemists are responsible for segregation of liquid waste to minimize the volume to be evaporated.

2.1.1. Prevent liquid waste from being diluted.

2.1.2. Segregate aqueous phase from non-aqueous phase.

2.2. Radiation Safety Officer (RSO)

The RSO (or designee, see RPP Section 3.3.4.12) is responsible for assay of low-level aqueous waste to determine if it may be discharged to the sanitary sewer (refer to SOP-07, *Liquid Waste Disposal Program*).

Liquid waste should be evaporated whenever possible to keep the activity discharged to the sanitary sewer as low as reasonably achievable.

2.3. Laboratory Technician

Whenever transporting a liquid waste container system (LWCS) between buildings, a disposable glove must be worn on the hand used to carry the LWCS. Keep the other hand ungloved for opening doors, etc. Do not allow the transfer container to come in contact with surfaces outside of restricted areas since the LWCS could be externally contaminated.

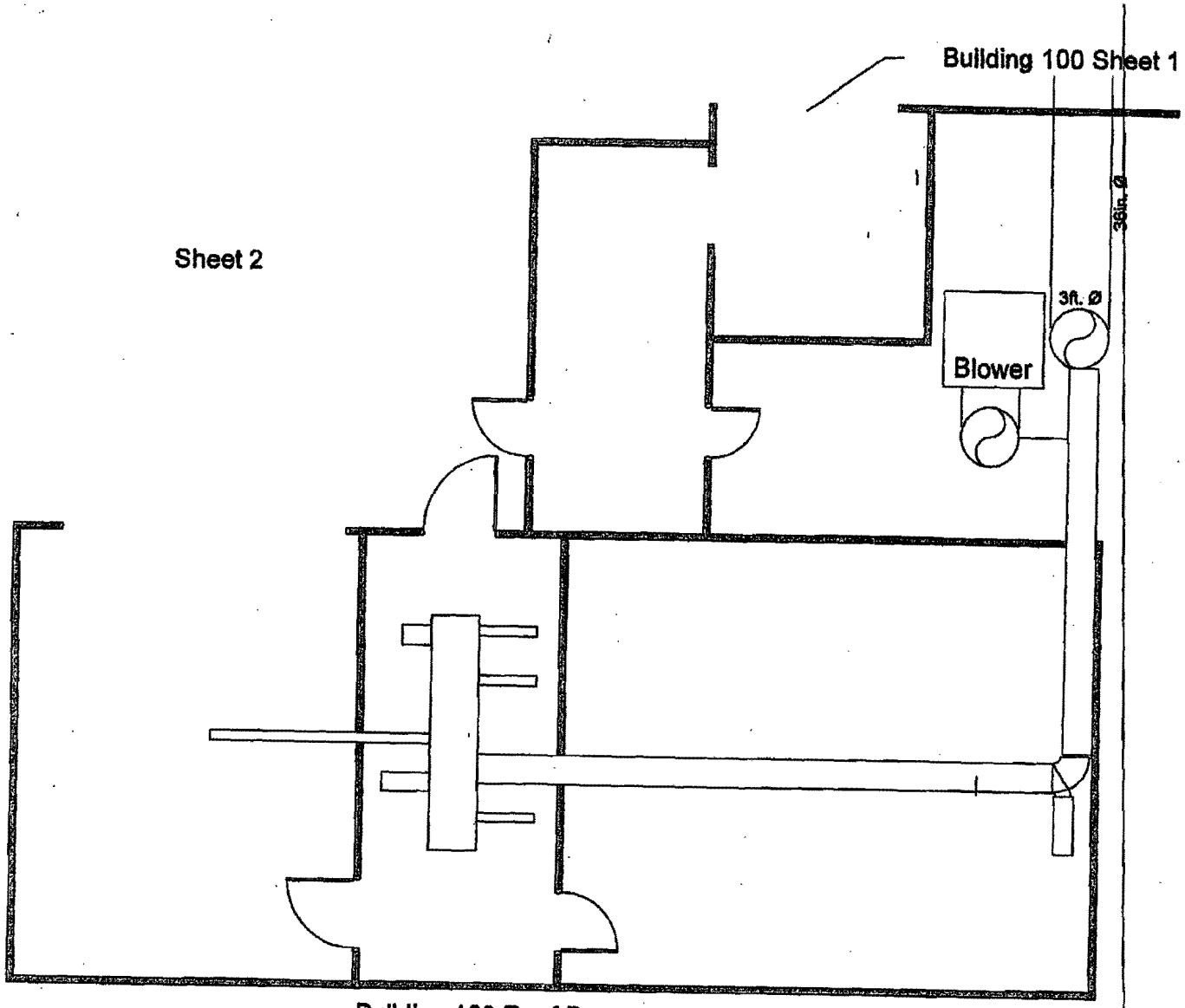
2.3.1. Whenever transporting a LWCS to building 200, exit buildings 100 or 300 through the respective change area.

2.3.2. Place the LWCS on the transfer cart in building 200.

2.3.3. Pour the liquid waste into an open pan containing absorbent sponges or paper. Fill the liquid to a depth of 1 inch or less.

2.3.4. Close the hood panels while evaporating to maximize air flow over the pan surfaces.

2.3.5. Return an empty LWCS to buildings 100 or 300 through its change area.




Building 100 Roof Ducts
Schematic Only

Do Not Scale
Approx. 1/8 in to 1 foot

SUBJECT: EXTENDED INTERIM-STORAGE OF LOW LEVEL WASTE

---

This SOP is suspended.

If waste disposal sites close, the extended interim-storage program will be re-instituted and this procedure will be updated at that time. At that time a license amendment request will be submitted to permit such storage. No long-term storage will be permitted until the amendment is received.

Supersedes: 7/27/2010 
Reviewed by RSC: 2/21/2011

SUBJECT: GLASSWARE DECONTAMINATION PROGRAM

---

OBJECTIVE: The glassware decontamination program provides a means to safely clean and re-use glassware contaminated with ARC licensed nuclides, predominately Tritium and C-14 (99+%)

RESPONSIBILITY: Radiation Safety Officer

REFERENCES: RPP Section 9, SOPs 2, 7, 8, 16, 18, and 33

PREREQUISITES:

- Glassware to be cleaned which contains volatile radioactive materials must be stored inside fume hoods under negative pressure.
- Fume hoods are connected to an air exhaust system.
- Effluent air is monitored before release to an unrestricted area.
- Lab coats and gloves must be worn by individuals cleaning glassware.
- A personal contamination survey is required after cleaning glassware..

PROCEDURE

**1.0 <u>Chemists</u>**

**Responsible for the initial cleaning of glassware before setting it aside for decontamination. Glassware should be free of volatile activity. The cleaning solvent is added to the non-aqueous waste collection container. It is now subject to the provision of SOP 18.**

**2.0 <u>Lab Technician</u>**

2.1. Collect glassware to be cleaned when requested by a chemist.

2.2. Identify the dishpan or bucket containing the glassware with the name of the chemist and transfer it to the decontamination hood.

2.3. Remove stopcock grease from glass joints with hexane or toluene.

2.4. Rinse the glassware with suitable solvents such as acetone or ethyl acetate.

2.5. Retain solvents and cleaning solution in the decon hood and evaporate.

2.6. Transfer the dishpan or bucket containing the glassware to the decon sink and soak glassware in a detergent solution. This aqueous waste is now subject to the provisions of SOP 07. **Before discharge this solution must be analyzed and discharge approved by the RSO or designee, see RPP Section 3.3.4.12.** After approval this solution should be directly discharged.

2.7. Scrub the glassware with a brush and detergent solution. Discharge the detergent solution to the retention tank.

2.8. Rinse the glassware with water. Discharge the water to the retention tank.

2.9. Load the glassware in the dishwasher. Fill the dispenser with dishwasher detergent and run the machine. Discharge the dishwasher to the retention tank.

## 3.0 Further Cleaning

3.1. An alcohol/NaOH solution may be used if the glassware is still not clean after the above steps. This cleaning solution is very caustic and must be used with extreme caution. Consult with a senior chemist before using this cleaning solution.

## 4.0 Return the glassware to the chemist.

Supersedes: 3/9/2005 
Reviewed by RSC: 7/27/2010

SUBJECT: TRAINING AND DOSE ESTIMATES FOR NON-LABORATORY PERSONNEL

---

OBJECTIVE: This procedure is designed to provide individuals who are not ARC employees (e.g. outside contractors), as well as ARC employees who are not assigned full time to the laboratories, radiation safety training specific to the work functions they will perform in contaminated areas, and to provide training commensurate with the hazard(s) present.

It also is designed to provide a conservative estimate (an upper bound) of the dose equivalent received.

RESPONSIBILITY: Radiation Safety Officer

PROCEDURE:

## 1.0 Occupational Exposure

As any dose equivalent received will be as a direct consequence of the individual's work/occupation, the individuals are considered to be Occupationally Exposed.

## 2.0 Radiation Safety Training

2.1 Requirement

2.1.1 Training is required for individuals who perform work functions such as (but not limited to) the installation or repair of air supply or exhaust systems, HVAC systems, plumbing, and carpentry within contaminated areas.

2.2 Providing Training and Qualifications.

2.2.1 RSO Regis Greenwood

2.2.1.1 CHP FHPS, Masters Degree in Health Physics from University of Pittsburgh and forty-seven years of experience.

2.2.2 Health Physicist Donald Lite

2.2.2.1 Bachelor of Science from Oregon State University with a major in Radiation Health Physics and a minor in Environment, Safety and Health.

2.2.3 Health Physics Technician Joshua Campbell

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2.2.3.1 Bachelor of Science from University of Missouri with a major in Chemistry

2.3 Training subjects.

2.3.1 Site Specific Training (estimated time: 20min)

2.3.1.1 The location of radioactive materials within the area.

2.3.1.2 Requirements for wearing protective clothing.

2.3.1.3 DO NOT TOUCH OR HANDLE RADIOACTIVE MATERIALS.

2.3.1.4 Internal exposure to radioactive materials.

2.3.1.5 Yearly permissible exposure for radiation workers.

2.3.1.6 Yearly permissible exposure for outside contractors.

2.3.1.7 Removal of protective clothing when exiting a contaminated area.

2.3.1.8 Monitoring and surveys.

2.3.1.9 Site Specific Training Test

2.3.1.9.1 Must have an 80% to pass

2.3.1.9.2 Any test scores below 80% and the trainer will go over what was missed and the test will be retaken until the appropriate score is achieved.

2.3.2 ARC: Basic Radiation Safety Training (estimated time: 60min)

2.3.2.1 Nature of Radioactive Material

2.3.2.2 Radiation Vs Contamination

2.3.2.3 Types of Emissions

2.3.2.4 Beta Emission

2.3.2.5 Shielding

2.3.2.6 Effects of Beta Radiation

2.3.2.7 Types of Dose

2.3.2.8 Protective Clothing and Equipment

2.3.2.9 Donning and Doffing (Practical exercise)

2.3.2.10 Surveys and Meters

2.3.2.11 Basic Radiation Safety Test

2.3.2.11.1 Must have an 80% to pass

2.3.2.11.2 Any test scores below 80% and the trainer will go over what was missed and the test will be retaken until the appropriate score is achieved.

2.3.3 Survey Meter Training (estimated time: 20min)

2.3.3.1 Parts of a Meter

2.3.3.2 CPM Vs mR/hr

2.3.3.3 Scales and Reading a Meter (Practical Exercise)

2.3.3.4 Meter Test

2.3.3.4.1 Must have an 80% to pass

2.3.3.4.2 Any test scores below 80% and the trainer will go over what was missed and the test will be retaken until the appropriate score is achieved.

2.4 Training Exception

2.4.1 Contractors that are repairing an instrument or performing building maintenance that is short term and under direct supervision by the RSO, assistant RSO, or Health Physics Technician does not require above training. Instead of the above training the person providing the direct supervision will also provide guidance to the contractor such as but not limited to locations of RAM, exiting survey, and donning and doffing PPE.

## 3.0 Description of Area and Work Performed

_____
_____
_____
_____
_____

## 4.0 Certification of training and exposure time

I certify that I have received the training instructions listed in 2.0 above.

Company name _____ Name (please print) _____

And that I spent the following time within the area described in 3.0 above

Start date _____ End date _____ Hours _____

_____
Signature

## 5.0 Estimate of radiation dose received

5.1 Air concentrations

The concentration will be based on the highest air sample result within the laboratory building in which work is taking place. (Use the previous week survey). The DAC fraction is the sum of the fractions for the nuclides present.

The air concentrations within the area is _____(decimal fraction of DAC limit), **f**.

D = dose (mrem)

T = time (hours)

F = fraction of DAC

D = T x f x 2.5 mrem/ DAC hour

D (mrem) _____ = T _____ x f _____ x 2.5

5.2 Bioassays

If an individual is likely to spend more than 40 hours in a contaminated area, it is advisable to obtain a base level bioassay and a final bioassay to confirm the dose estimate from 5.1 above.

**6.0 <u>Training provided and dose estimated by</u>**

| _____ | _____ | _____ |
|---|---|---|
| Name | Signature | Date |

SUBJECT: ARC SHIPPING PACKAGE TESTING PROGRAM

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This SOP has been terminated, having been superseded by more recent requirements.

Supersedes: 03/09/2005 
Reviewed by RSC: 7/27/2010

SUBJECT: EXHAUST STACK FLOWRATE MEASUREMENT PROGRAM

---

**OBJECTIVE:** This program provides a means to measure stack flow rates and maintain them within acceptable standards.

**RESPONSIBILITY:** Radiation Safety Officer

**PROCEDURE:**

**1.0 Frequency**

Stack flow rate measurements shall be performed upon initial start-up of a new stack and after any maintenance or modification that could affect flow rate such as, but not limited to, motor speed, fan speed.

1.1 Daily Checks to verify stack flow

As part of the daily walk thru note on the walk thru form that hood flows are in to the hoods, this verifies that the exhaust blower for each building is operating.

1.2 Annual Flow Rate verification

Annually have the HVAC vendor measure the flow rate of the stacks. The vendor will certify the calibration and measurement accuracy.

**2.0 Performance**

2.1 Measurements may be made by the HVAC Vendor using vendor owned equipment, or by the RSO (or designee, see RPP Section 3.3.4.12).

2.2 If performed by the RSO, the following procedure shall be used

**3.0 Stack flow rate measurements**

3.1 For round stacks, divide a stack into 10 equal areas using 5 concentric circles bisected through their common center.

3.2 Upon entry of the stack diameter, the spreadsheet calculates the midpoint insertion depths for the thermo anemometer probe. Note: The spreadsheet rounds the insertion depths to the nearest 1/8 inch.

3.3 Place the cap on the end of the probe and carefully zero the meter.

3.4 Insert the probe to the predetermined depths first from one side of the stack and then from the other side.

3.5 Rotate the probe to assure that the probe tip is perpendicular to the airflow. This will result in the maximum velocity in linear feet per minute (LFM).

3.6 Record the LFM for each of the 10 data points and (for comparison) at the center of the stack.

3.7 Enter the date, building, stack location, stack diameter, and the LFMs from step 3.6 above into the spreadsheet.

3.8 The spreadsheet will calculate the average LFM, the cross-sectional area of the stack and the product of the two that is the average flow rate in cubic feet per minute (CFM).

3.9 Enter the CFM in the AIR SAMPLING/STACK spreadsheet for use in calculating the total activity discharged from the stacks.

Supersedes: May 30, 2001
Reviewed by RSC: 7/27/2010



SUBJECT: TRANSPORTATION OF RAM USING PRIVATE VEHICLES

---

**OBJECTIVE:** This procedure provides a means for ARC to transport packages of radioactive materials using either a Company vehicle or a private owned vehicle (POV)

**RESPONSIBILITY:** Radiation Safety Officer

**PROCEDURE:** **A written test will be given on the SOP content**

**Refresher training will be conducted annually**

## 1.0 ARC driver duties

1.1 Placarding

Placarding of the vehicle is required only if transporting one or more packages labeled with a Yellow III label.

***Note: Radioactive Yellow III will not be transported by ARC personnel***

1.2 Blocking and bracing

Packages should be placed in the trunk or rear seat of the vehicle and prevented from shifting during transport. Note: Seatbelts may be used for blocking and bracing. Small packages may be placed inside a larger consolidation box (the box should not have a top so the package labels may be viewed). It isn't necessary to label the consolidation box.

1.3 Separation distances

| Feet (minimum) | TI (maximum) | Label |
|---|---|---|
| 1 ..... | 0.1 to 1.0 | Yellow II |
| 2 ..... | 1.1 to 5.0 | Yellow III |

1.4 Shipping papers

Verify that the number of packages and the package labels agree with the shipping papers. The shipping papers must be within reach of the driver's seat.

## 2.0 Emergencies

In case of emergency, refer to the ARC *Emergency Instructions and Procedures Manual* carried in your vehicle.

## 3.0 Security

Keep your vehicle locked when it contains radioactive materials and you are not in the Vehicle.

## 4.0 Written Examination

4.1 When must a vehicle be placarded?

4.2 How do you block and brace packages?

4.3 For a package with a TI=1.5, what kind of label is required?

4.4 Always keep shipping papers on top of the packages. True ☐ False ☐

4.5 What is the first thing to do if you suspect the loss or theft of a package?

Instructor _____

Trainee _____

Date _____

Supersedes:5/19/2006 
Reviewed by RSC: 7/27/2010

SUBJECT: GAMMA AIR MONITORING PROGRAM

---

Historical sampling has shown that airborne concentrations of gamma emitters in ARC restricted areas **DO NOT** normally exist in concentrations in excess of 10% of the DACs.

This procedure is suspended.

In the event conditions change sufficiently to have a potential for exceeding 10% of the DAC for any gamma emitter, this procedure will be re-instated and updated

SUBJECT: BETA/GAMMA TLD MONITORING PROGRAM

---

Under present conditions, radiation levels **DO NOT** normally exist which would result in ARC employees receiving a deep dose equivalent of 500 millirem in a year or a shallow dose equivalent of 5 rem in a year to the skin or to each extremity.

This procedure is suspended.

In the event conditions change sufficiently to require external monitoring, this procedure will be re-instated and updated

.

Supersedes: 4/14/2008 
Reviewed by RSC: 2/21/2011

SUBJECT: SKIN DOSE ASSESMENT PROGRAM

---

OBJECTIVE: The skin dose assessment program provides a means to estimate the SDE that ARC employees receive from fixed $^{14}C$ contamination.

RESPONSIBILITY: Radiation Safety Officer

PROGRAM

## 1.0 Maximum permissible dose

The maximum permissible yearly dose to the skin or extremities is 50 Rem.

## 2.0 Assessment frequency

Skin dose assessments are performed when ARC employees report fixed $^{14}C$ contamination to the Radiation Safety Staff

## 3.0 Requirement

Skin dose assessments are required when radiation workers find and report skin contamination that they were unable to remove. Additional assessments may be required at the direction of the RSO.

## 4.0 Procedure

4.1 The RSO, or designee, see RPP Section 3.3.4.12, shall interview the radiation worker to determine how and when the contamination occurred.

4.2 The contaminated individual, under supervision of the RSO or designee, see RPP Section 3.3.4.12 should attempt to remove additional contamination before a skin dose assessment is made.

4.3 If the contaminated skin area is greater than $10cm^2$, divide the area into a grid containing approximate 10 $cm^2$ units

4.4 Place the probe within 1 cm (but not touching) of the contaminated area and measure and record the gross count rate. Also record the background count rate and a check-source count rate.

4.5 Repeat step 4.4 for each finger or for each of the $10cm^2$ areas.

4.6 Use the latest approved version of VARSKIN to determine the dose to the affected area.

4.7 The dose assessment shall be included in the individual's radiation history file and in his or her NRC-5 record.

## 5.0 Action Levels

5.1 >1000 mRem/week – the individual is restricted from further work with radionuclides that could result in additional dose.

5.2 The individual shall remain restricted until the dose rate falls below 500 mRem/week.

5.3 Alternatively, the RSO (by telephone if necessary) may waive the restriction providing the individual can prevent additional exposure by covering the contaminated area. For example, tape may be used to cover a contaminated spot on a finger and a second inner pair of clean gloves may be worn.

5.4 The RSO or designee, see RPP Section 3.3.4.12 shall attempt to determine the cause of the exposure and to propose corrective actions to minimize a recurrence.

5.5 >12,500 millirem per year – The RSC reviews annual reports for the extremities or skin dose and identifies the primary sources of exposure in order to take possible corrective actions to reduce them.

## 6.0 Calibration

6.1 Calibration of the beta probe is performed through the use of $^{14}C$ secondary standards.

## 7.0 Quality assurance.

7.1 Quality assurance is performed by counting available $^{14}C$ reference standards. Results must be +-10% of the standard value.

SUBJECT: AIR SAMPLING LINE CONTINUITY

---

**OBJECTIVE:** To assure air sampling line continuity from a particular stack or laboratory location to a particular air sampling station.

**RESPONSIBILITY:** Radiation Safety Officer

**PROGRAM**

**1.0 Continuity check requirement**

A continuity check is required whenever the radiation safety officer suspects that continuity has been compromised.

The daily checks for sampler bubbles and flow meter indication is sufficient evidence that the line is intact.

**2.0 Effluent air sampling lines**

- Use 1/4 inch stainless steel (SS) tubing and fittings wherever exposed to ultra-violet light from sunlight.
- Polyethylene (PE) tubing may be used out-of-doors in place of SS tubing if shielded from Ultra violet (UV) light within electrical conduit.
- Air sampling lines should enter at right angles to a stack or duct at least 5 stack diameters away from elbows or other sources of turbulence and make a ninety-degree turn at the center of the stack or duct to face into the air stream.
- PE lines are connected to SS lines after a roof penetration. Run the PE line to where the gas-washing bottles are located inside the building.
- PE lines should be continuous from beginning to end.
- Air sampling lines should be permanently and clearly identified on each end of the tubing
- If practical, use different colored PE tubing for each effluent air system.

**3.0 Continuity check – stacks**

3.1 Attach a flow meter to the input end of a sampling line on the roof. This may require breaking a connection or removing a line from a stack or duct.

3.2 If no airflow is present, trace the line from beginning to end to determine and correct the problem.

3.3 If airflow is present, contact another individual located inside the building near the output end of the sampling line. A pair of cell phones or radios can be used for this purpose.

3.4 Instruct the individual inside the building to unplug the stopper from the first gas-washing bottle corresponding to the line being checked.

3.5 The flow meter on the input end of the sampling line should drop to zero. This confirms continuity of the sampling line.

3.6 If the flow meter does not drop to zero, unplug other stoppers one-at-a-time until the flow rate does drop to zero. Use this information to correctly label and identify the input and output ends of the line.

## 4.0 Laboratory air sampling lines

- Use clear 1/4 inch Lucite tubing for the exposed sample line hanging vertically from the ceiling at a selected sampling location.
- Connect the Lucite tubing to a PE line and run it above the ceiling to where the gas washing bottles are located.
- PE lines should be continuous from beginning to end.
- Air sampling lines should be permanently and clearly identified on each end of the tubing.

## 5.0 Continuity check – laboratories

5.1 Attach a flow meter to the input end of the Lucite tubing. If the Lucite tubing has a filter head attached, permanently remove the filter head.

5.2 If no airflow is present, trace the line from beginning to end to determine and correct the problem.

5.3 If airflow is present, unplug the stopper from the first gas-washing bottle corresponding to the line being checked

5.4 The flow meter on the input end of the sampling line should drop to zero. This confirms continuity of the sampling line.

5.5 If the flow meter does not drop to zero, unplug other stoppers one-at-a-time until the flow rate does drop to zero. Use this information to correctly label and identify the input and output ends of the line.

**AMERICAN RADIOLABELED CHEMICALS, INC.**
**STANDARD OPERATING PROCEDURE - SOP-29**

Supersedes: 05/19/2006
Approved by RSC: 4/30/08



SUBJECT: STORAGE OF SURFACE CONTAMINATED OBJECTS

---

**OBJECTIVE:** To ensure proper storage of surface contaminated objects (SCO) that are not in use

**RESPONSIBILITY:** Radiation Safety Officer

**REFERENCES:** SOPs 16, 21, 33, 35, and 38

## PROGRAM

### 1.0 Description

1.1. Surface contaminated objects (SCO) are pieces of equipment or objects that have become contaminated on their surfaces by use in restricted areas. When no longer being used, these items are transferred to building 200 for temporary storage. A decision is made by the Senior Chemist and the RSO on the future usefulness of the item prior to movement of the item. The possibilities are (1) reused sometime in the future (2) discarded as non radioactive waste (3) discarded as radioactive waste

### 2.0 Placing SCO in storage

2.1. Move the object/equipment to building 200 (roll up door area). Exercise caution so that contamination does not spread from the object.

2.2. Depending upon the decisions made concerning the usefulness of the item

2.2.1. For possible future use – Place the item safely with other equipment being held for future use. As this equipment will be used in the future, take care not to damage or degrade the item.

2.2.2. For future decon and disposal – Place the item with other equipment being held for decon and disposal.

2.2.3. For disposal as radioactive waste – place the item in the SeaLand container for shipment as Rad Waste.

### 3.0 Removing SCO from storage

3.1. If an item is to be removed from storage for disposal as non-radioactive waste, it must be surveyed and pass the release level of 1000 dpm/100 $cm^2$total.

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Survey prior to release must be done by a member of the Rad Safety organization

3.1.1. Scan the item with a GM survey meter and outline any areas where activity is detected.

3.1.2. Wipe test the marked areas. Decon and rewipe until the areas are below the release level. Take a few random wipes at other locations.

3.2. If an item removed from storage cannot be cleaned satisfactorily, then dispose as radioactive waste.

3.3. Mark storage areas within building 200 with magenta and yellow rope with appropriate signage

## 4.0 Annual audits

The RSO shall perform annual audits to assure the timely disposition of items placed in storage.

Supersedes: 4/30/08 (never official)
Reviewed by RSC: 7/27/2010



SUBJECT: RELEASE OF MATERIAL

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**OBJECTIVE:** To survey and, if necessary, decontaminate equipment before release to vendors. This applies to all tools or equipment brought into any restricted area. In addition, this procedure applies to any tools or equipment used for excavation on site.

**RESPONSIBILITY:** Radiation Safety Officer

## PROGRAM

### 1.0 Description

Equipment released to vendors includes, but is not limited to, such things as gas cylinders and other laboratory equipment released for repair or calibration; Equipment and/or tools used in such maintenance work or tools which disturbs the soil on site

### 2.0 Release of equipment

2.1 Scan the equipment with a GM survey meter and outline (with grease pencil or "magic marker) any areas where activity exceeding two times background is detected.

2.1.1 Use a survey meter calibrated for C-14 cpm and record the total for the marked area being surveyed.

2.1.2 Sub-divide the marked area so that each resulting sub area is less than one square meter

2.2 Mark the areas detected on an appropriate survey form.

Note: Sample survey forms are included as attachment A. These are given as examples only and should not be taken as inclusive.

2.3 Wipe test the outlined areas and take a few random wipes at other locations where contamination is likely.

2.3.1 Wipe approximately 100 $cm^2$ of the surface being surveyed. A 16 square inch area is approximately 100 $cm^2$ (i.e. 4 x 4, 2 x 8, etc.). If the surface being surveyed is less than 100 $cm^2$, wipe the entire surface.

2.3.2 Enter the number of the wipe on a diagram of the area being surveyed. Use a standard survey form if possible, otherwise use a sketch of the object.

2.4 Assay the wipes in a liquid scintillation counter (LSC) that automatically converts the count rate to net dpm/100 $cm^2$.

2.5 Decontaminate and rewipe any surface areas above the action levels.

2.6 Repeat the above step as necessary.

2.7 Attach all annotated print outs from the LSC to the survey form or sketch and enter the following information.

2.8 Pen in the *Description* of what is being released

## 3.0 Release Levels

Decon and rewipe until the areas are below the release level, which is:

3.1 1000 dpm/100 $cm^2$ for the sum of tritium and carbon-14.

**AND**

3.2 Less than 5000 dpm average over the surface of the object, with no single reading greater than 15,000 dpm by direct scan with a survey meter.

**NOTE: Survey meter reads in cpm, not dpm to find the limit in cpm, multiply the dpm limit by the meter efficiency (as a decimal fraction).**

**Example**:

The limit is 5000 dpm; the meter efficiency for C-14 is 4.3% (0.043)

5000 X 0.043 = 215

Therefore any reading greater than 215 CPM **above background** exceeds the limit

## 4.0 Documentation

Whether or not the item is released, all forms, maps, notes and print outs shall be captured and filed in the Material Release File

## 5.0 Release

5.1 When all wipes are below the release level, **AND** all direct scans are below the release level the object may be released.

## 6.0 Records

Retain the Material Release File for review by NRC inspectors.

**Attachment A** Typical Forms

Dry Ice Box Release Survey

Box Serial Number _____

Wipe Test Results Attached

Direct Scan

| No. | Location | Scan (cpm) | |
|---|---|---|---|
| 1 | Top | | |
| 2 | Front | | |
| 3 | Left | | |
| 4 | Right | | |
| 5 | Rear | | |
| 6 | Wheels | | |

Detector_____

Background_____

Survey Date_____

Surveyed By:

Survey Meter Release Survey

Meter Serial Number _____
Detector Serial Number _____

Wipe Test Results Attached

Direct Scan

| Meter | Location | Scan (cpm) |
|---|---|---|
| 1 | Front | |
| 2 | Top | |
| 3 | Left | |
| 4 | Right | |
| 5 | Rear | |
| 6 | Bottom | |
| Detector | | |
| 1 | Top | |
| 2 | Bottom | |
| Cord | | |
| 1 | Ends | |
| 2 | Middle | |
| Plug | | |
| 1 | Ends | |
| 2 | Middle | |

Detector Used_____

Background_____

Survey Date_____

Surveyed By:

Supersedes: 05/19/2006 
Approved by RSC: 4/30/08

SUBJECT: PROTOCOL FOR PACKAGING AND SHIPPING ITEMS TO JAPAN

---

**OBJECTIVE:** Ensure that all packages and internal components there of meet the expressed requirements of the Japanese customer.

**RESPONSIBILITY:** Radiation Safety Officer; Packaging Chemist; Shipping Clerk

**PROCEDURE:**

**1.0 Packaging Chemist**

1.1 The packaging chemist shall ensure that all seals and closures for any primary package are proper in all respects.

1.2 The packaging chemist shall clean all ampules, vials etc prior to passing them to the shipping room.

1.2.1 The vial, ampule, etc shall first be immersed in a detergent/water solution.

1.2.2 The vial, ampule, etc. shall be rinsed in clear water, and

1.2.3 Wiped dry with "Kim-wipes" or a similar product.

**2.0 Shipping Clerk**

2.1 Primary Containers

2.1.1 The shipping clerk shall perform additional cleaning, using disposable towelettes, of each vial, ampule, etc to arrive from the packaging chemist.

2.1.2 Prior to further processing, the Radiation Safety Officer (or designee, see RPP Section 3.3.4.12)

2.1.2.1 Wipe all primary product containers (the inner vial) *individually*:

2.1.2.2 Count each wipe using "Ship/Receive" Protocol

2.1.2.3 If the result is less than 200 counts, the vial is approved for further processing

2.1.2.4 If greater than 200 counts, clean and re-wipe until less than 200 each, then continue processing.

2.1.3 All primary containers with screw cap or friction fitted closures shall be tightened as necessary and then taped closed with transparent tape.

2.1.4 The shipping clerk shall affix the correct label (number one of two) to the primary container.

2.1.5 The shipping clerk shall place the primary container inside a "Ziploc" type bag and seal the bag.

2.1.6 The shipping clerk shall wrap the bagged primary container with sufficient absorbent material to completely absorb the contents of the primary container.

2.1.7 The shipping clerk shall place the absorbent wrapped primary container inside a 120 milliliter plastic secondary container.

2.1.8 The shipping clerk shall place the second label on the secondary container.

2.1.9 The shipping clerk shall write the JRIA number on the lid of the secondary container.

2.2 Secondary Containers

2.2.1 All secondary containers with screw cap closures shall be tightened as necessary and then taped closed with transparent tape.

2.2.2 The shipping clerk shall place transparent tape over the label.

2.2.3 The shipping clerk shall thoroughly clean the outside of the secondary container using pre-moistened towelettes.

2.2.4 Prior to further processing, the Radiation Safety Officer (or designee, see RPP Section 3.3.4.12) shall:

2.2.4.1 Compare label and JRIA number with invoice.

Bring discrepancies to the attention of the shipping clerk, and, if necessary, the main office.

2.2.4.2 Compare data sheet with label and JRIA number.

Bring discrepancies to the attention of the shipping clerk, and, if necessary, the main office.

2.2.5 Prior to further processing, the Radiation Safety Officer (or designee, see RPP Section 3.3.4.12)

2.2.5.1 Wipe all secondary containers (The P-cup) individually:

2.2.5.2 Count each wipe using "Ship/Receive" Protocol

2.2.5.3 If the result is less than 200 counts, the vial is approved for further processing

2.2.5.4 If greater than 200 counts, clean and re-wipe until less than 200 counts each, then continue processing.

2.3 Shipping Containers

2.3.1 Prior to further processing, the Radiation Safety Officer (or designee, see RPP Section 3.3.4.12) shall:

2.3.1.1 Separate the products into "ICE" and "NO ICE" groups.

2.3.1.2 Determine the number of Extra Small boxes for the "No Ice" part of the shipment.

2.3.1.3 Wipe each of these boxes, inside and out separately, each must be less than 200 counts.

2.3.1.4 Wipe the inside of the medium box that will hold the extra small boxes for the no ice shipment. Must be less than 200 counts

2.3.1.5 Wipe the inside of the insulated "ice" box. Must be less than 200 counts

## 3.0 Shipping surveys

3.1 Wipe Survey

3.1.1 A member of the Radiation Safety Staff shall wipe test the outside of the boxes individually. Each box is wiped over a 300cm$^2$ area. Boxes are released for shipment if the composite wipe is less than the DOT limit of 2200 dpm/300 cm$^2$. Since this is an international shipment, meeting the DOT limit automatically meets the International Air Transport Association (IATA) requirements. The individual boxes must meet the Japanese customer's criteria of less than 200 cpm on the wide setting of the LSC

3.1.2 The wipe survey results are added to the data package for a Japan shipment

3.1.3 If a shipping package is found to be contaminated, area surveys are performed to determine the extent of the contamination. The area surveys will be wipe surveys of the entire surface in the shipping room that were used to prepare the shipment. After cleanup, the RSO or designee, see RPP Section 3.3.4.12 attempts to determine the cause and to take corrective actions to prevent a recurrence.

3.2 Radiation Levels

3.2.1 Radiation level surveys shall be performed using an instrument calibrated to read mr/hr. The Radiation Safety Staff member measures the dose rate on the package surfaces to assure that excepted packages and White I packages do not exceed 0.5 mrem/hour.

3.2.2 If the surface dose rate exceeds 0.5 mrem/hr, The Radiation Safety Staff member measures the Transport Index (TI) and writes this number in the box provided on a Yellow II label. The TI is recorded to the nearest one tenth of a millirem/hour. The minimum TI to be entered on a label is 0.1. *NOTE: The TI (transport index) is the net mrem/hr at 1 meter from the package surfaces.* ARC does not ship Yellow III items.

| Millirem/hour | Excepted | White I | Yellow II | Yellow III |
|---|---|---|---|---|
| Surface | <=0.5 | <= 0.5 | 0.5 - 50 | 50 - 200 |
| Transport Index | NA | (TI=0*) | 0.1 – 1.0 | 1.1 – 10 |

*(On shipping papers, not on label)

3.2.3 As required, the Radiation Safety Staff member places White I or Yellow II labels on two opposite sides of the package.

## 4.0 Radiation Safety Officer

4.1 The RSO or his designee, see RPP Section 3.3.4.12 certifies each package of radioactive material as required by 49 CFR § 172.204 *Shipper's certification* by his signature or facsimile on one of the following statements on the *Shipper's Declaration for Dangerous Goods*:

4.1.1 DOT

"This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation."

4.1.2 DOT and IATA

"I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national government regulations."

4.2 The RSO or designee, see RPP Section 3.3.4.12 fills out the "Package Survey" form (see attached) for each outgoing Dangerous Goods shipment (Radioactive White I or Radioactive Yellow II).

ARC does not ship packages which require a Radioactive Yellow III label.

4.3 The RSO or designee, see RPP Section 3.3.4.12 uses the IATA Checklist (see attached) to ensure that all Dangerous Goods shipment traveling by air meet all IATA and DOT requirements.

# Attachment One

# Package Survey Form

# Attachment Two

# IATA Checklist

Supersedes: 5/19/2006
Approved by RSC: 4/30/08



SUBJECT: Segregation of Dry Active Waste

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**Segregation of Dry Active Waste - SOP 32**

**OBJECTIVE:** To survey Dry Active Waste (DAW) and segregate, as necessary, "hot" objects from "cold".
Including "cold" items in with DAW is an added expense to the Company.
Including "hot" items in regular trash is a violation of the license and of Federal Regulations.

**RESPONSIBILITY:** All Laboratory Personnel. It is forbidden to place hot trash in a cold trash receptacle. It is forbidden to place cold trash in a hot trash receptacle.

**REFERENCES:** SOPs 16, 21, 33, 35, and 38

**PROGRAM**

**1.0 Description**

1.1. Dry Active Waste is made up of non-liquid "trash" from the production laboratories.

DAW will include disposable protective clothing, paper towels, lab bench paper, packing material, pipettes and other small glassware.

***UNDER NO CIRCUMSTANCES SHOULD ANY LIQUID OF ANY TYPE BE PERMITTED IN WASTE CLASSED AS "DRY ACTIVE WASTE" (DAW).***

1.2. Surveys will be performed by an individual designated by the RSO, either a Lab Technician or by the Health Physics staff.

1.3. Survey activities will be periodically "spot checked" by the RSO, or designee, see RPP Section 3.3.4.12.

**2.0 Survey of "Cold Trash"**

2.1. Wear all normal protective clothing while sorting trash

2.2. Remove any disposable gloves, disposable shoe covers, and lab bench paper from the cold trash place these items in a "Hot" trash container.

2.3. Scan the remaining cold trash with a GM survey meter and place any item with 150, or greater, counts per minute above background in a "hot" trash container.

**NOTE: This requirement assumes a C-14 efficiency (see calibration sticker) of at least 4%**

2.4. Place all of the trash with less than 150 net counts per minute in a clean trash bag and remove the bag from the laboratory.

2.5. Place the bag of cold trash in the dumpster.

## 3.0 Survey of "Hot Trash"

3.1. Wear all normal protective clothing while sorting trash

3.2. Disposable gloves, disposable shoe covers, and lab bench paper found in the laboratory are considered to be contaminated and do not require survey.

3.3. Scan the remaining trash with a GM survey meter and return any item with 150, or greater, counts per minute above background in a "hot" trash container.

**NOTE: This requirement assumes a C-14 efficiency (see calibration sticker) of at least 4%**

3.4. Move the bag containing only "hot trash" to the Hot Waste transfer container for transfer to Building 200 for further processing.

3.5. Place all of the trash with less than 150 net counts per minute in a clean trash bag and remove the bag from the laboratory.

3.6. Place the bag of cold trash in the dumpster.

## 4.0 Out of Service or Unusable Items and Equipment

4.1. Scan the item with a GM survey meter

**IF** the item has any areas equal to or greater than 150 net counts per minute, **GO TO 5.0 below**

4.2. Items less than 150 net counts per minute should be wipe surveyed, and removed from the laboratory if less than 1000 dpm total by LSC; and **EITHER** discarded in normal Trash (the dumpster) **OR** returned to the warehouse/storage for re-use.

## 5.0 Contaminated Items and Equipment, readily cleaned items

5.1. Scan the equipment with a GM survey meter and outline any areas where activity is detected.

5.2. Wipe test the outlined areas and take a few random wipes at other locations where contamination is likely.

5.3. If the item appears to be readily cleanable, then decon and re-wipe until the areas are below the release level, which is 1000 dpm/100 $cm^2$ for the sum of tritium and carbon-14, or less than 500 cpm using the WIDE setting of the scintillation counter.

AND

The item is less than 150 cpm direct survey.

5.4. Items meeting the above criteria should be removed from the laboratory and **EITHER** discarded in normal Trash (the dumpster) **OR** returned to the warehouse/storage for re-use.

## 6.0 Contaminated Items Not Readily Cleaned

6.1. Decide if the item or some of its parts are likely to be...

6.1.1. reused sometime in the future

6.1.2. discarded as non radioactive waste

6.1.3. discarded as radioactive waste

6.2. If the item will be reused, wrap and label in accordance with SOP 29.

6.3. If the item will be discarded as non-radioactive waste, the RSO will specify decontamination procedures and survey methods on a case-by-case basis.

6.4. If the item will be discarded as radioactive waste **(no cost effective decontamination procedure is available),** then the item shall be handled in accordance with the Waste Processor's requirements.

Supersedes: New
Approved by RSC: 6/15/2008



SUBJECT: Use of Protective Clothing and Equipment (PCE)

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**OBJECTIVE:** To ensure the proper selection and wear of PCE

**RESPONSIBILITY:** All Personnel Working with Radioactive Material

**PROGRAM**

**1.0 Purpose**

a) Protect the radiation worker from contamination.

b) Contain radioactive contamination within the bounds of designated areas

**2.0 Definitions**

2.1 Unrestricted areas.

2.1.1 These areas include the eating area in each lab building, but do not include any posted buffer zone within the lab building.

2.1.2 All areas outside the laboratory buildings unless temporarily posted otherwise.

2.2 Restricted Areas

Restricted Areas are further sub-divided into:

2.2.1 High Contamination Areas (HCA)

Areas such as, but not limited to, inside fume hoods, inside bench top trays, inside the compactor enclosure; other areas as designated by the RSO

2.2.2 Contamination Areas (CA)

Areas inside the laboratories not listed as High contamination areas.

2.2.3 Buffer Zones (BZ)

Areas such as, but not limited to, change areas, the shipping area, the building 300 garage or other areas designated by the RSO.

## 3.0 Use of PCE

3.1 Lab Coat – required for entering CAs

3.2 Safety glasses – required for entering CAs

3.3 Disposable gloves – required for entering CAs

3.4 Lab shoes – required for all work in CAs; see 3.9 and 3.10 below.

3.5 Rubber shoe covers – required for all work in CAs

3.6 Aprons – worn under lab coats whenever brushing against, or leaning on benches or hood ledges is likely to occur.

3.7 Sleeve Protectors – worn whenever reaching into HCAs is likely.

3.8 Trouser protectors – worn in laboratories when seated work is likely.

3.9 Cloth Booties – worn only for inspections and tours. The floor (or other walking surface) must be dry.

3.10 Tyvek or vinyl booties – worn only for inspections or tours.

3.11 Rubber or nitrile gloves – worn when high specific activity work is done, or when (in the judgment of the senior chemist(s)), they are required by the chemical hazard.

## 4.0 Donning and Removal of PCE

4.1 Donning

4.1.1 Don footwear. Stand inside marker line for the contaminated area.

4.1.2 Don gloves, the remainder of the PCE, if re-usable, is potentially contaminated.

4.1.3 Don apron, if required

4.1.4 Don lab coat

4.1.5 Don sleeve protector, if required.

4.1.6 Don required eye wear.

4.1.7 Don additional gloves if required

4.2 Removal

4.2.1 Remove outer gloves, if worn.

4.2.2 Remove gloves.

4.2.3 Wash hands at lab sink

4.2.4 Taking care to touch only inside, non-contaminated, inner surfaces, remove:

4.2.4.1 Sleeve protectors

4.2.4.2 Lab coat,

4.2.4.3 Apron

4.2.4.4 Eye protection

4.2.4.5 Foot wear, stepping over the marker line as each foot is uncovered

4.2.5 Wash hands at change area sink

4.3 Monitor hands using the G-M detector at the change area sink. Reading should be less than twice background.

**If the monitor reading is greater than twice background, wash hands thoroughly and re-monitor. If still greater than twice background, call the RSO for assistance.**

**AMERICAN RADIOLABELED CHEMICALS, INC.**
**STANDARD OPERATING PROCEDURE - SOP-34**

Supersedes: New
Approved by RSC: 7/20/10
Approved by NRC:



SUBJECT: Surface Soil Sampling for Site Characterization

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**OBJECTIVE:** To determine the radioactive status and amount of accumulated radioactivity on the ARC site.

**RESPONSIBILITY:** Radiation Safety Officer

**PREREQUISITES:** The ARC License has been amended to permit site characterization
A sample plan has been prepared using VSP
The sample plan has been approved by the NRC

**REQUIRED EQUIPMENT:** Scale map of the site showing location of sample points.
Measuring tape at least 100" in length.
Suitable tools for digging to a six inch depth
Container for sorting and mixing soil sample
Sample containers capable of holding at least 50 gm of soil

## PROGRAM

### 1.0 Purpose

1.1 To determine the radioactive status and amount of accumulated radioactivity on the ARC site.

1.2 To provide sufficient information to propose the time and type of any remediation which may be required.

### 2.0 Procedure

2.1 Location

2.1.1 Transfer the sample location from the VSP print out to the scale site plan.

2.1.2 Using the scale site plan and a 100' steel tape, locate the first sample point of the survey unit "on the ground".

2.1.3 Mark the sample point with a flag or landscaper paint.

2.1.4 Repeat for the remaining points of the survey unit.

2.1.5 Repeat for each additional survey unit.

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2.2 Sampling

2.2.1 If necessary, loosen the soil at the sample point with a trowel or other digging implement.

2.2.2 Using the sampler rig to obtain a sample of the first 6 inches of soil.

2.2.3 Place the soil in a "clean" bucket. Remove all rocks, stones, twigs etc and discard. Stir the soil to remove any lumps. Repeat as necessary until the required sample size is obtained

**(NOTE: Teledyne Brown, the analyst for ARC, requires a minimum of 50 grams. If the NRC is splitting sample, ORISE, the analyst for NRC requires 1 kilogram.)**

2.2.4 Place the sample in an appropriate container, see note above. Label appropriately.

2.2.5 Clean the sampling tools of all visible dirt wash if necessary.

2.2.6 Clean the mixing bucket

2.2.7 Record the sample details on the chain of custody form.

2.2.8 Seal the sample container.

2.2.9 Repeat for each Sample point in the survey unit.

2.2.10 Package all the samples from this sample unit, with the chain of custody form for this sample unit in one box for shipment to the analytic lab.

2.2.11 Repeat 2.1 through 2.10 above for each additional survey unit

## 3.0 Disposition of Results

3.1 Transmit a copy of the raw results data to the Decommissioning Branch Region III, NRC

## 4.0 Remediation

4.1 Any proposed remedial actions must be submitted to the Decommissioning Branch Region III, NRC prior to taking any action.

## 5.0 Confirmatory Sampling

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5.1 Site characterization sampling will be repeated at three-year intervals.

5.2 Results of sampling will be submitted to the Decommissioning Branch Region III, NRC

5.3 Sampling may be discontinued if two successive results show no increase in soil contamination.

Supersedes: New
Approved by RSC: 4/13/10



SUBJECT: Maintaining a Safety Conscious Work Environment

---

OBJECTIVE: This procedure provides a means to assure safety concerns raised by individuals at ARC are reviewed, dispositioned and corrected in a timely manner. And to ensure that there is no retaliation for raising the concern

RESPONSIBILITY: Radiation Safety Committee (RSC).

PROGRAM

## 1.0 Raising concerns directly

1.1. A safety concern may be raised directly with any Company Officer, Member of the RSC, Authorized User, or any member of the Radiation Safety Organization (RSO).

1.2. The individual raising the concern shall remain anonymous at all times.

1.3. It is against ARC policy and contrary to Federal Regulations to permit any form of retaliation for raising safety concerns.

## 2.0 Use of Suggestion Boxes

2.1. Location

Suggestion Boxes are located in the lunchroom areas of each of the ARC buildings

2.2. Forms

A supply of "Report of Condition Adverse to Safety" (ROCATS) forms are maintained with the suggestion boxes

2.3. Use

The individual shall list his/her concern in the first box of the form. And place the form in the suggestion box.

2.4. The RSO shall, periodically open the suggestion boxes and deliver any ROCATS to the RSC

## 3.0 Disposition

3.1. The RSC discusses the merits of the ROCATS and if justified assigns the corrective action to an individual by name and a due date for completion.

3.2. The assigned individual makes such corrective actions (both short term and long term), as are necessary.

3.3. The completed ROCATS are returned to the RSC

3.4. A copy of the completed ROCATS is posted for a minimum of 30 days in order that all may see that actions were taken.

## 4.0 Records

Completed ROCATS are kept in the RSC minutes file for a minimum of four years.

# REPORT OF CONDITION ADVERSE TO SAFETY

Describe the condition You Believe to be Unsafe.

RSC Concurs_____ RSC does not Concur_____

Individual assigned to fix the problem_____

Due Date_____

Describe the Actions Taken

Supersedes: New
Approved by RSC: 6/17/10
Approved by NRC:



SUBJECT: Excavation and Backfill of Soil Due to Gas Line Repair

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OBJECTIVE: This procedure is designed to ensure that no contaminated, or potentially contaminated, soil is removed from the ARC site due to excavation necessary to repair a leaking natural gas line.

It also is designed to provide the involved (non ARC) workers with radiation safety training commensurate with the hazard involved.

RESPONSIBILITY: Radiation Safety Officer

PROCEDURE:

1.0 **Scoping Survey**

1.1 A direct scan survey using a calibrated survey meter with a G-M pancake probe will be performed covering the area marked on the survey map. (Attachment A)

1.2 Results from the characterization survey (H-3 and C-14 pCi/g at 6 inch depth) are posted on plan of the area. (Attachment B)

**2.0 Radiation Safety Training**

2.1 Requirement

Training is required for individuals who perform work functions such as (but not limited to) the excavation of soil to repair or replace underground piping in contaminated (or potentially contaminated) areas

2.2 Training subjects.

2.2.1 Nature of radioactive material

2.2.2 Difference between radiation and contamination

2.2.3 Beta emitters vs other emissions

2.2.4 Effect of beta energy

2.2.5 Beta shielding from clothing, etc

2.2.6 Dose, internal vs external, internal only

2.2.7 Protective clothing and equipment (PCE)

2.2.8 Donning and wear of PCE

2.2.9 Removal of protective clothing when exiting a contaminated area.

2.2.10 Surveys and survey meters.

**3.0 Certification of training and exposure time**

3.1 Each individual trained shall fill out and sign the" Certificate of Training and Exposure Time" (Attachment C)

**4.0 Location and Description of Excavation Site**

4.1 ***At this time the exact location of the leak is not known. However, the general area is encompassed in areas 5, 7, and the street between shown on Attachments A and B***

**5.0 Soil Contamination of areas 5 and 7.**

5.1 Area 5

During the characterization survey, three (3) samples were taken at a depth of

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ATTACHMENT A DIRECT SCAN SURVEY

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ATTACHMENT B LOCATION OF CLOSEST CHARACTERIZATION SURVEY POINTS

ATTACHMENT C Certificate of Training and Exposure Time

I certify that I have received the training instructions listed in 2.2 above.

Company name _____ Name (please print) _____

And that I spent the following time within the area described in 4 .0 above

Start date _____ End date _____ Hours _____

Start date _____ End date _____ Hours _____

Start date _____ End date _____ Hours _____

Start date _____ End date _____ Hours _____

_____
Signature

Supersedes: New
Reviewed by RSC: 20 July 2010
Approved by NRC:



SUBJECT: Excavation and/or Soil Removal on the ARC Site

---

OBJECTIVE: This procedure is designed to ensure that no contaminated, or potentially contaminated, soil is removed from the ARC site due to excavation necessary for normal operation, maintenance and/or landscape modifications.

RESPONSIBILITY: Radiation Safety Officer

PROCEDURE:

## 1.0 Scoping Survey

1.1 A direct scan survey using a calibrated survey meter with a G-M pancake probe will be performed covering the area where the soil is to be disturbed. The results of this survey will be marked on the survey map.

1.2 Results (H-3 and C-14 pCi/g at 6 inch depth) from relevant areas of the characterization survey will be posted on the survey map.

1.3 The survey map is attached to a copy of this SOP as the first part of the work package.

1.4 If the excavated soil is to be returned to the excavation, no further survey is required.

1.5 If the soil is to be removed from the site as radioactive waste, additional surveys and/or analysis may be necessary.

## 2.0 Radiation Safety Training

2.1 Requirement

Training is required for individuals who perform work functions such as (but not limited to) the excavation of soil, as described above in the OBJECTIVE, in contaminated (or potentially contaminated) areas.

2.1.1 The amount and depth of training will be a function of the prior training and experience of the individuals concerned

2.1.2 The amount and depth of training will be commensurate with the identified hazard.

2.2 Training subjects.

At a minimum, the following areas are required to be part of the knowledge base of the individuals concerned.

2.2.1 Nature of radioactive material

2.2.2 Difference between radiation and contamination

2.2.3 Beta emitters vs other emissions

2.2.4 Effect of beta energy

2.2.5 Beta shielding from clothing, etc

2.2.6 Dose, internal Vs external

2.2.7 Protective clothing and equipment (PCE)

2.2.8 Donning and wear of PCE

2.2.9 Removal of protective clothing when exiting a contaminated area.

2.2.10 Surveys and survey meters.

2.3 Training shall be performed in accordance with SOP 21 as appropriate

2.4 The completed training material will be checked and signed by the RSO, or designee, see RPP Section 3.3.4.12, to provide documentation that appropriate training was provided. This documentation will be attached and become part of the work package.

## 3.0 Certification of training and exposure time

Each individual trained shall fill out and sign the" Certificate of Training and Exposure Time" (Attachment A). This documentation will be attached and become part of the work package

## 4.0 Location and Description of Work Site

4.1 Any additional work descriptions, contractor job orders, etc. shall be attached and become part of the work package.

4.2 The RSO or designee, see RPP Section 3.3.4.12 will prepare a description of the work to be done including any special procedure, precautions, limitations, and required PCE. This document will be signed and dated by the preparer.

4.3 The work description will be signed by each worker or individual who enters the work site, indicating that they have read and understood the requirements for the task.

## 5.0 Sectioning off the work area

When an excavation area is specified it will be roped off with an entrance and an exit. A tarp will be laid down to collect the excavated soil. Any soil excavated will be placed on the tarp and covered whenever possible. The soil will also be kept damp enough to avoid dust from the excavated soil.

## 6.0 Protective clothing and equipment

6.1 Necessary protective clothing and equipment will be determined by the RSO.

For example: Paper coveralls, rubber gloves, and safety glasses.

6.2 PCE will be worn and removed in accordance with SOP 33.

## 7.0 Health physics coverage

7.1 A Health Physics technician or other individual designated by the RSO will be in contact with the workers when the excavation is taking place.

7.2 Anyone leaving the specified dig site will be surveyed and cleaned if necessary.

7.2.1 Surveys will be made initially with a G-M pancake probe, any area exceeding twice background will be wipe surveyed as well.

7.2.2 Appropriate survey sketches will be used to identify survey locations and document the results. These sketches with survey results will be attached to this procedure as part of the documented record.

7.2.3 Personal contamination will be reduced to as close to background as is reasonably achievable.

7.2.4 If anything is over 1000 dpm it will be cleaned and if that level is detected on an individual, they will be cleaned and a bioassay sample will be taken.

7.3 Any equipment leaving the specified dig site will be surveyed and cleaned if necessary.

7.3.1 Surveys will be made initially with a G-M pancake probe, any area exceeding twice background will be wipe surveyed as well.

7.3.2 Appropriate survey sketches will be used to identify survey locations and document the results. These sketches with survey results will be attached to this procedure as part of the documented record.

7.3.3 Tools and equipment will be cleaned to less than 5000 dpm/ 100 sq.cm. of which no more than 1000 is readily removable. All reasonable efforts will be made to reduce any contamination to as far below this level as possible.

7.3.4 If anything is over 1000 dpm it will be cleaned and if that level is detected on an individual, they will be cleaned and a bioassay sample will be taken.

## 8.0 Completion of the work

8.1 After the completion of the work, the excavated soil that was collected on the tarp will be placed back into the excavation site.

8.2 A scan survey will take place on the excavation site after the soil has been put back into the ground. This survey will become part of the work package

## 9.0 Completed survey documents

A copy of this SOP, with all completed survey documents and paperwork attached will be filed and kept available for inspection.

---

ATTACHMENT A Certificate of Training and Exposure Time

I certify that I have received the training instructions listed in 2.2 above.

Company name _____ Name (please print) _____

And that I spent the following time within the area described in 4 .0 above

Start date _____ End date _____ Hours _____

Start date _____ End date _____ Hours _____

Start date _____ End date _____ Hours _____

Start date _____ End date _____ Hours _____

_____
Signature

SUBJECT: TRAINING AND DOSE ESTIMATES FOR LABORATORY PERSONNEL

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OBJECTIVE: This procedure is designed to provide ARC laboratory personnel, including maintenance personnel who work in the laboratories, with radiation safety training specific to the work functions they will perform in contaminated areas, and to provide training commensurate with the hazard(s) present.

RESPONSIBILITY: Radiation Safety Officer

REFERENCES: General Reference Only: NUREG-1556, Vol 12, Program Specific Guidance About Possession Licenses for Manufacturing and Distribution

**This reference is used for guidance only and not for any specific quantity or use.**

PROCEDURE:

## 1.0 Occupational Exposure

As any dose equivalent received will be as a direct consequence of the individual's work/occupation, the individuals are considered to be Occupationally Exposed.

## 2.0 Radiation Safety Training

2.1. Requirement

Training is required for individuals who perform a majority of their work inside the lab. This includes chemists, lab technicians, and any health physics staff.

2.2. Providing Training and Qualifications.

2.2.1. RSO Regis Greenwood

2.2.1.1. CHP, FHPS, Masters Degree in Health Physics from University of Pittsburgh and forty-seven years of experience.

2.2.2. Health Physicist Donald Lite

2.2.2.1. Bachelor of Science in Radiation Health Physics from Oregon State University.

2.2.3. Health Physics Technician Joshua Campbell

2.2.3.1. Bachelor of Science in Chemistry from University of Missouri

2.3. Training subjects.

2.3.1. Site Specific Training (estimated time: 20min) (SOP 21)

2.3.1.1. The location of radioactive materials within the area.

2.3.1.2. Requirements for wearing protective clothing.

2.3.1.3. DO NOT TOUCH OR HANDLE RADIOACTIVE MATERIALS.

2.3.1.4. Internal exposure to radioactive materials.

2.3.1.5. Yearly permissible exposure for radiation workers.

2.3.1.6. Yearly permissible exposure for outside contractors.

2.3.1.7. Removal of protective clothing when exiting a contaminated area.

2.3.1.8. Monitoring and surveys.

2.3.1.9. Site Specific Training Test

2.3.1.9.1. Must have an 80% to pass

2.3.1.9.2. Any test scores below 80% and the trainer will go over what was missed and the test will be retaken until the appropriate score is achieved.

2.3.2. ARC: Basic Radiation Safety Training (estimated time: 60min) (SOP 21)

2.3.2.1. Nature of Radioactive Material

2.3.2.2. Radiation Vs Contamination

2.3.2.3. Types of Emissions

2.3.2.4. ALARA

2.3.2.5. Time, Distance, and Shielding

2.3.2.6. Effects of Beta Radiation

2.3.2.7. Types of Exposure

2.3.2.8. Protective Clothing and Equipment

2.3.2.9. Donning and Doffing (Practical exercise)

2.3.2.10. Surveys and Meters

2.3.2.11. Basic Radiation Safety Test

2.3.2.11.1. Must have an 80% to pass

2.3.2.11.2. Any test scores below 80% and the trainer will go over what was missed and the test will be retaken until the appropriate score is achieved.

2.3.3. Survey Meter Training (estimated time: 20min)

2.3.3.1. Parts of a Meter

2.3.3.2. CPM Vs mR/hr

2.3.3.3. Scales and Reading a Meter (Practical Exercise)

2.3.3.4. Meter Test

2.3.3.4.1. Must have an 80% to pass

2.3.3.4.2. Any test scores below 80% and the trainer will go over what was missed and the test will be retaken until the appropriate score is achieved.

2.3.4. Regulatory Requirements (estimated time: 30 min) (RPP 4.1)

2.3.4.1. RSO

2.3.4.2. Material Control and Accountability

2.3.4.3. Personal Dosimetry

2.3.4.4. Radiation Safety Program Audits

2.3.4.5. Record Keeping

2.3.4.6. Surveys

2.3.4.7. Postings

2.3.4.8. Labeling of Containers

2.3.4.9. Handling and Reporting of Incidents

2.3.4.10. Licensing and Inspection by NRC

2.3.4.11. Importance of Complete and Accurate Information

2.3.4.12. Employee Protection

2.3.4.13. Deliberate Misconduct

2.3.5. Emergency Procedure (estimated time: 15min) (RPP 8)

2.3.5.1. RSO Contact Information

2.3.5.2. Steps to Control Spill

2.3.5.3. Clean Up Instructions and Decontamination

2.3.5.4. Emergency Exit Plans

2.3.6. Survey Programs (estimated time: 15min) (RPP 4.1)

2.3.6.1. Survey Instrument's Accessibility

2.3.6.2. Survey Responsibility

2.3.6.3. Types, Contamination, and areas

2.3.6.4. Frequency

2.3.6.5. Levels of Contamination

2.3.6.6. Personnel, Hands, and Shoes

2.3.6.7. Records

2.3.7. Waste (estimated time: 20min) (SOP 8)

2.3.7.1. Liquid Waste

2.3.7.2. Solid Waste

2.3.7.3. Sanitary Sewer

2.3.7.4. Storage

2.3.7.5. Decay in Storage

2.3.7.6. Waste Storage Surveys

2.3.7.7. Records

2.3.8. Dosimetry (estimated time: 20 min) (RPP 4.1)

2.3.8.1. Whole Body

2.3.8.2. Extremities

2.3.8.3. Bioassay Procedures

2.3.8.4. Badge Procedure

2.3.8.5. Records

2.4. Refresher Frequency

2.4.1. The laboratory personnel will have refresher training annually.

## 3.0 Certification of training

I certify that I have received the training instructions listed in 2.0 above.

Name (please print)

_____

_____
Signature

# For Radioactive Spills and other Emergencies

During working hours use the phone system page (Dial "42")

After working hours, call, in the order listed, the numbers listed below:

| | |
|---|---|
| Regis A. Greenwood, CHP, RSO | (314) 738-0048 Home<br>(314) 406-2101 Cell |
| Donald Lite, Assistant RSO | (971) 227-9129 Cell |
| April Birkholz, HP Tech | (636) 293-6278 Cell |
| Surendra Gupta, PhD<br>President | (314) 878-1220 Home<br>(314) 479-8839 Cell |

- Alert Co-workers of the spill and its' location
- Stop the spread of the spill Cover spill with absorbent material
- Call the RSO or assistant (after hours, use the list above)
- Check yourself for contamination
- If contaminated, stay in the area
- Have everyone stay clear of spill
- Wait for Health Physics Personnel to survey spill
- Assist in decontaminating the area of the spill

Supersedes: NEW
Reviewed by RSC: 12/30/2010
Approved by NRC:



SUBJECT: Spills and Other Emergencies

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**OBJECTIVE:** This procedure provides a means to assure that spills of radioactive materials are captured and personnel and/or equipment is returned to a non-contaminated state with the least dose to individuals.

**RESPONSIBILITY:** Radiation Safety Office

**REFERENCES:** a) General Reference Only: NUREG-1556, Vol 12, Program Specific Guidance About Possession Licenses for Manufacturing and Distribution, Appendices N and P.

**This reference is used for guidance only and not for any specific quantity or use.**

b) ARC Radiation Protection Program, Section 8.

## PROGRAM

### 1.0 Equipment

1.1 Spill Kits are maintained in each Laboratory. See Attachment A for the contents of a typical Spill Kit. (Brand names, number of each item and so forth may change without a revision of this procedure.)

1.2 Instruction Signs – Instruction on what to do in case of a spill or other radiological emergency are posted on each wall of each laboratory building. See Attachment B for a Typical Sign (Names and/or Telephone Numbers may change without a revision of this procedure.)

### 2.0 Requirement

2.1 Reference a) above, Appendix N for general guidance

2.2 Letter from USNRC Region III to ARC, transmitting License renewal, dated 30 Sep 2010

### 3.0 Procedure

3.1 Medical Emergencies

Appropriate first aid and other immediate medical needs of injured individuals shall not be neglected, delayed, or ignored due to radioactive contamination.

Provisions have been made for treatment of occupational injuries by appropriately trained physicians in the St. Louis County area.

3.1.1 Barnes Care – 314-993-3014 (Located in the Park, less than ¼ mile.)

Barnes West County Hospital – 314-434-0600

3.1.2 For minor injuries not involving radioactive materials

3.1.3 St. Johns Mercy Hospital Emergency Room – 314-569-6090

For Major injuries or injuries involving radioactive materials

3.2 Fires

NOTE: Any fires which sets off either the smoke alarms or the sprinkler system will also sound alarms and notify the fire department

3.2.1 Immediately attempt to put out the fire by approved methods (i.e. fire extinguisher) if other fire hazards or radioactive hazards are not present

3.2.2 Notify all persons present to vacate the area and call the RSO

3.2.3 Once the fire is out, isolate the area to prevent the spread of possible contamination.

3.2.4 The RSO or designee, see RPP Section 3.3.4.12 will:

- Survey all persons involved in combating the fire for contamination.
- Decontaminate affected personnel
- Determine a plan of decontamination for the equipment and area
- Attempt to determine root cause,

3.3 Spills of RAM not involving contamination of personnel

NOTE: Due to the extremely small volume/mass of the typical reaction, use of the Spill Kit may not be necessary. The priority should be given to stopping any spread of the spill.

3.3.1 Notify co-workers and block access to the spill area

3.3.2 Cover the spill with an absorbent material (i.e. paper towels) to prevent spreading the radionuclide.

3.3.3 Notify the RSO or designee, see RPP Section 3.3.4.12 and other individuals in the area that a spill has occurred.

3.3.4 Keep coworkers away from the spill area. Don't try to clean the spill yourself.

3.3.5 Remain in the area until the RSO or designee, see RPP Section 3.3.4.12 arrives. Provide the RSO or designee, see RPP Section 3.3.4.12 all relevant information.

3.3.6 The RSO or designee, see RPP Section 3.3.4.12 will survey the individual's protective clothing, personal clothing, and exposed skin areas and will release the individual if not contaminated

3.3.7 Individuals under the direction of the RSO or designee, see RPP Section 3.3.4.12 perform area decontamination and surveys.

3.3.8 The RSO or designee, see RPP Section 3.3.4.12 will survey and wipe test the area to verify the effectiveness of the cleanup operation.

3.4 Spills of RAM involving contamination of personnel

NOTE: Due to the extremely small volume/mass of the typical reaction, use of the Spill Kit may not be necessary. The priority should be given to stopping any spread of the spill.

3.4.1 Notify co-workers and block access to the spill area

3.4.2 Cover the spill with an absorbent material (i.e. paper towels) to prevent spreading the radionuclide.

3.4.3 Notify the RSO or designee, see RPP Section 3.3.4.12, and other individuals in the area that a spill has occurred. Keep coworkers away from the spill area. Don't try to clean the spill yourself.

3.4.4 Remain in the area until the RSO or designee, see RPP Section 3.3.4.12, arrives. Provide the RSO or designee, see RPP Section 3.3.4.12, with all relevant information.

3.4.5 The RSO or designee, see RPP Section 3.3.4.12, will survey the individual's protective clothing, personal clothing, and exposed skin areas.

3.4.6 The RSO or designee, see RPP Section 3.3.4.12, will remove any contaminated clothing and decontaminate any contaminated skin areas.

3.4.7 If necessary, the RSO or designee, see RPP Section 3.3.4.12, will direct the individual to use the building 300 shower stall. The RSO will provide soap, a hand brush, shampoo, towels, booties and a jumpsuit.

3.4.8 If skin areas are still contaminated, the RSO or designee, see RPP Section 3.3.4.12, will evaluate the skin dose. Do not leave the facility until released by the RSO or designee, see RPP Section 3.3.4.12.

3.4.9 Individuals under the direction of the RSO or designee, see RPP Section 3.3.4.12, perform area decontamination and surveys.

3.4.10 The RSO or designee, see RPP Section 3.3.4.12 shall survey and wipe test the area to verify the effectiveness of the cleanup operation

3.5 Major Spills; classified as those giving at or more than 10% of the annual dose limit (500mrem urine sample) or in the event of a fire sprinkler discharging.

**NOTE 1: Any discharge of a fire suppression sprinkler will bw regarded as having caused a major spill.**

**NOTE 2: Due to the high specific activity of the compounds prepared at ARC, the assistance of the involved chemist is necessary to determine if a spill is major. Guidelines are: (these are estimates by the involved chemist)**

3.5.1 Very Low Volatility compounds – Greater than 10 Curies of H-3 or greater than 2 curies of C-14

3.5.2 Low volatility compounds – greater than 5 Curies (but less than 10 Curies) of H-3 or greater than 1 Curie (but less than 2 Curies) of C-14.

3.5.3 High volatility Compounds – greater than 2 Curies (but less than 5 Curies) of H-3 or greater than 0.5 Curies (but less than 1 Curie) of C-14.

3.5.4 Very High volatility Compounds – greater than 1 Curie (but less than 2 Curies) of H-3 or greater than 200 millicuries (but less than 500 millicuries) of C-14.

3.5.5 Depending on whether or not personnel were contaminated, major spills will include section 3.3 or 3.4 above.

3.5.6 In addition a specific work instruction will be developed by the RSO and a copy of the work instruction will be filed with the investigation report in the off-normal file.

3.6 Investigation and Reports

3.6.1 A detailed investigation of the incident shall be prepared by the RSO, or designee, see RPP Section 3.3.4.12, including, but not limited to the apparent cause; the root cause, if possible: **actions to prevent recurrence**; and the dose consequences, if any

3.6.2 The report shall include recommendations for any additional surveys etc. that may be necessary to prevent future spills and the frequency of such surveys.

3.6.3 The RSO will conduct, in the event of the spill being handled by a designee, an audit of all actions by the designee

3.6.4 The report shall be reviewed by the Radiation Safety Committee.

3.6.5 The report shall be filed with the RSC minutes and in the Off Normal File

Actions by a designee, taken in the absence of the RSO, which are inappropriate, incorrect, and/or not in compliance with NRC requirements of the ARC license shall be handled in accordance with ARC policy. "Consequences of Procedural Non-compliance".

# Attachment A

# Spill Kit Contents

Disposable Gloves

Housekeeping glove

Disposable lab coats

Disposable shoe covers

Absorbent paper with plastic backing

Masking tape

Plastic trash bags

"Radioactive Material" labeling tape

Marking pen

Pre-strung "Radioactive Material" labeling tags

Wipes

Copy of this Procedure

Pencil

# Attachment B

# Liquid Waste Inventory

| Container Number | Container Volume gallons | Container Volume liters | Concentration, H-3 microcurie/liter | Concentration, C-14 microcurie/liter | Activity, H-3 millicuries | Activity, C-14 millicuries |
|---|---|---|---|---|---|---|
| 1 | | 0 | | | 0 | 0 |
| 2 | | 0 | | | 0 | 0 |
| 3 | | 0 | | | 0 | 0 |
| 4 | | 0 | | | 0 | 0 |
| 5 | | 0 | | | 0 | 0 |
| 6 | | 0 | | | 0 | 0 |
| 7 | | 0 | | | 0 | 0 |
| 8 | | 0 | | | 0 | 0 |
| 9 | | 0 | | | 0 | 0 |
| 10 | | 0 | | | 0 | 0 |

Total Inventory Tritium millicuries 0

Total Inventory C-14, millicuries 0

Supersedes: 12/30/2010 
Reviewed by RSC: X/XX/2011
Approved by NRC:

SUBJECT: Liquid Waste Inventory

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**OBJECTIVE:** This procedure provides a means to assure that the activity of liquid waste waiting processing is included in ARC's nuclide inventory.

**RESPONSIBILITY:** Radiation Safety Officer (or designee, see RPP Section 3.3.4.12).

**REFERENCES:**

a) General Reference Only: NUREG-1556, Vol 12, Program Specific Guidance About Possession Licenses for Manufacturing and Distribution **This reference is used for guidance only and not for any specific quantity or use.**

b) ARC Radiation Protection Program, Section 9

c) SOP

7 – Liquid Waste Processing
8 – Radioactive Waste Processing
16 – Contamination Control Program
18 – Liquid Waste Evaporation
33 – Use of PCE
38 – Laboratory Personnel Training
39 – Spills and Other Emergencies

## PROGRAM

### 1.0 Equipment

1.1 Spill Kits are maintained in each Laboratory. See SOP 39 for the contents of a typical Spill Kit. (Brand names, number of each item and so forth may change without a revision of this procedure.)

1.2 Instruction Signs --Instruction on what to do in case of a spill or other radiological emergency are posted on each wall of each laboratory building. See SOP 39 for a Typical Sign (Names and/or Telephone Numbers may change without a revision of this procedure.)

### 2.0 Requirement

Letter from USNRC Region III to ARC, transmitting License renewal, dated 30 Sep 2010

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## 3.0 Prerequisites

3.1 Individuals performing activities controlled by this SOP have been trained in accordance with SOP – 38.

3.2 Liquid waste has been segregated, analyzed and transported to the waste processing facility in accordance with SOPs – 7, 8, and 18.

3.3 Protective Clothing and Equipment is available in accordance with SOP – 33.

## 4.0 Procedure

**NOTE: The analysis and labeling should take place prior to transport of the waste to the processing facility, but may take place at the facility.**

4.1 Measure, or estimate, wastewater volume in liters.

4.2 Stir the wastewater thoroughly, collect a 1 mL aliquot.

4.3 Assay the sample in the liquid scintillation counter (LSC) using the Liquid Waste (Counting Protocol 6).

4.4 The LSC automatically makes corrections for quench, overlap, efficiency and background to yield results in net μCi/L.

4.5 Calculate the activity of the waste by multiplying the volume from 4.1 by the concentration from 4.4

4.6 Label the container with:

4.6.1 the next sequential number, restart numbers only in the new year.

4.6.2 the date entered into liquid waste

4.6.3 the isotope if other than C-14 or H-3

4.6.4 whether it is aqueous or not

4.6.5 source of waste

4.7 Enter the data from 4.6 in the Liquid waste spreadsheet (Attachment A), citing which container it was added to.

4.8 At the time the liquid waste is processed in accordance with SOP 18, transfer the entry from Liquid Waste Inventory, see attachment A, to Evaporation Log, see attachment B, including the date removed from inventory.

**5.0 Use**

5.1 The inventory Spreadsheet shall be used to ensure that the ARC possession limit of 12,000 Curies of Tritium and 400 Curies of C-14 is not exceeded.

5.2 The liquid waste inventory spreadsheet shall be used to update the total possession inventory (kept in SBT) on a monthly basis.

5.3 It is expected that the total inventory of liquid waste activity will be a very small fraction of the ARC possession limit.

# Attachment

# A

# Attachment

# B

# Waste Inventory SCO

| SEQUENTIAL NUMBER | DESCRIPTION | AREA IN SQ CM | C-14 CPM | C-14 DPM PER SQ CM | H-3 DPM/ 100 SQ CM | H-3 DPM/ SQ CM | C-14 millicuries | H-3 millicuries |
|---|---|---|---|---|---|---|---|---|
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |
| | | | | 0 | | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| Total Inventory | Tritium | millicuries | 0 | |
| Total Inventory | C-14 | millicuries | | 0 |

Supersedes: NEW 
Reviewed by RSC: 12/30/2010
Approved by NRC:

SUBJECT: Inventory of Surface Contaminated Objects (SCO)

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**OBJECTIVE:** This procedure provides a means to assure that the activity on Surface Contaminated Objects (SCO) is captured for the ARC nuclide inventory.

**RESPONSIBILITY:** Radiation Safety Officer (or designee, see RPP Section 3.3.4.12).

**REFERENCES:**

a) General Reference Only: NUREG-1556, Vol 12, Program Specific Guidance About Possession Licenses for Manufacturing and Distribution, Appendix N
**This reference is used for guidance only and not for any specific quantity or use.**

b) General Reference Only: NUREG-1556, Vol 12, Program Specific Guidance About Possession Licenses for Manufacturing and Distribution, Appendix P

c) ARC Radiation Protection Program, Section 9

d) SOP

8 – Radioactive Waste Processing
16 – Contamination Control Program
33 – Use of PCE
38 – Laboratory Personnel Training
39 – Spills and Other Emergencies

## PROGRAM

### 1.0 Equipment

1.1 Spill Kits are maintained in each Laboratory. See SOP 39 for the contents of a typical Spill Kit. (Brand names, number of each item and so forth may change without a revision of this procedure.)

1.2 Instruction Signs – Instruction on what to do in case of a spill or other radiological emergency are posted on each wall of each laboratory building. See SOP 39 for a Typical Sign (Names and/or Telephone Numbers may change without a revision of this procedure)

1.3 Properly calibrated survey instruments.

---

## 2.0 Requirement

Letter from USNRC Region III to ARC, transmitting License renewal, dated 30 Sep 2010

## 3.0 Prerequisites

3.1 Individuals performing activities controlled by this SOP have been trained in accordance with SOP – 38

3.2 SCO have been appropriately stored in the waste processing facility.

3.3 Protective Clothing and Equipment is available in accordance with SOP – 33.

## 4.0 Procedure

NOTE: The analysis and labeling should take place prior to transport of the SCO to the processing facility, but may take place at the facility.

4.1 Measure, or estimate, the surface area of the object in square centimeters.

4.2 Determine the surface activity of the object by taking the following measurements

4.2.1 Measure, by direct scan, the total C-14 activity in counts per minute (cpm)

4.2.2 Convert the cpm per probe area to disintegrations per minute (dpm) per square centimeter by multiplying by 0.72

4.2.3 Measure, by dry wipe, the activity on 100 sq cm of surface.

4.2.4 Count the wipe using any Liquid Scintillation Counter (LSC) protocol that delivers H-3 dpm. The LSC automatically makes corrections for quench, overlap, efficiency and background to yield results in net dpm/100 $cm^2$.

4.2.5 Convert the dpm per 100 sq cm to dpm per sq cm by dividing by 100.

**NOTE: The calculations given in this procedure are listed for the rare case where the calculations must be done manually. The Inventory spreadsheet (Attachment A) performs all the required calculations**

4.3 Repeat 4.2 above for each square meter of surface area as a minimum.

4.4 Using the highest H-3 and C-14 values found in 4.3 above, multiply these results by the total square centimeters determined in 4.1 above. This result is the total C-14 and H-3 activity for the SCO. Convert to millicuries by dividing the respective dpm value by $2.22 \times 10^9$.

4.5 Label the SCO with the results found in 4.4.

4.5.1 the next sequential number

4.5.2 the area, in sq cm, of the SCO

4.5.3 the total Tritium activity

4.5.4 the total C-14 activity

4.6 Enter the data from 4.4 in the SCO Inventory spreadsheet (Attachment A)

4.7 At the time the SCO is decontaminated and released OR the SCO is shipped as RAD Waste delete the entire entry for that object number from the spreadsheet.

## 5.0 Use

5.1 The inventory Spreadsheet shall be used to ensure that the ARC possession limit of 12,000 Curies of Tritium and 400 Curies of C-14 is not exceeded.

5.2 The liquid waste inventory spreadsheet shall be used to update the total possession inventory (kept in SBT) on a monthly basis.

5.3 It is expected that the total inventory of SCO contamination activity will be a very small fraction of the ARC possession limit.

# Attachment

# A

# ATTACHMENT TWO

This attachment is composed of a list of changes to the renewal application necessitated by changes to the License made by Amendments 48, 47, 46, 45, and 44.

These changes deal with possession limits and uses for various nuclides, as well as changes to Authorized Users, staffing and nomenclature.

NRC License Application Modifications

Application Part: Item 5 Radioactive Materials

Change: Added line items N and O

Justification: Change made to reflect NRC approved license amendment number 47

Application Part: Item 6 Authorized Use

Change: Added "N and O" to paragraph one to now state, "Items A through I, N and O – To be used…"

Justification: Added line items N and O to reflect NRC approved license amendment number 47

Change: Added "Items A through I above – Possession incident to outdoor site construction and site beautification activities involving movement of site soils, radiological site characterization, collection and analysis of water and soil samples containing residual contamination."

Justification: Change made to reflect NRC approved license amendment number 43

Change: Added "Items A and E above – Possession incident to distribution of labeled compounds in accordance with NRC License Number 24-21362-02E."

Justification: Change made to reflect NRC approved license amendment number 47

Application Part: Item 7 Individuals Responsible

Change: Under Authorized Users section delete paragraph "R.C. Speth, for details of primary experience see attached Resume."

Justification: Robert Speth, PhD is no longer employed at American Radiolabeled Chemicals, Inc.

Application Part: Item 9 Facilities and Equipment

Change: Under paragraph titled Building 100, second sentence reads, "A small area in the North end of the building includes an entry area, a kitchen/lunchroom (these areas are unrestricted), a bathroom…" delete "unrestricted" and replace with "controlled"

Justification: Per facility definitions under the ARC Radiation Protection Program 2.1 part C, SOP-16 section 1.2 and SOP-33 section 2.2; lunchrooms in the laboratory buildings are defined as controlled areas.

Change: Under paragraph titles Building 300 Annex second paragraph, states, "The exhaust ducting for this area is composed of two separate systems, one for the clean labs and one for the contaminated labs. Provision has been made for charcoal and/or HEPA filtration of the contaminated exhaust if required." Amend this paragraph to state, "The exhaust ducting for this area is composed of two separate systems, each one containing a contaminated lab and a clean lab. Provisions have been made for charcoal and/or HEPA filtration of each exhaust if required."

Justification: At the time this was written, the NRC had not yet approved Building 300 Annex for use and the contaminated and clean labs were not yet defined. Refer to the letter dated 1 November 2011.

Application Part: Item 10 Radiation Safety Program

Change: Paragraph titled Spreadable (Loose) Contamination, "Unrestricted Areas – total loose 1,000" add the word to read, "Unrestricted/Controlled Areas – total loose 1,000"

Justification: There are three defined areas on ARC property, restricted, controlled and uncontrolled. This paragraph only defined two of the areas.

# ATTACHMENT THREE

This attachment is a list of changes to Standard Operating Procedures due to discrepancies, out dated equipment an similar findings.

These discrepancies were found during our annual review of PPP

ANNUAL REVIEW OF SOP's

**SOP-01 Waste Compaction**

Currently States

3.2.6 "Before compacting, spread a plastic sheet or plastic-backed bench- paper on the floor in front of the compactor and tape in place."

3.2.11 "After compacting, remove the plastic sheet or bench-paper from the floor and place it in a compactor bag."

3.2.12 "After compacting, remove the additional PCE and place it in the compactor bag."

3.2.13 "Survey the floor area and clean as may be required. Action level is 50,000 dpm H-3 and 10,000 dpm C-14. Inform the RSO if Action Level is exceeded."

Action: Delete All

Justification: This SOP was written based on the idea that the area around the compactor enclosure was to remain uncontaminated. Building 200 is contaminated throughout so laying plastic down to prevent the spread of contamination, wearing additional PCE, and surveying the floor after use are unnecessary.

3.2.15 "Mark the container with the next sequential number and the date the container is closed."

3.2.16 "Place a temporary RAM label on the container. Fill in the label with the date and <10 mCi $^{14}C$ and <10 mCi $^{3}H$."

3.2.17 "Inform the RSO of the box number (the date the box was sealed) and the weight."

Action: Add "After weighing, load the container inside the Sea Land and" and delete "and the date the container is closed" from 3.2.15; Delete 3.2.16; and add "and the contents of the container" to 3.2.17

Justification: Several containers are simultaneously filled over a period of weeks, marking them with numbers before they are full and ready to load in the Sea Land, may cause confusion in numbering with maintenance staff. At the time this SOP was written, ARC used 55-gallon metal drums as individual containers of radioactive waste, because they are individual containers, they each needed to be labeled with this information. Currently ARC uses a Sea Land shipping container as the means for disposal and cardboard boxes for convenience. The Sea Land is the container and is labeled. The date the cardboard container is closed is irrelevant and RAM labels are unnecessary. Loading staff also reports the general contents of the container to the RSO.

**SOP-06 Package Receipt**

Currently States

2.1 "Put on gloves to prevent hand contamination."

Action: Delete 2.1

Justification: The shipment has left the shipper's facility, has been handled by employees of the shipping company, and been laid to rest on the floor of the main office until wipes can be done on the outside of the package. At no time in transit are gloves required to handle the box, ARC feels that gloves are unnecessary to handle the outer package.

**SOP-08 Radioactive Waste Processing**

Currently States

1.3.2.5 "Before compacting, spread a plastic sheet or plastic backed bench paper on the floor in front of the compactor and tape in place

1.3.2.9 "After compacting, remove the plastic sheet or bench paper from the floor and place it in a compactor bag

1.3.2.10 "Survey the floor area according to the weekly schedule

Action: Delete All

Justification: At the time this SOP was written, the compactor enclosure was in an uncontaminated place. It is now inside of Building 200 in a contaminated area, and these steps are no longer necessary. The part requiring that the floor area be surveyed according to the weekly schedule, is redundant and unnecessary.

1.3.2.12 "Mark the container with the next sequential number, the date the container is closed, and the weight of the container."

1.3.2.13 "Place a temporary RAM label on the container. Fill in the label with the date and <10 mCi $^{14}C$ and <10 mCi $^{3}H$."

Action: Add to 1.3.2.12 "After weighing, load the container inside the Sea Land and" and delete ", the date the container is closed, and the weight of the container"; delete 1.3.2.13

Justification: Several containers are simultaneously filled over a period of weeks, marking them with numbers before they are full and ready to load in the Sea Land, may cause confusion in numbering with maintenance staff. At the time this SOP was written, ARC used 55-gallon metal drums as individual containers of radioactive waste, because they are individual containers, they each needed to be labeled with this information. Currently ARC uses a Sea Land shipping container as the means for disposal and cardboard boxes for convenience. The Sea Land is the container and is labeled. The date the cardboard container is closed is irrelevant and RAM labels are unnecessary.

4.1.6 "A personal contamination survey is required after an individual performs liquid waste evaporation operations and before they exit Building 200."

Action: Delete 4.1.6

Justification: Evaporation takes place in Building 200 and in order to access it, one must go through the Building 100 change area. Exiting the change area requires all persons to do a personal contamination survey. This is a redundant statement because you are already required to survey yourself whether handling evaporating liquids or not.

4.2.3 "Laboratory Technician

Whenever transporting a liquid waste container system (LWCS) between buildings, a disposable glove must be worn on the hand used to carry the LWCS. Keep the other hand ungloved for opening doors, etc. Do not allow the transfer container to come in contact with surfaces outside of restricted areas since the LWCS could be externally contaminated."

4.2.3.1 Whenever transporting a LWCS to building 200, exit buildings 100 or 300 through the respective change area.

4.2.3.2 Place the LWCS on the transfer cart in building 200.

4.2.3.3 Pour the liquid waste into an open pan containing absorbent sponges or paper. Fill the liquid to a depth of 1 inch or less.

4.2.3.5

4.2.3.6 Return an empty LWCS to the buildings 100 or 300 through its change area.

Action: Delete 4.2.3 and replace with, "Store the liquid waste container system (LWCS) in the HP work area, do not bring it into the lab. This will prevent external contamination so that the container will only contaminated internally."; delete from 4.2.3.1 "100 or" and "respective change area" and add "most direct route possible; delete from 4.2.3.2 "on the transfer cart" and add "outside of (building 200) and set the liquid waste bottle inside the door"; delete from 4.2.3.3 "Fill the liquid to a depth of 1 inch or less" and add "or transfer it to an empty liquid waste bottle for temporary storage"; add section 4.2.3.5 to state, "Return the empty liquid waste bottle to the originating hood. Use the LWCS for Building 300, using the most direct route possible. Reusing the empty liquid waste bottles will reduce radioactive waste. Because different chemists create different types of waste, always return the bottles to their originating hoods." Delete from 4.2.3.6 "buildings 100 or 300 through its change area" and add "HP work area"

Justification: 4.2.3 Formerly the LWCS was stored in a contaminated area, currently it is stored in an uncontaminated restricted area so there is no external contamination on the transport container. 4.2.3.1 Buildings 100 and 200 are connected so when transporting liquid waste from 100 to 200, there is no need to exit. 4.2.3.2 The LWCS never enters the contaminated area and therefore does not need to be placed on the transfer cart which will be contaminated. 4.2.3.3 On occasion there are no evaporation trays open, so we have empty temporary containers for the liquid to wait in until a tray has evaporated all of its liquid. The depth of liquid does not affect the evaporation rate of the liquid and is unnecessary. 4.2.3.5 This section was added so that emptied liquid waste containers are

returned to their source hood. In the past a brand new uncontaminated liquid waste container would replace the old one in the hood. By reusing the same containers in the hoods, we greatly reduce the amount of waste created. 4.2.3.6 Empty LWCS are returned HP work areas so they will remain uncontaminated externally.

**SOP-16 Radioactive Contamination Control Program**

Currently States

1.3.2.2 "Any area, no matter where located, where the following limits are exceeded:
Total – 5000 dpm/100cm$^2$ average, not to exceed 15,000 for a single point"

Action: Delete ", not to exceed 15,000 for a single point"

Justification: The sentence states that contamination areas includes, "Any area, no matter where located, where the following limits are exceeded" but then later it says "not to exceed 15,000 for a single point" This statement was cut and pasted from the definition for a Controlled Area. The "not to exceed" part is applicable to the controlled area, but is unnecessary when defining areas which do exceed 15,000 for a single point.

**SOP-18 Liquid Waste Evaporation**

Currently States

1.6 "A personal contamination survey is required after an individual performs liquid waste evaporation operations and before he exits building 200.

Action: Delete All

Justification: This was written when Buildings 100 and 200 were separate. They are now connected through a door, so all who enter Building 200 to perform evaporation, must exit through the Building 100 change area. One is already required to do a personal contamination survey when exiting the change area, therefore this statement is redundant.

2.3 Laboratory Technician

Whenever transporting a liquid waste container system (LWCS) between buildings, a disposable glove must be worn on the hand used to carry the LWCS. Keep the other hand ungloved for opening doors, etc. Do not allow the transfer container to come in contact with surfaces outside of restricted areas since the LWCS could be externally contaminated.

2.3.1 Whenever transporting a LWCS to building 200, exit buildings 100 or 300 through the respective change area.

2.3.2 Place the LWCS on the transfer cart in building 200.

2.3.3 Pour the liquid waste into an open pan containing absorbent sponges or paper. Fill the liquid to a depth of 1 inch or less.

2.3.5

2.3.6 Return an empty LWCS to buildings 100 or 300 through its change area.

Action: From 2.3 delete and replace with "Store the liquid waste container system (LWCS) in the HP work area, do not bring it into the lab. This will prevent external contamination so that the container will only contaminated internally." From 2.3.1 delete "100 or" and "respective change area" and add "most direct route possible" From 2.3.2 delete "on the transfer cart in" and add "outside of (building 200) and set the liquid waste bottle inside the door" From 2.3.3 add ", or transfer it to an empty liquid waste bottle for temporary storage" and delete "fill the liquid to a depth of 1 inch or less" Add a section called 2.3.5 stating "Return the empty liquid waste bottle to the originating hood. Use the LWCS for Building 300, using the most direct route possible. Reusing the empty liquid waste bottles will reduce radioactive waste. Because different chemists create different types of waste, always return the bottles to their originating hoods." From 2.3.6 delete "building 100 or 300 through its change area" and add "the HP work area".

Justification: This was done to reflect the changes recommended in SOP-08 Radioactive Waste Processing. The justification is stated above.

**SOP-21 Training and Dose Estimates for Non-Laboratory Personnel**

Currently States

2.4.1 "Contractors that are repairing an instrument or performing building maintenance that is short term and under direct supervision by the RSO, assistant RSO, or Health Physics Technician does not require above training. Instead of the above training the person providing the direct supervision will also provide guidance to the contractor such as but not limited to locations of RAM, exiting survey, and donning and doffing PPE.

Action: Delete "assistant RSO, or Health Physics Technician" and replace with "or someone whose experience with contractors is deemed sufficient by the RSO,"

Justification: These are job titles and they may change in the future or if someone new is hired and they hold the job title, but may not be qualified to give a facility tour to contractors. Therefore someone whose experience with touring contractors is deemed sufficient by the RSO, may perform this duty.

**SOP-30 Release of Material**

Currently States

2.1 "Scan the equipment with a GM survey meter and outline (with grease pencil or "magic marker") any areas where activity exceeding two times background is detected."

Action: Delete "outline (with grease pencil or "magic marker)" and replace with "note"

Justification: Some items, like gas cylinders and dry ice boxes, are returned to vendors. Permanently marking an item for contamination when the contamination is readily cleanable is unnecessary and will ruin said items.

Justification: SOP-16 Contamination Control Program Section 1.0 Requirement; gives specific definitions for unrestricted, controlled, restricted contaminated and restricted uncontaminated areas of ARC property. However the definitions of these areas differ in SOP-33. This change will reflect the definitions in SOP-16 for uniformity.

AMERICAN RADIOLABELED CHEMICALS, INC
STANDARD OPERATING PROCEDURE – SOP-42

Supersedes: new
Reviewed by RSC: 5/17/12



SUBJECT: Repair or replace Contaminated Roofing

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OBJECTIVE: This procedure is designed to ensure that no contaminated, or potentially contaminated, roofing material is removed from the ARC site due to repair and/or replacement of the laboratory roofs due to severe hail damage.

It also is designed to provide the involved (non ARC) workers with radiation safety training commensurate with the hazard involved.

This SOP will go into effect at the time an amendment request to replace the roofs, is approved by Region III. This SOP will be suspended upon completion or termination of the job.

RESPONSIBILITY: Radiation Safety Officer

PROCEDURE:

1.0 **Scoping Survey**

1.1 A direct scan survey using a calibrated survey meter with a G-M pancake probe will be performed covering the entire roof area of each building.

1.2 An approximate one-meter grid will be used for the survey. All results will be documented

1.3 Results of more than twice background will require wipe measurements.

1.4 As the survey meter results will not include Tritium, a scaling factor of 25 will be used. This is the historical ratio of H-3 to C-14 in ARC gaseous effluent.

**2.0 Radiation Safety Training**

2.1 Requirement

2.1.1 Training is required for individuals who perform work functions such as (but not limited to) the removal of contaminated (or potentially contaminated) roofing material.

2.2 Training subjects.

2.2.1 Nature of radioactive material

2.2.2 Difference between radiation and contamination

2.2.3 Beta emitters vs other emissions

2.2.4 Effect of beta energy

2.2.5 Beta shielding from clothing, etc

2.2.6 Dose, internal vs external, internal only

2.2.7 Protective clothing and equipment (PCE)

2.2.8 Donning and wear of PCE

2.2.9 Removal of protective clothing when exiting a contaminated area.

2.2.10 Surveys and survey meters.

## 3.0 Certification of training and exposure time

3.1 Each individual trained shall fill out and sign the" Certificate of Training and Exposure Time"

## 4.0 Location and Description Repair Site

***At this time it is possible that the entire roof of each of the three buildings will require replacement***

## 5.0 Disposal

5.1 Any contaminated or potentially contaminated material will be disposed of as Rad Waste.

## 6.0 End of Day

6.1 All workers will be surveyed as they leave the roof and again at the end of the workday before leaving site.

ATTACHMENT A

Certificate of Training and Exposure Time

I certify that I have received the training instructions listed in 2.2 above.

Company name _____ Name (please print) _____

And that I spent the following time within the area described in 4 .0 above

Start date _____ End date _____ Hours _____

Start date _____ End date _____ Hours _____

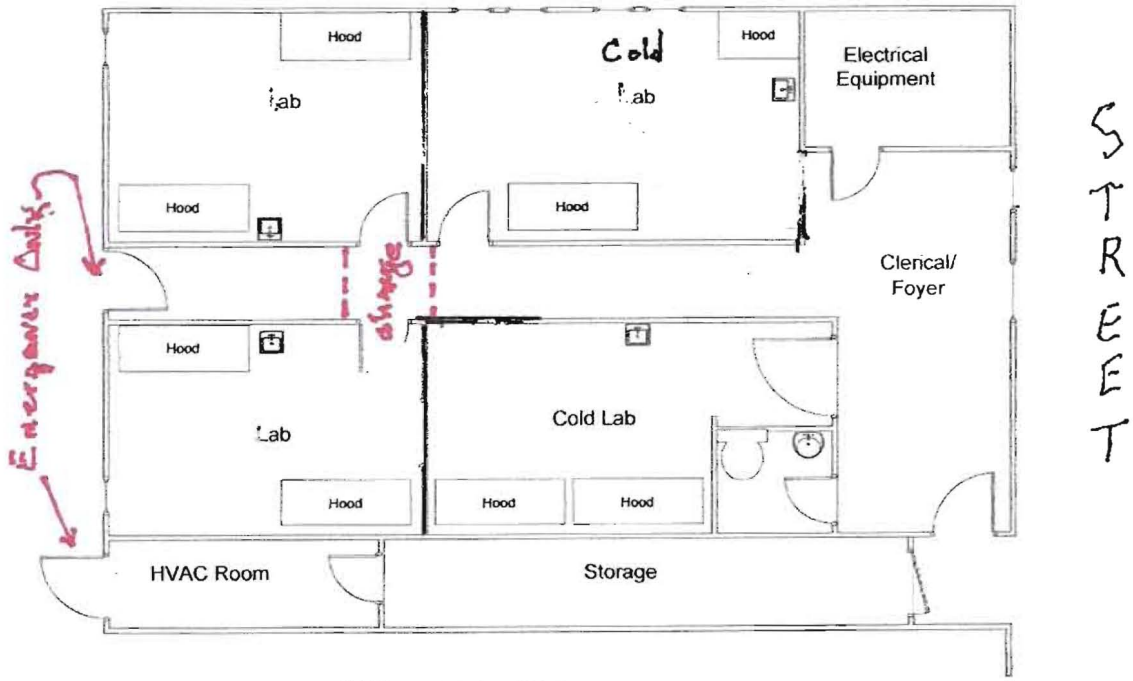
Start date _____ End date _____ Hours _____

Start date _____ End date _____ Hours _____

_____
Signature

# ATTACHMENT FOUR

This Attachment describes updates to floor plans, duct schematics and drawing that describe the facility.The changes to these items were made due to License Amendments 48, 47, 46, 45, and 44.



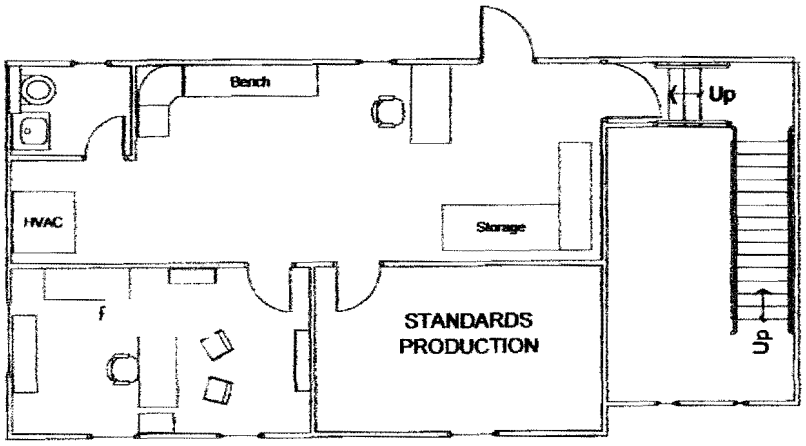

Building 300 Annex

Replace existing [illegible] Floor Plan with this sketch

Do Not Scale

Approx 1/8 " per foot

a




Building 300 Upper Level

Do Not Scale
Approx. 1/8 in to 1 foot

Replace existing Building 300 Upper Level

Floor Plan with this drawing

# ATTACHMENT FIVE

This Attachment is the updated Decommissioning Funding Plan (DFP) which was not included in the original application for renewal.

The DFP is updated every three years.

# Decommissioning Funding Plan

## June 2012

**Prepared By:**
**Regis A. Greenwood, CHP**

**And**

**Donald Lite**

**American Radiolabeled Chemicals, Inc.**
**100 ARC Drive and 104 ARC Drive**
**St. Louis, MO 63146**
**(Buildings 100, 200, & 300)**

**U.S. Nuclear Regulatory Commission License Number 24-21362-01**

TABLE OF CONTENTS

***This document is submitted as the Decommissioning Funding Plan required by the Nuclear Regulatory Commission (NRC) in accordance with NUREG-1556, Vol. 12 to accompany an application for license amendment to include expansions to the facility Applicable parts of 10 CFR include parts 30, 40, 70 and 72.***

# Executive Summary

Reliable estimated total facility decommissioning costs for the expanded American Radiolabeled Chemicals, Inc (ARC) facility located in Maryland Heights, MO; have been determined. based on the methodology contained in the US Nuclear Regulatory Commission (NRC) document NUREG/CR-6477, "Revised Analyses of Decommissioning Reference Non-Fuel-Cycle Facilities" This methodology was modified and supplemented as necessary to: incorporate changes in Criteria for License Termination; account for realities associated with project field implementation; account for current market place rates and accounting practices.

These Cost Estimates are allocated as follows.

| Task/Component | Cost | Percentage |
|---|---|---|
| Planning and Preparation (from Table 3.13) | $49,058 | 7.1% |
| Decontamination and/or Dismantling of Radioactive Facility (From Table 3.13) | $275,944 | 39.8% |
| Restoration of Contaminated Areas on Facility Grounds (From Table 3.13) | $20,598 | 3.0% |
| Final Radiation Survey (From Table 3.13) | $41,443 | 6.0% |
| Packing Material Costs (TOTAL from Table 3.14(a)) | $12,625 | 1.8% |
| Shipping Costs (TOTAL from Table 3.14(b)) | $4,200 | 0.6% |
| Waste Disposal Costs (TOTAL from Table 3.14(c)) | $246,987 | 35.7% |
| Equipment/Supply Costs (TOTAL from Table 3.15) | $29,600 | 4.3% |
| Laboratory Costs (TOTAL from Table 3.16) | $9,200 | 1.3% |
| Miscellaneous Costs (TOTAL from Table 3.17) | $3,000 | 0.4% |
| SUBTOTAL | $692,655 | 100.0% |
| 25% Contingency | $173,164 | 25.0% |
| TOTAL DECOMMISSIONING COST ESTIMATE | $865,819 | 125.0% |

**SECTION 1**

## OBJECTIVES

The objectives of this analysis are to develop reliable estimated total facility decommissioning costs for the American Radiolabelled Chemicals, Inc (ARC) facility located in Maryland Heights, MO; and to obtain current marketplace rates for services including waste transportation, processing and disposal, and labor costs associated with project management, engineering, and field activities.

Cost estimates were based on the methodology contained in the US Nuclear Regulatory Commission (NRC) document NUREG/CR-6477, "Revised Analyses of Decommissioning Reference Non-Fuel-Cycle Facilities" This methodology was modified and supplemented as necessary to: incorporate changes in Criteria for License Termination; account for realities associated with project field implementation; account for current market place rates and accounting practices.

## FACILITY DESCRIPTION SUMMARY

RADIOACTIVE MATERIALS

| a. Element and mass number | b. Chemical and/or physical form | c. Maximum amount which will be possessed at any one time |
|---|---|---|
| A. Carbon-14 | A. Any | A. 400 curies |
| B. Calcium-45 | B. Any | B. 1 curie |
| C. Chlorine-36 | C. Any | C. 300 millicuries |
| D. Chromium-51 | D. Any | D. 100 millicuries |
| E. Hydrogen-3 | E. Any | E. 12,000 curies |
| F. Iodine-125 | F. Any | F. 1.5 curies |
| G. Phosphorous-32 | G. Any | G. 1 curie |
| H. Phosphorous-33 | H. Any | H. 1 curie |
| I. Sulfur-35 | I. Any | I. 10 curies |
| J. Iron-59 | J. Prepackaged units | J. 100 millicuries |
| K. Strontium-85 | K. Prepackaged units | K. 100 millicuries |
| L. Cobalt-60 | L. Prepackaged units | L. 100 millicuries |
| M. Iron-55 | M. Prepackaged units | M. 100 millicuries |
| N. Iron-55 | N. Any | N. 10 millicuries |
| O. Iron-59 | O. Any | O. 10 millicuries |

## PURPOSES FOR WHICH LICENSED MATERIAL HAVE BEEN USED

Items A through I, N, and O above – Used in the manufacture and synthesis of radiolabeled chemicals for distribution to persons authorized to receive the licensed material under the terms of a specific license issued by the Commission or an Agreement State.

Items J through M above – For redistribution to persons authorized to receive the licensed material under the terms of a specific license issued by the commission or an Agreement State.

Items A and E – Possession incident to distribution of labeled compounds in accordance with NRC license Number 24-21362-02E.

## DESCRIPTION OF FACILITIES

ARC laboratories are located at 100 ARC Drive and 104 ARC Drive, St. Louis, Missouri 63146. ARC is a manufacturer of radiolabeled chemicals for the research industry. These chemical compounds are utilized in the biomedical research industry with the radionuclides serving as an accurate means of tracing compounds through their corresponding pathways and uptakes.

The facility has three buildings listed on NRC license number 24-21362-01 that have areas that will need to be surveyed and decontaminated before decommissioning. Building 100, 100 ARC Drive, has approximately 2,815 square feet of contaminated lab space and approximately 343 square feet of uncontaminated space; building 200, has approximately 1450 square feet of contaminated space, is used as a waste processing and equipment decontamination facility. The ground floor of building 300, 104 ARC Drive, has approximately 2,666 square feet of contaminated lab space and approximately 1622 square feet of office space that will not require decontamination. An annex to building 300 has been constructed; 570 square feet of this annex is contaminated.

Due to the age of the buildings, construction type, and changes in building codes, re-use of the existing buildings is highly unlikely. The ARC plan envisions a procedure calling for the removal of all equipment which can be readily decontaminated to free release levels; Equipment and/or furnishings which are not amenable to relatively simple decontamination, and are readily removable, would be disposed of as rad waste

Decon of the remainder of the buildings and non-removable furnishings would proceed to the levels set out as default screening values in NUREG 1727, followed by release for demolition. Demolition and transport of the rubble to a land fill would proceed outside the scope of the decommissioning plan.

QUANTITIES OF WASTE

Liquid radioactive waste with an organic solvent base has been collected and evaporated in fume hoods located in building 200. Air sampling records are maintained to verify that ARC is in compliance with regulations governing the emission of radioactive materials into the air. Water or inorganic based radioactive liquids are sampled and disposed of via the sanitary sewer system. Liquid waste records are maintained to verify that ARC is in compliance with regulations governing the disposal of radioactive materials into the sanitary sewer system. Therefore, no liquid waste from prior operations will require disposal at decommissioning.

Aqueous liquid wastes, such as aqueous cleaning solutions generated as part of the decommissioning process, are assumed to be discharged to the sanitary sewage system under the provisions of the existing license.

Historically, the only non-aqueous liquid wastes that are not readily evaporable have been vacuum pump oil contaminated with Tritium and/or Carbon –14 during the course of synthesizing labeled compounds. The volume accumulates to 50 gallons over a three to five year period. It has been assumed that this oil would have been shipped to a rad waste incinerator as part of the process of shutting down operations.

Solid wastes have been collected in 6 cubic foot boxes and stored in a 20 ft SeaLand container. Shipment is normally scheduled when the container is filled. The normal shipment consists of approximately 1200 cubic feet of waste. In addition to the SeaLand container, there is normally equipment or large items stored in the eastern area of building 200 that may be in storage or waiting for shipment. The number of items in the garage area for storage varies greatly and is difficult to estimate for the time of decommissioning.

Additional dry active waste has been added to the DCF to account for the 30 to 35 boxes of waste that accumulate during the course of a year's operation and may be present at the start of the decommissioning process.. It should be noted that ARC no longer ships waste in drums, but has switched to using Sea Land Containers to permit disposal of contaminated equipment no longer usable as well as the accumulated DAW.

## SECTION 2

### ASSUMPTIONS USED

Overall, "middle of the road" assumptions were made concerning likely extent and duration of necessary remedial activities. Remediation is to unrestricted release criteria, in accordance with up to date Criteria for Termination of License, with the buildings removed. This assumption means there are no long term costs associated with site surveillance and monitoring following decommissioning.

Decommissioning will involve removal of facility components or decontamination of selected components of the facility only to the extent that the NRC license may be terminated and the remaining facility and site may be released for unrestricted use. This plan does not consider the option of complete decontamination of the facility components before disposal. Extensive decontamination of the small number of small components in facilities such as these is expensive, and does not warrant the extra clean-up of the components needed for unrestricted use. Rather, minimal decontamination is carried out in this study, followed by cutting and packaging and volume reduction of the radioactively contaminated material for disposal at a licensed LLW burial ground.

The study does not address the removal of bulk, packaged, inventory quantities of radionuclides from the facilities and their ultimate disposition. Removal off-site of these quantities is assumed to have been completed before physical decommissioning begins.

The cost estimates in this plan. take into consideration only those decommissioning costs that affect public health and safety (i.e., costs to reduce the residual radioactivity in a facility to a level that permits the facility to be released for unrestricted use and the NRC license to be terminated). Hence, the cost estimate includes neither the cost to remove clean materials and equipment nor to restore the land to a "green field," which would require additional demolition and site restoration activities in some cases. Although the additional costs for site restoration will be expended from the viewpoint of public relations or site resale value, they are not related to health and safety, and therefore were considered to be outside of NRC's area of responsibility.

ARC's plan was developed with the guidance in Appendix A of NUREG/CR-6477, quoted below.

"All decommissioning activities within a facility, starting with the predecommissioning work (e.g., planning. activity specifications and procedures), and continuing through the final license termination, are assumed to be carried out by the facility staff, except where otherwise identified (e.g.. super compacting, incineration, waste transportation, waste disposal). Decommissioning of outside facilities (e.g., sink drain line and buried holdup tank) and site land where necessary, and waste volume reduction, are assumed to be performed by a contractor hired by the facility operator."

It is ARC's intent to use outside contractors only for the final survey phase of the decommissioning. The portion of the DCF Tables 3.12 and 3.13 show a Contractor profit of 20% for the Final Radiation Survey portion of the project

Salaries and or wages projected for the other portions of the project reflect actual wages paid to facility staff, rounded to the nearest thousand.

Contamination present in the building was assumed to be limited to portions of the building posted and controlled as "restricted areas". In particular, contamination was presumed not to be present beneath the concrete floors. Allowances were made, however, to estimate the costs of sampling under concrete slabs to confirm this assumption.

In developing estimates of volume of radioactive waste overall outside dimensions were used for equipment, components and furnishings. These overall or "envelope" volumes were multiplied by an average density of 16 lbs/ft$^3$ to determine the total mass of waste. For example a standard office desk would be estimated as 5 ft. wide by 2.5 ft. deep and 2.5 ft. tall with an overall volume of 31.25 ft$^3$ and an estimated mass of 500 lbs.

It was assumed, based on existing surveys, that approximately 2/3 of the furnishings, etc. could be decontaminated to the accepted decommissioning levels and be removed as part of the building rubble. These items would not require separate packaging and disposal as radioactive waste.

The remaining 0.33 of the waste mass was then multiplied by marketplace rates for waste processing and disposal. Packaging and transportation costs were estimated by volume and were added to the total waste disposal figure. Potential overestimates of component volumes as a result of using overall dimensions were offset by smaller pieces of equipment that were not individually estimated.

Costs associated with consumable materials and supplies were estimated based on similar projects and the size and complexity of the ARC facilities. Consumables used in the D&D process showed up in waste estimates under Dry Active Waste (DAW).

All labor estimates are expressed in workdays. Workdays are actual days on the job excluding weekends, holidays, etc. Project schedules were based on 5-day workweeks consisting of 8 hours per day.

Labor estimates for Planning and Preparation included time for document preparation, decommissioning plan submittal to regulatory agencies, work plan development, equipment procurement, staff training and mobilization. Pre-planning labor estimates assume straightforward internal and external document, plan, and procedure reviews and approvals.

The duration of field activities for decontaminating and dismantling the facilities were estimated based on a "straw man" task sequence and project schedule. Crew sizes and number of workers were limited to those that could be efficiently utilized in the field.

The duration of activities for restoration of facilities and grounds was based on the expected level of remediation that would be required to return the facility to unrestricted release conditions. As noted above the assumed endpoint for is license termination and unrestricted release of the facility. This implies that removal of all radioactive materials from the facility has been confirmed. Consequently, long-term stabilization and monitoring is not required and no costs are incurred for this element.

Annual labor rates were estimated for the project manager, a project supervisor, a health physicist, a shipper, health physics technicians, radiation workers and administrative support. Labor rates included base salary and fringe benefits (e.g., vacation, health insurance, etc.). A rate of 50% was applied for overhead cost; this is typical of the St. Louis metropolitan area.. The base annual labor rate plus the overhead expenses was divided by the number of workdays per year (taken as 270) to determine a daily cost for each category of employee.

All additional workers and administrative support staff were assumed to be local hires and are not paid a living allowance.

Radioactive waste packaging, shipping, processing and disposal costs were determined based upon the expected volume generation and disposal facility waste acceptance criteria. Waste processing activities were assumed to take place in Tennessee, the location of the nearest waste processing companies with metal sizing capabilities.

Assuming the present regulatory structure of the radioactive waste disposal industry, nearly all of the waste generated from decommissioning ARC facilities will be disposed at the Envirocare of Utah disposal facility located near Salt Lake City, UT. The Envirocare method of disposal requires that waste be mixed with soil and placed in "lifts" or layers that are not higher than 12 inches tall. As a result, all waste must be processed to less than 10 inches in one dimension. Envirocare can also dispose of waste in 96 $ft^3$ metal boxes and similar containers; however, the boxes must be filled with a cement grout. The cost of disposal in this manner is much greater than the "lift" method. In summary, the most cost effective manner for disposing waste in the Envirocare facility is to send it to a processor where it is screened for non-conforming materials, sized to meet the Envirocare Waste Acceptance Criteria and then efficiently packaged for transport and disposal. Consequently, the assumptions were made that waste is shipped 300 miles to a processor for disposal. The shipping cost is taken to be $2.25 per mile.

# SECTION 3

## ESTIMATED DECOMMISSIONING COSTS

**Section 3.5 Number and Dimensions Of Facility Components**
**Total ARC Site**

| Component | Number of Components | Dimensions of Component (specify units) | Total Dimensions (specify units) | |
|---|---|---|---|---|
| Glove Boxes | 0 | | 0 | ft3 |
| Fume Hoods | 39 | | 2055 | ft3 |
| Lab Benches | 49 | | 2484 | ft3 |
| Sinks | 8 | | 281 | ft3 |
| Drains | | | 16 | ft3 |
| Floors | 6 | | 7457 | ft2 |
| Walls | 22 | | 15203 | ft2 |
| Ceilings | 5 | | 7457 | ft2 |
| Ventilation/Ductwork | 41 | | 145 | ft3 |
| Hot Cells | 0 | | 0 | ft3 |
| Equipment/Materials(refrigerators) | 24 | | 1992 | ft3 |
| Soil Plots | 0 | | 0 | ft2 |
| Storage Tanks | 2 | | 20 | ft3 |
| Storage Areas | 0 | | 0 | ft3 |
| Radwaste Areas | 0 | | 0 | ft3 |
| Scrap Recovery Areas | 0 | | 0 | ft3 |
| Compactor | 1 | | 13 | ft3 |
| Equipment Decon Areas | 1 | | 48 | ft3 |
| Other (specify)Cabinets | 13 | | 914 | ft3 |
| Other (specify)Chests | 7 | | 158 | ft3 |
| | | Features/Equipment Volume | 8127 | ft3 |
| | | Waste Fraction | 0.33 | |
| | | Waste Volume | 2682 | ft3 |
| | | Density (lb/ft3) | 16 | |
| | | Waste Mass | 42910.56 | lb |

Table 1.1

**Section 3.5 Number and Dimensions Of Facility Components**
**Building 100**

| Name of room, laboratory, or area: | Building 100 | | | |
|---|---|---|---|---|
| Level of Contamination: | 1,000,000 dpm/100 sq cm of either H-3 or C-14 | | | |
| Component | Number of Components | Dimensions of Component (specify units) | Total Dimensions (specify units) | |
| | | | | |
| Glove Boxes | 0 | 0 | 0 | ft3 |
| Fume Hoods | 13 | 52.7 | 685.1 | ft3 |
| Lab Benches | 21 | 59.7 | 1253.7 | ft3 |
| Sinks | 3 | 35.1 | 105.3 | ft3 |
| Drains | 3 | | 6 | ft3 |
| Floors | 1 | | 2819 | ft2 |
| Walls | 4 | | 4483 | ft2 |
| Ceilings | 1 | | 2819 | ft2 |
| Ventilation/Ductwork | 16 | | 64 | ft3 |
| Hot Cells | 0 | 0 | 0 | ft3 |
| Equipment/Materials(refrigerators) | 6 | 42.2 | 253.2 | ft3 |
| Soil Plots | 0 | 0 | 0 | ft2 |
| Storage Tanks | 2 | 6.7 | 13.4 | ft3 |
| Storage Areas | 0 | 0 | 0 | ft3 |
| Radwaste Areas | 0 | 0 | 0 | ft3 |
| Scrap Recovery Areas | 0 | 0 | 0 | ft3 |
| Compactor | 0 | 0 | 0 | ft3 |
| Equipment Decon Areas | 0 | 0 | 0 | ft3 |
| Other (specify)Cabinets | 8 | 35.1 | 280.8 | ft3 |
| Other (specify)Chests | 4 | 17.6 | 70.4 | ft3 |

Table 1.2

## Section 3.5 Number and Dimensions Of Facility Components
## Building 200

| Name of room, laboratory, or area: | Building 200 | | | |
|---|---|---|---|---|
| Level of Contamination: | 100,000 dpm/100 sq cm | | | |
| Component | Number of Components | Dimensions of Component (specify units) | Total Dimensions (specify units) | |
| | | | | |
| Glove Boxes | 0 | 0 | 0 | ft3 |
| Fume Hoods | 4 | 52.7 | 210.8 | ft3 |
| Lab Benches | 2 | 26.4 | 52.8 | ft3 |
| Sinks | 0 | 0 | 0 | ft3 |
| Drains | 0 | 0 | 0 | ft3 |
| Floors | 2 | 670 | 1340 | ft2 |
| Walls | 6 | 336 | 2016 | ft2 |
| Ceilings | 1 | | 1340 | ft2 |
| Ventilation/Ductwork | 15 | | 21 | ft3 |
| Hot Cells | 0 | 0 | 0 | ft3 |
| Equipment/Materials(refrigerators) | 12 | 42 | 504 | ft3 |
| Soil Plots | 0 | 0 | 0 | ft2 |
| Storage Tanks | 0 | 0 | 0 | ft3 |
| Storage Areas | 0 | 0 | 0 | ft3 |
| Radwaste Areas | 0 | 0 | 0 | ft3 |
| Scrap Recovery Areas | 0 | 0 | 0 | ft3 |
| Compactor | 1 | 13 | 13 | ft3 |
| Equipment Decon Areas | 2 | 24 | 48 | ft3 |
| Other (specify)Cabinets | 8 | 17.6 | 140.8 | ft3 |
| Other (specify)Chests | 2 | 17.6 | 35.2 | ft3 |

Table 1.3

## Section 3.5 Number and Dimensions Of Facility Components
## Building 300

| Name of room, laboratory, or area: | Building 300 | | | |
|---|---|---|---|---|
| Level of Contamination: | 1,000,000 dpm/100 sq cm H-3 and C-14 | | | |
| Component | Number of Components | Dimensions of Component (specify units) | Total Dimensions (specify units) | |
| | | | | |
| Glove Boxes | 0 | 0 | 0 | ft3 |
| Fume Hoods | 17 | 52.7 | 896 | ft3 |
| Lab Benches | 18 | 45.3 | 815 | ft3 |
| Sinks | 3 | 35.1 | 105 | ft3 |
| Drains | 3 | | 6 | ft3 |
| Floors | 1 | | 2668 | ft2 |
| Walls | 4 | | 3034 | ft2 |
| Ceilings | 1 | | 2668 | ft2 |
| Ventilation/Ductwork | 8 | 6 | 48 | ft3 |
| Hot Cells | 0 | 0 | 0 | ft3 |
| Equipment/MaterialsRefrig/freexer | 27 | 44.1 | 1190.7 | ft3 |
| Soil Plots | 0 | 0 | 0 | ft2 |
| Storage Tanks | 1 | 6.7 | 7 | ft3 |
| Storage Areas | 0 | 0 | 0 | ft3 |
| Radwaste Areas | 0 | 0 | 0 | ft3 |
| Scrap Recovery Areas | 0 | 0 | 0 | ft3 |
| Maintenance Shop | 0 | 0 | 0 | ft3 |
| Equipment Decontamination | 0 | 0 | 0 | ft3 |
| Other (specify)cabinets | 12 | 17.6 | 211.2 | ft3 |
| Other (specify)chests | 3 | 17.6 | 52.8 | ft3 |

Table 1.4

## Section 3.5 Number and Dimensions Of Facility Components
## Building 300 Annex

| Name of room, laboratory, or area: | Building 300 Annex | | | |
|---|---|---|---|---|
| Level of Contamination: | | | | |
| Component | Number of Components | Dimensions of Component (specify units) | Total Dimensions (specify units) | |
| | | | | |
| Glove Boxes | 0 | 0 | 0 | ft3 |
| Fume Hoods | 5 | 52.7 | 263.5 | |
| Lab Benches | 8 | 45.3 | 362.4 | ft3 |
| Sinks | 2 | 35.1 | 70.2 | |
| Drains | 2 | | 4 | |
| Floors | 2 | | 630 | ft2 |
| Walls | 8 | | 5670 | ft2 |
| Ceilings | 2 | | 630 | ft2 |
| Ventilation/Ductwork | 2 | 6 | 12 | ft3 |
| Hot Cells | 0 | 0 | 0 | |
| Equipment/Materials(refrigerators) | 1 | 44.1 | 44.1 | ft3 |
| Soil Plots | 0 | 0 | 0 | |
| Storage Tanks | 0 | 0 | 0 | ft3 |
| Storage Areas | 0 | 0 | 0 | |
| Radwaste Areas | 0 | 0 | 0 | |
| Scrap Recovery Areas | 0 | 0 | 0 | |
| Compactor | 0 | 0 | 0 | |
| Equipment Decon Areas | 0 | 0 | 0 | |
| Other (specify)Cabinets | 16 | 17.6 | 281.6 | ft3 |
| Other (specify)Chests | 0 | 0 | 0 | |

# SECTION 4

## LABOR COSTS

Table 2

## Section 3.6 Planning and Preparation

| Activity | Project Mgr | Supervisor | Health Physicist/ Shipper | HPT's/Drafting | Radiation Workers | Clerical |
|---|---|---|---|---|---|---|
| Preparation of Documentation for Regulatory Agencies | 3 | 0 | 12 | 0 | 0 | 8 |
| Submittal of Decommissioning Plan to NRC when required by 10 CFR 30.36(g)(1), 40.42(g)(1), or 70.38(g)(1) | 5 | 0 | 7 | 0 | 0 | 5 |
| Development of Work Plans | 0 | 5 | 5 | 0 | 0 | 5 |
| Procurement of Special Equipment | 0 | 0 | 0 | 0 | 0 | 0 |
| Staff Training | 0 | 0 | 3 | 3 | 18 | 0 |
| Characterization of Radiological Condition (including sampling, soil and tailings analysis, or groundwater analysis, if applicable) | 1 | 0 | 5 | 5 | 0 | 2 |
| Other (specify) Mobilization | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTALS | 9 | 5 | 32 | 8 | 18 | 20 |

Table 3

## Section 3.7Decontamination or Dismantling of Radioactive Facility Components

| Name of room, laboratory, or area: | | Total ARC Site | | | | | |
|---|---|---|---|---|---|---|---|
| Component | Decon Method | Project Mgr | Supervisor | Health Physicist/ Shipper | HPT's/Drafting | Radiation Workers | Clerical |
| Glove Boxes | Decon/Remove | 0 | 0 | 0 | 0 | 0 | 0 |
| Fume Hoods | Decon/Remove | 7 | 14 | 14 | 30 | 240 | 12 |
| Lab Benches | Decon/Remove | 1 | 2 | 5 | 12 | 48 | 2 |
| Sinks | Decon/Remove | 0 | 1 | 1.5 | 2 | 5 | 0 |
| Drains | Decon/Remove | 0 | 0 | 0 | 2 | 3 | 0 |
| Floors | Scabble | 1 | 1 | 1 | 2 | 10 | 1 |
| Walls | Remove/Disp | 1 | 1 | 2 | 5 | 20 | 2 |
| Ceilings | Vac/Wipe | 1 | 1 | 1 | 3 | 10 | 1 |
| Ventilation/Ductwork | Remove/Disp | 9 | 9 | 9 | 16 | 30 | 1 |
| Hot Cells | Remove/Disp | 0 | 0 | 0 | 0 | 0 | 0 |
| Refrigerator Freezers | Sur/Rem/Disp | 1 | 1 | 1 | 2 | 12 | 1 |
| Soil Plots | Sample | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Tanks | Remove/dispose | 0 | 0 | 0 | 1 | 3 | 0 |
| Storage Areas | Remove/Disp | 0 | 0 | 0 | 0 | 0 | 0 |
| Radwaste Areas | Remove/Disp | 0 | 0 | 0 | 0 | 0 | 0 |
| Scrap Recovery Areas | N/A | 0 | 0 | 0 | 0 | 0 | 0 |
| Maintenance Shop | Remove/Disp | 0 | 0 | 0 | 0 | 0 | 0 |
| Equipment Decontamination | Remove/Disp | 0 | 0 | 0 | 0 | 0 | 0 |
| Other (specify)Cabinets | Remove/Disp | 1 | 1 | 1 | 3 | 12 | 1 |
| Other (specify)Chests | Remove/Disp | 0 | 1 | 0 | 1 | 5 | 0 |
| TOTALS | | 22 | 32 | 35.5 | 79 | 398 | 21 |

**Table 4**

## Section 3.8 Restoration of Contaminated Areas on Facility Grounds

**(Work Days)**

| Activity | Project Mgr | Supervisor | Health Physicist/ Shipper | HPT's/Drafting | Radiation Workers | Clerical |
|---|---|---|---|---|---|---|
| Restore Floors | 1 | 1 | 0 | 4 | 10 | 1 |
| Restore Walls | 1 | 1 | 0 | 3 | 8 | 1 |
| Restore Roof | 1 | 1 | 0 | 3 | 8 | 1 |
| Restore Utilites | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTALS | 3 | 3 | 0 | 10 | 26 | 3 |

**Table 5**

## Section 3.9 Final Radiation Survey

**(Work Days)**

| Activity | Project Mgr | Supervisor | Health Physicist/ Shipper | HPT's/Drafting | Radiation Workers | Clerical |
|---|---|---|---|---|---|---|
| FSS Setup | 0.5 | 0.5 | 0.5 | 3 | 0 | 0.5 |
| Survey Packages | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0.5 |
| Class 1 | 3 | 3 | 3 | 30 | 0 | 2 |
| Class 2 | 2 | 1 | 2 | 15 | 0 | 1 |
| Class 3 | 1 | 1 | 1 | 4 | 0 | 1 |
| TOTALS | 7 | 6 | 7 | 52.5 | 0 | 5 |

Table 6

## Section 3.10 Site Stabilization and Long-Term Surveillance

**(Work Days)**

| Activity | Project Mgr | Supervisor | Health Physicist/ Shipper | HPT's/Drafting | Radiation Workers | Clerical |
|---|---|---|---|---|---|---|
| Not Applicable | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| TOTALS | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 7**

## Section 3.11 Total Work Days by Labor Category

| Task | Project Mgr | Supervisor | Health Physicist/ Shipper | HPT's/Drafting | Radiation Workers | Clerical |
|---|---|---|---|---|---|---|
| Planning and Preparation (TOTALS from Table 3.6) | 9 | 5 | 32 | 8 | 18 | 20 |
| Decontamination and/or Dismantling of Radioactive Facility Components (Sum of TOTALS from all copies of Table 3.7) | 22 | 32 | 35.5 | 79 | 398 | 21 |
| Restoration of Contaminated Areas on Facility Grounds (TOTALS from Table 3.8) | 3 | 3 | 0 | 10 | 26 | 3 |
| Final Radiation Survey (TOTALS from Table 3.9) | 7 | 6 | 7 | 52.5 | 0 | 5 |
| Site Stabilization and Long-Term Surveillance (TOTALS from Table 3.10) | 0 | 0 | 0 | 0 | 0 | 0 |

Table 8

## Section 3.12 Worker Unit Cost Schedule

| Labor Cost Component | Project Mgr | Supervisor | Health Physicist/ Shipper | HPT's/Drafting | Radiation Workers | Clerical |
|---|---|---|---|---|---|---|
| Salary & Fringe ($/year) | $134,106 | $97,650 | $125,200 | $75,933 | $80,464 | $53,655 |
| Overhead Rate (%) | 50% | 50% | 50% | 50% | 50% | 50% |
| Total Cost Per Year | $201,159 | $146,475 | $187,800 | $113,900 | $120,696 | $80,483 |
| Living Expenses (PD*7/5)[1] | $0 | $0 | $0 | $0 | $0 | $0 |
| Total Cost Per Work Day[2] | $745 | $543 | $696 | $422 | $447 | $298 |

[1] Per Diem Rate: $120 per day.

[2] Based on 270 work days per year (e.g., 260).

Table 9

## Section 3.13 Total Labor Costs by Major Decommissioning Task

| Labor Cost Component | Project Mgr | Supervisor | Health Physicist/ Shipper | HPT's/Drafting | Radiation Workers | Clerical | Total Labor Cost |
|---|---|---|---|---|---|---|---|
| Planning and Preparation | $6,705 | $2,713 | $22,258 | $3,375 | $8,046 | $5,962 | $49,058 |
| Decontamination and/or Dismantling of Radioactive Facility Components | $16,391 | $17,360 | $24,692 | $33,326 | $177,915 | $6,260 | $275,944 |
| Restoration of Contaminated Areas on Facility Grounds | $2,235 | $1,628 | $0 | $4,219 | $11,623 | $894 | $20,598 |
| Final Radiation Survey (cost includes 25% Contractor Profit) | $4,725 | $2,970 | $4,095 | $16,403 | $0 | $13,250 | $41,443 |
| Site Stabilization and Long-Term Surveillance | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

## SECTION 5

## NON-LABOR COSTS

**Table 10**

## Section 3.14 Packaging, Shipping, and Disposal of Radioactive Wastes

**(a) Packing Material Costs**

Estimate the types and volumes of waste expected to be generated, along with the number and types of containers required for packaging the waste. Multiply the number of containers required by the unit cost per container.

| Waste Type | Volume (ft3) | Number of Containers | Type of Containers | Unit Cost of Container | Total Packaging Costs |
|---|---|---|---|---|---|
| DAW | 1000 | 11 | B-25 | $875 | $9,625 |
| Metal | 2,682 | 1 | SeaLand | $3,000 | $3,000 |
| Contaminated Lead | 0 | 0 | | | $0 |
| Class B/C | 0 | 0 | | | $0 |
| TOTAL | | | | | $12,625 |

**(b) Shipping Costs**

Estimate the types and volumes of waste expected to be generated, along with the number and types of containers required for packaging the waste. Multiply the number of containers required by the unit cost per container.

| Waste Type | Number of Truckloads | Unit Cost ($/mile/truckload) | Surcharges ($/mile) | Overweight Charges($/mile) | Distance Shipped (miles) | Total Shipping Costs |
|---|---|---|---|---|---|---|
| DAW | 1 | $7.00 | 1 | 1 | 300 | $2,100 |
| Metal | 1 | $7.00 | 1 | 1 | 300 | $2,100 |
| Contaminated Lead | 0 | | 1 | 1 | 1 | $0 |
| Class B/C | 0 | | 1 | 1 | 1 | $0 |
| TOTAL | 2 | | | | | $4,200 |

**(c) Waste Disposal Costs**

Estimate the volume of waste to be disposed. Multiply the volume of waste disposed by the unite\disposal cost (including any volume based surcharges). Add any surcharges that are based on the number of containers of waste. along with the number and types of containers required for packaging the waste. Multiply the number of containers required by the unit cost per container.

| Waste Type | Disposal Volume (ft3) | Density (lb/ft3) | Disposal Mass (lbs) | Unit Cost | Surcharges ($/ft3 or $/container) | Total Disposal Costs |
|---|---|---|---|---|---|---|
| DAW | 1225 | 10 | 12250 | 5.45 | 1 | $66,763 |
| Metal | 2682 | 16 | 42910.56 | 4.20 | 1 | $180,224 |
| Contaminated Lead | 0 | | 0 | | 1 | $0 |
| Class B/C | 0 | | 0 | | 1 | $0 |
| TOTAL | 3907 | | | | | $246,987 |

Table 11 NUREG 1727

## Section 3.15 Equipment/Supply Costs (Excluding Containers)

| Equipment/Supplies | Quantity | Unit Cost | Total Equipment/Supply Cost |
|---|---|---|---|
| Protective Clothing | 240 | $15 | $3,600 |
| Respirators | 0 | | $0 |
| Misc Tools | 1 | $6,000 | $6,000 |
| Consumables | 1 | $20,000 | $20,000 |
| TOTAL | | | $29,600 |

Table 12 **NUREG 1727**

## Section 3.16 Laboratory Costs

| If applicable, estimate the costs for analyses to be performed by an independent third party laboratory. | | | |
|---|---|---|---|
| Activity | Quantity | Unit Cost | Total Item Cost |
| Sampling | 60 | $25 | $1.500 |
| Transport of Sample Batch | 2 | $100 | $200 |
| Testing and Analysis | 60 | $125 | $7,500 |
| Other (specify) | | | |
| TOTAL | | | $12,100 |

Table 13 **NUREG 1727**

## Section 3.17 Miscellaneous Costs

| Estimate any other applicable costs. | |
|---|---|
| Activity | Total Cost |
| License Fees | |
| Curie surcharge | |
| Insurance | |
| Taxes | |
| Other (specify): Access Fee | $3,000 |
| TOTAL | $3,000 |

# SECTION 6

## TOTAL DECOMMISSIONING COSTS

## Section 3.18 Total Decommissioning Costs

| Task/Component | Cost | Percentage |
|---|---|---|
| Planning and Preparation (from Table 3.13) | $49,058 | 7.1% |
| Decontamination and/or Dismantling of Radioactive Facility (From Table 3.13) | $275,944 | 39.8% |
| Restoration of Contaminated Areas on Facility Grounds (From Table 3.13) | $20,598 | 3.0% |
| Final Radiation Survey (From Table 3.13) | $41,443 | 6.0% |
| Packing Material Costs (TOTAL from Table 3.14(a)) | $12,625 | 1.8% |
| Shipping Costs (TOTAL from Table 3.14(b)) | $4,200 | 0.6% |
| Waste Disposal Costs (TOTAL from Table 3.14(c)) | $246,987 | 35.7% |
| Equipment/Supply Costs (TOTAL from Table 3.15) | $29,600 | 4.3% |
| Laboratory Costs (TOTAL from Table 3.16) | $9,200 | 1.3% |
| Miscellaneous Costs (TOTAL from Table 3.17) | $3,000 | 0.4% |
| SUBTOTAL | $692,655 | 100.0% |
| 25% Contingency | $173,164 | 25.0% |
| TOTAL DECOMMISSIONING COST ESTIMATE | $865,819 | 125.0% |

**SECTION 7**

## MEANS FOR ADJUSTING THE COST ESTIMATE

ARC will review the Decommissioning Funding Plan every year to ensure funding levels are adequate for current market prices. Considerations for salary changes, waste disposal charges of the waste broker currently being used, and any program changes will be used when determining current market prices. Based on this information, adjustments will be made as necessary.

**SECTION 9**

**DUPLICATE OF FINANCIAL INSTRUMENTS**

As there has been a change in the financial documents from our previous submittal, a copy of the revised escrow documents will be submitted as soon as they have been completed.

Bank of America
Merrill Lynch

**CMA** Trust for Retirement Plans Statement

FINANCIAL STATEMENT
05/01/2012 THRU 05/31/2012

278-74T05

BANK OF AMERICA (MLTC)
ESCROW AGENT FBO AMERICAN
RADIOLABELED CHEMICALS
ESCROW AGREEMENT

VK 000000 308 000 000013 #002 XX 1.100
MS KAREN GUPTA
AMER RADIOLABELED CHEMICALS
101 ARC DRIVE
ST LOUIS, MO 63146

IF YOU HAVE ANY QUESTIONS CONCERNING THIS STATEMENT,
PLEASE CALL 1-800-EBT-MLTC

Bank of America Merrill Lynch

**CMA** Trust for Retirement Plans Statement

STATEMENT OF ASSETS AND LIABILITIES
AS OF 05/31/12

ACCOUNT NUMBER 278-74T05
AMERICAN RADIOLABELED CHEMICALS

SUMMARY STATEMENT



| | CARRY VALUE | TOTAL MARKET | % OF TOTAL ACCOUNT AT MARKET | ESTIMATED ANNUAL INCOME | % YIELD MARKET VALUE |
|---|---|---|---|---|---|
| CASH | $.83 | $.83 | .00 | $.00 | .00 |
| CORPORATE/GOVERNMENT SECURITIES | $1,014,432.98 | $1,144,328.09 | 99.99 | $23,804.84 | 2.08 |
| MONEY FUNDS | $144.00 | $144.00 | .01 | $.00 | .00 |
| TOTAL ASSETS | $1,014,577.81 | $1,144,472.92 | 100.00 | $23,804.84 | 2.08 |
| ACCRUED INCOME | | | | | |
| CORPORATE/GOVERNMENT SECURITIES | $7,501.08 | $7,501.08 | | | |
| TOTAL ACCRUALS | $7,501.08 | $7,501.08 | | | |
| TOTAL ASSETS AND ACCRUALS | $1,022,078.89 | $1,151,974.00 | | | |
| NET ACCOUNT | $1,022,078.89 | $1,151,974.00 | | | |

CURRENT SUMMARY OF ACCOUNT
AS OF 05/31/12

ACCOUNT NUMBER 278-74T05
AMERICAN RADIOLABELED CHEMICALS



| STATEMENT POSITION OF ASSETS | CARRY VALUE | TOTAL MARKET |
|---|---|---|
| EQUITIES | .00 | .00 |
| MUTUAL FUNDS | .00 | .00 |
| MUNICIPAL BONDS | .00 | .00 |
| CORP/GOVERNMENT BONDS | 1,014,432.98 | 1,144,328.09 |
| MONEY FUNDS | 144.00 | 144.00 |
| CERTIFICATES OF DEPOSIT | .00 | .00 |
| COLLECTIVE FUNDS | .00 | .00 |
| OTHER ASSETS | .00 | .00 |
| CASH | .83 | .83 |
| LIABILITIES | .00 | .00 |
| TOTAL ASSETS & LIABILITIES | $1,014,577.81 | $1,144,472.92 |
| PENDING TRADES | | |
| EQUITIES | .00 | 0.00 |
| MUTUAL FUNDS | .00 | 0.00 |
| MUNICIPAL BONDS | .00 | 0.00 |
| CORP/GOVERNMENT BONDS | .00 | 0.00 |
| MONEY FUNDS | .00 | 0.00 |
| CERTIFICATES OF DEPOSIT | .00 | 0.00 |
| COLLECTIVE FUNDS | .00 | 0.00 |
| OTHER ASSETS | .00 | 0.00 |
| CASH | .00 | 0.00 |
| LIABILITIES | .00 | 0.00 |
| NET PENDING TRADES CHANGES | $0.00 | $0.00 |
| CURRENT POSITION OF ACCOUNT | | |
| EQUITIES | .00 | 0.00 |
| MUTUAL FUNDS | .00 | 0.00 |
| MUNICIPAL BONDS | .00 | 0.00 |
| CORP/GOVERNMENT BONDS | 1,014,432.98 | 1,144,328.09 |
| MONEY FUNDS | 144.00 | 144.00 |
| CERTIFICATES OF DEPOSIT | .00 | 0.00 |
| COLLECTIVE FUNDS | .00 | 0.00 |
| OTHER ASSETS | .00 | 0.00 |
| CASH | .83 | 0.83 |
| LIABILITIES | .00 | 0.00 |
| TOTAL CURRENT POSITION OF ACCOUNT | $1,014,577.81 | $1,144,472.92 |
| TOTAL ACCRUALS | $7,501.08 | $7,501.08 |
| TOTAL SUMMARY OF ACCOUNT | $1,022,078.89 | $1,151,974.00 |

Bank of America Merrill Lynch

**CMA** Trust for Retirement Plans Statement

SUMMARY OF TRANSACTIONS
FOR PERIOD 05/01/12 THRU 05/31/12

ACCOUNT NUMBER 278-74T05
AMERICAN RADIOLABELED CHEMICALS



| | CASH | TOTAL CASH | CARRYING VALUE EXCLUDING CASH | MARKET VALUE INCLUDING CASH |
|---|---|---|---|---|
| BALANCES BEGINNING OF PERIOD | | $ .32 | $ 1,014,764.98 | $ 1,128,359.45 |
| UNREALIZED APPRECIATION THIS PERIOD | | | | 21,846.63 |
| DIVIDENDS - MONEY FUNDS | .01 | | | |
| TOTAL INCOME RECEIVED | .01 | .01 | | .01 |
| EXPENSES PAID | | -187.50 | | -187.50 |
| ASSETS SOLD/REDEEMED | | 188.00 | -188.00 | |
| PRIOR ACCRUALS | | | | -5,545.67 |
| CURRENT ACCRUALS | | | | 7,501.08 |
| BALANCES END OF PERIOD | | $ .83 | $ 1,014,576.98 | $ 1,151,974.00 |

STATEMENT OF ASSETS AND LIABILITIES AS OF 05/31/12

ACCOUNT NUMBER 278-74T05
AMERICAN RADIOLABELED CHEMICALS

VALUATION STATEMENT



| QUANTITY | DESCRIPTION | CARRY VALUE /PRICE | TOTAL MARKET /PRICE | % OF TOTAL PORTFOLIO AT MARKET | ESTIMATED ANNUAL INCOME | % YIELD MARKET VALUE |
|---|---|---|---|---|---|---|
| | * CORPORATE/GOVERNMENT SECURITIES * | | | | | |
| | GOVERNMENT BONDS | | | | | |
| 90,000 | US TREAS BOND<br>8.50% DUE 2/15/2020 | $129,317.63<br>143.68 | $139,183.20<br>154.648 | 12.16 | 7,650.00 | 5.50 |
| 100,000 | U.S. TREASURY BOND<br>5.375% FEB 15 2031 | 131,417.42<br>131.41 | 148,031.00<br>148.031 | 12.93 | 5,375.00 | 3.63 |
| 121,666 | U.S. TRSY INFLATION NOTE<br>2.375% JAN 15 2025 | 139,824.40<br>114.92 | 162,196.59<br>133.3129 | 14.17 | 2,889.56 | 1.78 |
| 113,722 | U.S. TRSY INFLATIN NTE<br>2.375% JAN 15 2017 | 117,917.41<br>103.68 | 132,343.98<br>116.375 | 11.56 | 2,700.89 | 2.04 |
| 212,106 | U.S. TRSY INFLATION NTE<br>1.375% JAN 15 2020 | 204,281.55<br>96.31 | 249,059.11<br>117.422 | 21.76 | 2,916.45 | 1.17 |
| 104,838 | U.S. TRSY INFLATION NTE<br>1.125% JAN 15 2021 | 103,125.49<br>98.36 | 121,719.01<br>116.1019 | 10.64 | 1,179.42 | .97 |
| 160,000 | U.S. TREASURY STRIPS<br>ZERO% NOV 15 2014 | 156,791.69<br>97.99 | 158,713.60<br>99.196 | 13.87 | 514.27 | .32 |
| 40,000 | U S TREASURY STRIPS<br>ZERO% NOV 15 2022 | 31,757.39<br>79.39 | 33,081.60<br>82.704 | 2.89 | 579.25 | 1.75 |
| | TOTAL GOVERNMENT BONDS | $1,014,432.98 | $1,144,328.09 | 99.99 | $23,804.84 | 2.08 |
| | * TOTAL CORPORATE/GOVT SECURITIES * | $1,014,432.98 | $1,144,328.09 | 99.99 | $23,804.84 | 2.08 |

STATEMENT OF ASSETS AND LIABILITIES
AS OF 05/31/12

ACCOUNT NUMBER 278-74T05
AMERICAN RADIOLABELED CHEMICALS

VALUATION STATEMENT



| QUANTITY | DESCRIPTION | CARRY VALUE /PRICE | TOTAL MARKET /PRICE | % OF TOTAL PORTFOLIO AT MARKET | ESTIMATED ANNUAL INCOME | % YIELD MARKET VALUE |
|---|---|---|---|---|---|---|
| | * MONEY FUNDS * | | | | | |
| 144 | ISA BANK OF AMERICA NATIONAL ASSOCIATION | $144.00 | $144.00 | 0.01 | N/A | N/A |
| | * CASH * | | | | | |
| | NET CASH | $.83 | $.83 | 0.00 | N/A | N/A |
| | ** TOTAL ASSETS ** | $1,014,577.81 | $1,144,472.92 | 100.00 | $23,804.84 | 2.08 |
| | ** TOTAL ACCRUALS ** | 7,501.08 | 7,501.08 | | | |
| | ** TOTAL ASSETS AND ACCRUALS ** | $1,022,078.89 | $1,151,974.00 | | | |

| | |
|---|---|
| UNREALIZED APPRECIATION END OF PERIOD | 129,895.11 |
| UNREALIZED APPRECIATION BEG OF PERIOD | 108,048.48 |
| NET CHANGE THIS PERIOD | 21,846.63 |

STATEMENT OF ACCRUALS

ACCOUNT NUMBER 278-74T05

AS OF 05/31/12

AMERICAN RADIOLABELED CHEMICALS



| QUANTITY | DESCRIPTION | ACCRUAL AMOUNT | EX-DIV DATE | RECORD DATE | PAYMENT DATE | CURRENT RATE |
|---|---|---|---|---|---|---|
| | * CORPORATE/GOVERNMENT SECURITIES * GOVERNMENT BONDS | | | | | |
| 90,000 | US TREAS BOND 8.50% DUE 2/15/2020 | $2,248.76 | | | 08/15/12 | .08500 |
| 100,000 | U.S. TREASURY BOND 5.375% FEB 15 2031 | 1,580.01 | | | 08/15/12 | .05375 |
| 121,666 | U.S. TRSY INFLATION NOTE 2.375% JAN 15 2025 | 1,095.50 | | | 07/15/12 | .02375 |
| 113,722 | U.S. TRSY INFLATIN NTE 2.375% JAN 15 2017 | 1,023.97 | | | 07/15/12 | .02375 |
| 212,106 | U.S. TRSY INFLATION NTE 1.375% JAN 15 2020 | 1,105.69 | | | 07/15/12 | .01375 |
| 104,838 | U.S. TRSY INFLATION NTE 1.125% JAN 15 2021 | 447.15 | | | 07/15/12 | .01125 |
| | TOTAL GOVERNMENT BONDS | $7,501.08 | | | | |
| | * TOTAL CORPORATE/GOVT SECURITIES * | $7,501.08 | | | | |
| | ** TOTAL ASSETS ** | $7,501.08 | | | | |

STATEMENT OF INCOME

ACCOUNT NUMBER 278-74T05
AMERICAN RADIOLABELED CHEMICALS

FOR PERIOD 05/01/12 THRU 05/31/12



| DATE | DESCRIPTION | CASH |
|---|---|---|
| | DIVIDENDS - MONEY FUNDS | |
| 05/31/12 | INTEREST<br>ISA BANK OF AMERICA<br>NATIONAL ASSOCIATION | $ .01 |
| | TOTAL DIVIDENDS - MONEY FUNDS | $ .01 |
| | TOTAL INCOME RECEIVED | $ .01 |

STATEMENT OF EXPENSES

ACCOUNT NUMBER 278-74T05
AMERICAN RADIOLABELED CHEMICALS

FOR PERIOD 05/01/12 THRU 05/31/12



| DATE | DESCRIPTION | CASH |
|---|---|---|
| 05/01/12 | FEE<br>1Q2012 TTEE FEES | $ -187.50 |
| | TOTAL EXPENSES | $ -187.50 |

ACCOUNT NUMBER 278-74T05
AMERICAN RADIOLABELED CHEMICALS

SALES AND REDEMPTIONS

FOR PERIOD 05/01/12 THRU 05/31/12



| DATE | DESCRIPTION | CARRY VALUE | PROCEEDS | REALIZED GAIN/LOSS |
|---|---|---|---|---|
| | MONEY FUNDS | | | |
| 05/02/12 | SOLD 188 SHARES ISA BANK OF AMERICA NATIONAL ASSOCIATION TRADED ON 05/02 AT $1 | $ -188.00 | $ 188.00 | $ .00 |
| | TOTAL SALES AND REDEMPTIONS | $ -188.00 | $ 188.00 | $ .00 |

AFFILIATES OF BANK OF AMERICA, N.A. RECEIVE FEES FOR PROVIDING SERVICES SUCH AS INVESTMENT ADVISOR, TRANSFER AGENT AND DISTRIBUTION SERVICES FOR CERTAIN MUTUAL FUNDS IN WHICH ASSETS OF THIS ACCOUNT MAY BE INVESTED. FOR A MORE COMPLETE DESCRIPTION OF THESE FEES AND SERVICES WITH RESPECT TO ANY SUCH MUTUAL FUND, PLEASE ASK YOUR TRUST OFFICER FOR A COPY OF THE FUND(S) PROSPECTUS.

WE WILL FURNISH A WRITTEN CONFIRMATION OF ANY SECURITIES TRANSACTION COVERED BY THIS STATEMENT WITHIN A REASONABLE TIME AFTER YOUR WRITTEN REQUEST.

THIS STATEMENT MAY INCLUDE ASSETS THAT ARE NOT HELD AND NOT MANAGED BY BANK OF AMERICA, N.A.. ASSETS THAT ARE NOT HELD AND NOT MANAGED BY BANK OF AMERICA, N.A. ARE LISTED SOLELY FOR THE CONVENIENCE OF THE CLIENT. BANK OF AMERICA, N.A. HAS NO RESPONSIBILITY TO MAINTAIN, MONITOR OR VALUE SUCH ASSETS.

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END OF STATEMENT

# ATTACHMENT SIX

This Attachment is the updated Environmental Report which was not included in the original application for renewal.

The Environmental Report is updated every three years.

# Environmental Data Presented in Support of Renewal of Material License 24-21362-01

## American Radiolabeled Chemicals, Inc
## 101 ARC Drive
## St. Louis, Missouri

**Prepared By**

**Regis A. Greenwood, CHP**

**And**

**Donald Lite, III**

# Environmental Report Supporting Renewal of By-product Material License 24-21362-01

## 1. Introduction

American Radiolabeled Chemicals, Inc (ARC) has filed for renewal of License 24-21362-01. US NRC, Region III, Material Licensing Branch has determined under 10CFR51.22(b) that an Environmental Assessment is required. This report contains the data requested by Materials Licensing to aid in preparation of that assessment.

## 1.1 Purpose and Need for the Proposed Action

The purpose of the proposed action, renewal of Material License 24-21362-01, is to permit the continued operation of ARC.

ARC is the sole supplier of many of the labeled chemicals used in scientific and medical research worldwide.

## 1.2 The Proposed Action

The proposed action is to renew Materials License 24-21362-01.

The present facility was originally licensed in 1983 and began using radioactive material at that time. The quantities of $^{3}H$ and $^{14}C$ used at the facility have increased over time. Other radionuclides were added to the license over time

The facility currently operates under NRC License Number 24-21362-01, Amendment 48 with an expiration date of October 31, 2011. The license is presently under timely renewal. This license authorizes the possession and use of 12,000 Ci of $^{3}H$ and 400 Ci of $^{14}C$. Lesser quantities of other radionuclides are also authorized. Current license limits of all nuclides are presented in Table 1.2

The license was originally granted in 1983 for ARC's operations conducted in downtown St. Louis. In 1985 operations were transferred from the downtown facility to the current location. The license has been periodically amended to add additional radionuclides and to adjust individual nuclide possession limits

Prior renewals of this license during the preceding 20 years of operation have been categorically excluded from the requirement for Environmental Assessment under the provisions of 10CFR51.22(c)(14)(xiii).

**Table 1.2 ARC Current Possession Limits**

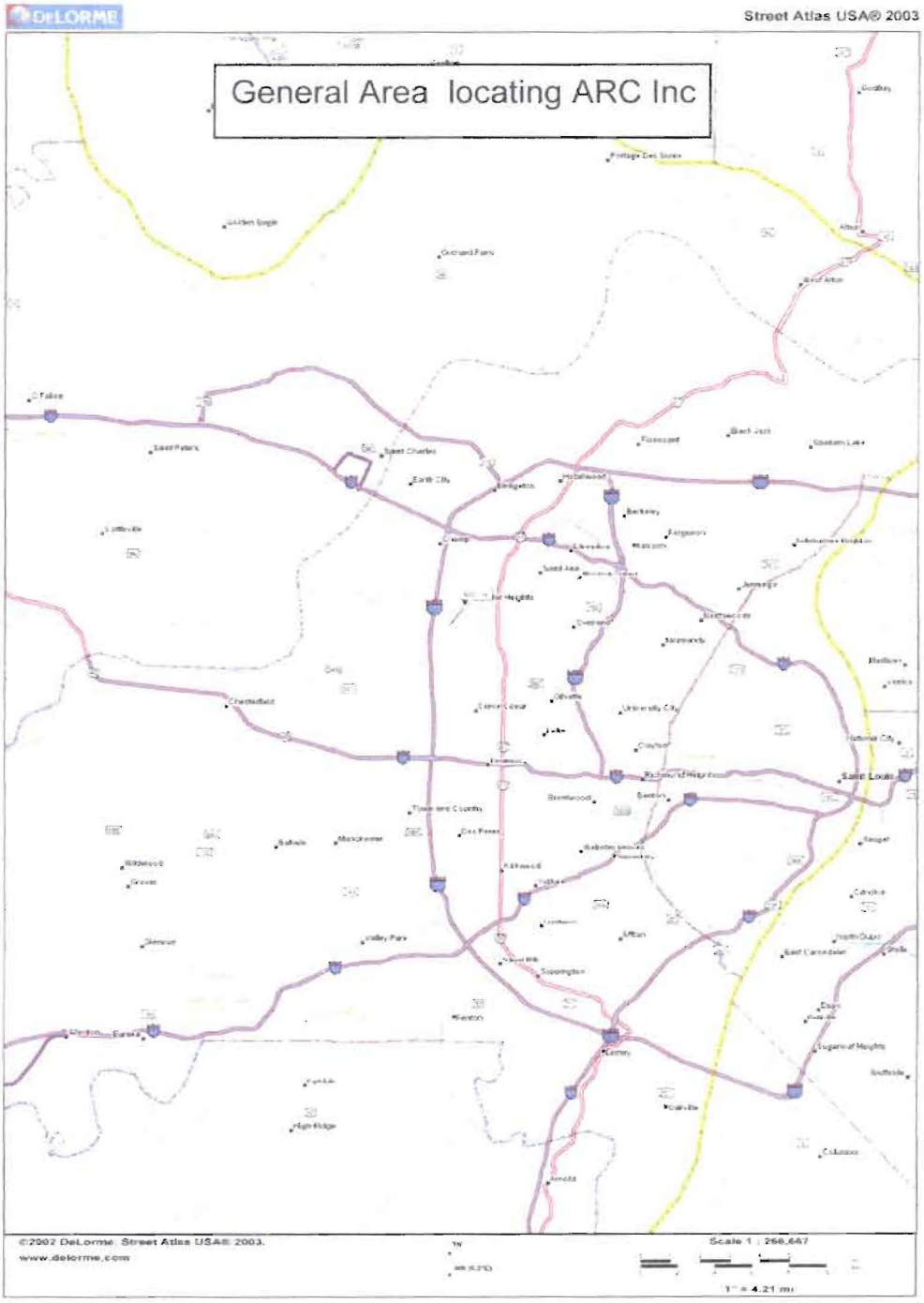
| Isotope | License Limit (Ci) | Form | Half-life |
|---|---|---|---|
| $^{14}C$ | 400 | Any | 5600 y |
| $^{45}Ca$ | 1 | Any | 165 d |
| $^{36}Cl$ | 0.3 | Any | 3E5 y |
| $^{51}Cr$ | 0.1 | Any | 28 d |
| $^{3}H$ | 12000 | Any | 12.2 y |
| $^{125}I$ | 1.5 | Any | 60 d |
| $^{32}P$ | 1 | Any | 14.5 d |
| $^{33}P$ | 1 | Any | 25 d |
| $^{35}S$ | 10 | Any | 88 d |
| Byproduct Material | All Above | Waste | --- |
| $^{59}Fe$ | 0.1 | Prepackaged Units | 44.5 d |
| $^{85}Sr$ | 0.1 | Prepackaged Units | 28.8 y |
| $^{60}Co$ | 0.1 | Prepackaged Units | 5.3 y |
| $^{55}Fe$ | 0.1 | Prepackaged Units | 2.7 y |
| $^{55}Fe$ | 0.01 | Any | 2.7 y |
| $^{59}Fe$ | 0.01 | Any | 44.5 d |

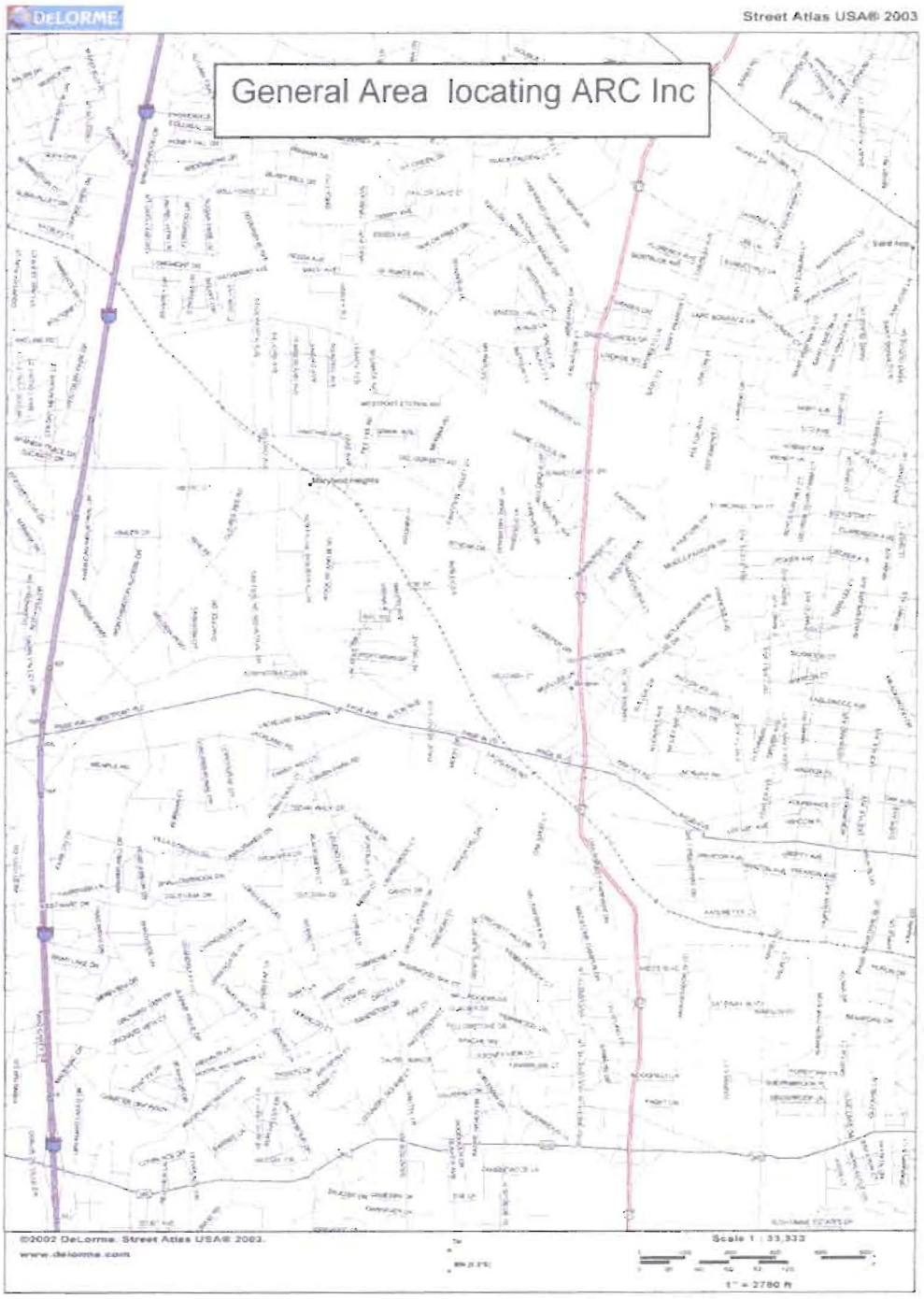
# 2.0 Description of the Affected Environment

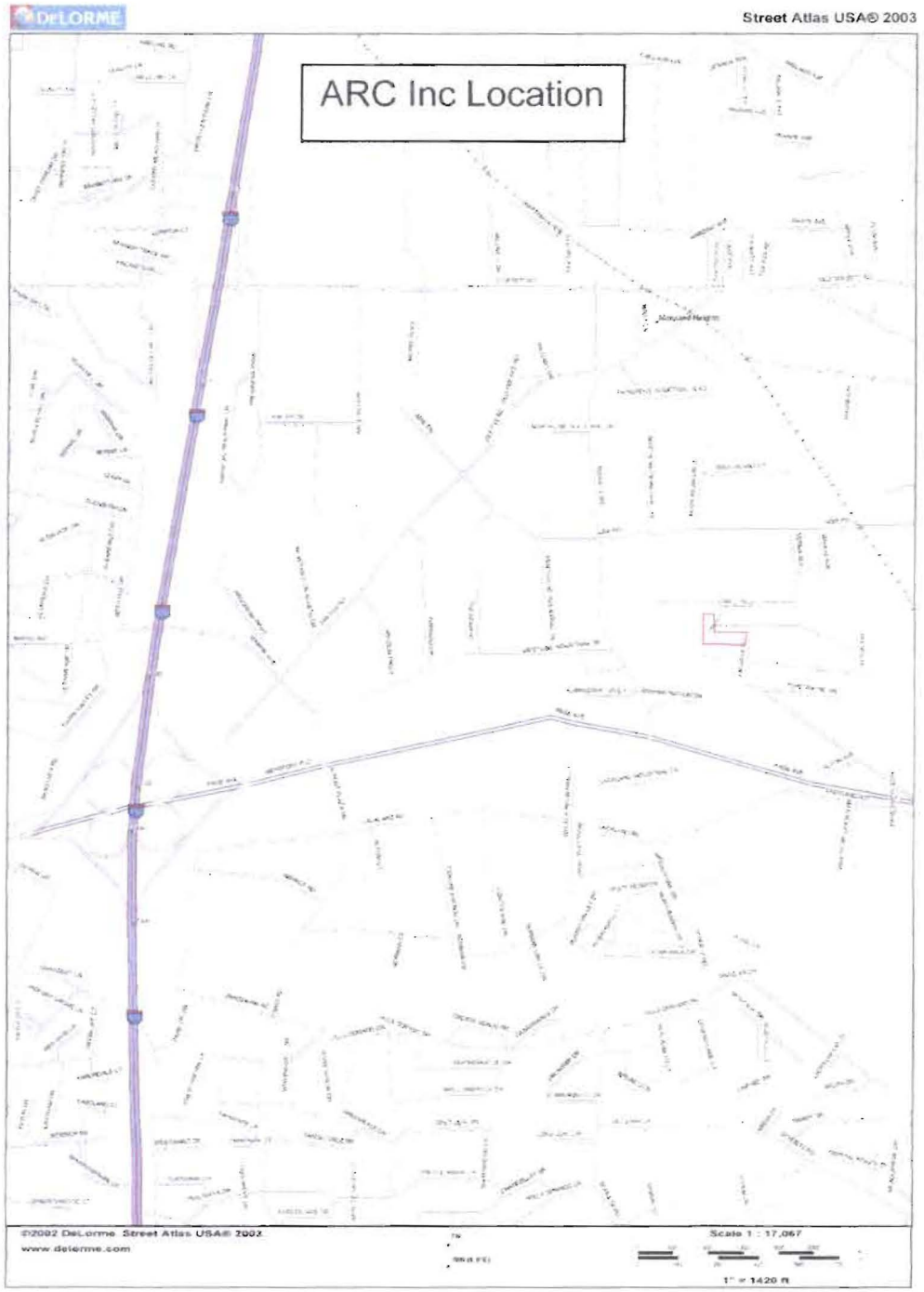
## 2.1 Site and Facility Description

The ARC facility, located at 101 ARC Drive in Maryland Heights, MO (38° 42.208' N, 90° 25.606" W) is an approximately 2 acre campus located approximately 15 miles WNW of downtown St. Louis. It is located approximately 1 mile east of exit 16 of I-270. The ARC facility is engaged in the production and distribution of radiolabeled chemicals and compounds. The ARC facility consists of four buildings. Building 100 is principally used for producing $^{14}C$ labeled chemicals. Building 200 is used for processing and storing waste resulting from facility operations. Building 300 is used for receiving radioactive material for incorporation into radiolabeled compounds and for receiving sealed unit packages of radiolabeled compounds for distribution to end users. Building 300 also includes labs for producing Tritium labeled compounds and an area for shipping finished products. Building 400 is a new 18,000ft$^2$ building that is used for managerial and administrative function and is not included in the license.

The ARC campus is located in the approximate center of ¾ mile by ½ mile area industrial park, Lakeside Crossing, adjacent to other commercial properties. Maps depicting the location of ARC are contained in the following pages The Lakeside Crossing Park is itself surrounded on four sides by other commercial properties. The properties bounded by Interstate 270, Dorsett Road, Lindbergh Blvd (US 67) and Page Avenue (MO Highway D) are commercial and/or industrial as are properties south of Page Avenue.


DeLORME
Street Atlas USA® 2003
General Area locating ARC Inc
©2002 DeLorme. Street Atlas USA®. 2003.
www.delorme.com
Scale 1 : 256,647
1" = 4.21 mi


DeLORME
Street Atlas USA® 2003
General Area locating ARC Inc
©2002 DeLorme. Street Atlas USA® 2003.
www.delorme.com
Scale 1 : 33,933
1" = 2780 ft


DeLORME
Street Atlas USA® 2003
ARC Inc Location
©2002 DeLorme. Street Atlas USA® 2003.
www.delorme.com
Scale 1 : 17,067
1" = 1420 ft


DeLORME
Street Atlas USA® 2003
Building Location
©2002 DeLorme. Street Atlas USA® 2003.
www.delorme.com
Scale 1 : 4,267
1" = 356 ft

Additional maps of a different size and scale are attached as Attachment 1 and Attachment 2

**Building 100 – Production Facility**

This facility is approximately 3,200 square feet with approximately 2,900 square feet dedicated to laboratory space. The balance of the floor space is used for an office, a lunchroom, and a bathroom. The building contains a security alarm system and is equipped with a sprinkler system for fire suppression.

**Building 200 – Storage Facility**

This building is approximately 660 square feet with approximately 220 square feet dedicated to radioactive waste storage. The remaining 440 square feet is equally divided between a chemical storage area (designed with a fire rating and ventilation) and a surplus/contaminated equipment storage area. This building is equipped with security and fire alarms.

**Building 300 - Office, Laboratory and Shipping Facility**

This building is approximately 5,800 square feet with approximately 3,000 $ft^2$ dedicated to laboratory space. The remaining 2,800 $ft^2$ is divided among office space, shipping, Health Physics laboratory, and shipping supplies storage.

There are no underground storage tanks, wells or pipelines on the property.

Sewage is handled by a municipal type sewer system that is operated by the Metropolitan Sewer District of St Louis.

American Radiolabelled Chemicals, Inc. (ARC) uses the following nuclides in the quantities and operations noted.

| | |
|---|---|
| Cl-36 | 300 millicuries max, in simple storage<br><1 millicurie, in very simple wet operations |
| Ca-45 | 1 Ci max, in simple storage<br>< 1 millicurie, in very simple wet operations. |
| Co-60 | 100 millicuries max, in simple storage (prepackaged units) |
| I-125 | 1500 millicuries max in simple storage.<br>< 1 millicurie, in very simple wet operations |

| | |
|---|---|
| C-14 | 400 Ci max, in simple storage<br>< 10 Ci, in very simple wet operations<br>< 2 Ci, in normal chemical operations<br>< 1 Ci in Complex operations |
| P-32 | 1 Ci max, in simple storage<br>< 100 millicurie, in very simple wet operations<br>< 10 millicurie, in complex operations |
| S-35 | 10 Ci max, in simple storage<br>< 100 millicurie, in very simple wet operations<br>< 10 millicurie, in complex operations |
| Fe-55 | 100 millicuries max, in simple storage (prepackaged units)<br>10 millicuries max, in simple storage |
| Fe-59 | 100 millicuries max, in simple storage (prepackaged units)<br>10 millicuries max, in simple storage |
| Sr-85 | 100 millicuries max, in simple storage (prepackaged units) |
| H-3 | 12,000 Curie max, in simple storage<br>< 10 Ci, in very simple wet operations<br>< 2 Ci, in normal chemical operations<br>< 1 Ci in Complex operations |
| P-33 | 1 Ci max, in simple storage<br>< 100 millicurie, in very simple wet operations<br>< 10 millicurie, in complex operations |
| Cr-51 | 100 millicuries max, in simple storage |

As ARC does not discharge to ground or surface water, there are no monitoring stations for these pathways.

ARC airborne effluents are emitted on a 24-hour per day basis, seven days per week.

The air-sampling program for determining dose to a member of the public is based on continuous occupancy, a conservative assumption, as it is highly unlikely for an individual to be present in any of the commercial/industrial buildings (the only type within 1000 meters) more than 50 hours per week, 50 weeks per year.
The sample methodology used for ARC airborne effluent sampling is described in ARC SOP –03 "$^{14}C$ and $^{3}H$ Air Monitoring Programs."

## 2.2 Land Use

The ARC campus is located in the approximate center of ¾ mile by ½ mile area industrial park, Lakeside Crossing, adjacent to other commercial properties. Maps showing nearest farmlands and residences follow this section The Lakeside Crossing Park is itself surrounded on four sides by other commercial properties. The properties bounded by Interstate 270, Dorsett Road, Lindbergh Blvd (US 67) and Page Avenue (MO Highway D) are commercial and/or industrial, as are properties south of Page Avenue. Essentially all properties within one kilometer of ARC are commercial/industrial in nature.

### 2.2.1 Recreational Areas

Creve Coeur Lake and Park are located 6 kilometers West Northwest of the facility.

### 2.2.2 Farmlands

The nearest farmlands are in the Missouri River Floodplains near Creve Coeur Park and Lake. Although used for growing crops, it may be conservatively assumed that this land could be used for producing meat and milk. The farmland closest to ARC is approximately 5 kilometers distant in the West Northwest to Northwest direction.

### 2.2.3 Residences

The closest residences are located slightly more than 1 kilometer South of ARC near Schuetz Road at 11503 Moonstone and 11500 Northbrook Way. The next closest residences are located approximately 1.2 kilometers in the North Northeast direction in the Pinehurst sub-division North of Dorsett Road.

### 2.2.4 Commercial/ Industrial Buildings

The4 nearest commercial building is directly across from ARC on the North Side of ARC Drive. The individuals working in these buildings are the closest individuals to ARC.

MapQuest - Printer-Friendly Map 7/27/99 10:27 AM

MAPQUEST
WWW.MAPQUEST.COM

FIGURE 1

Nearest Farmlands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Return to Map Get New Map





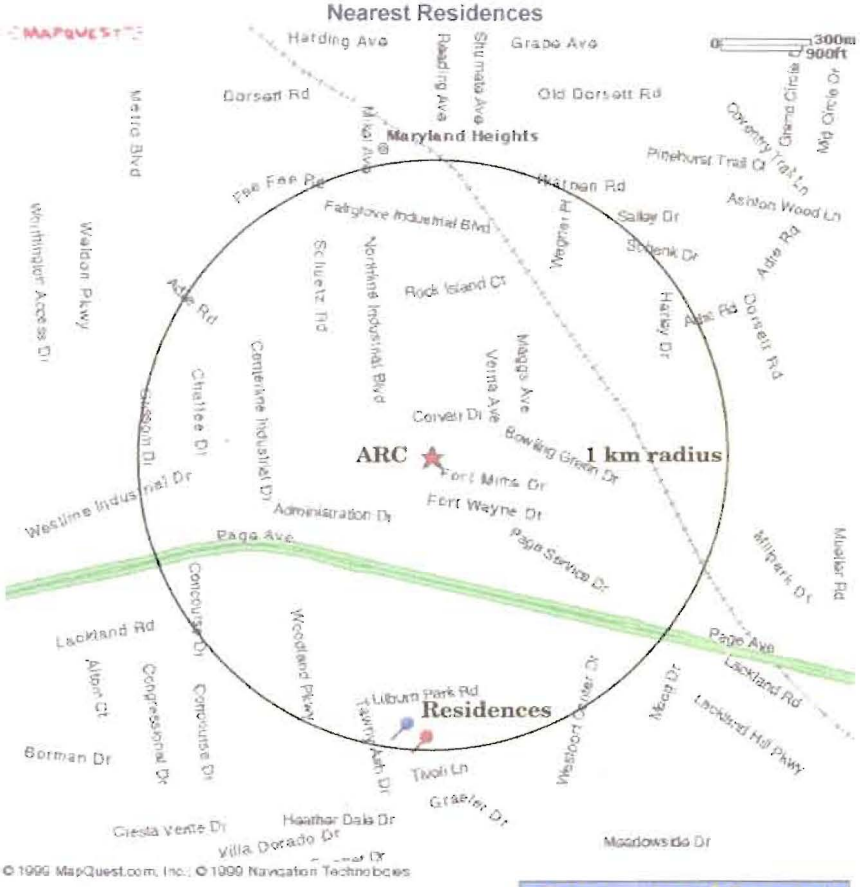
http://www.mapquest.com/cgi-bin/... Page 1 of 1

MAPQUEST

WWW.MAPQUEST.COM

**FIGURE 2**

Nearest Residences






Return to Map Get New Map

## 2.3 Transportation

### 2.3.1 Airports

Lambert International Airport is located 7.3 kilometers Northeast.

### 2.3.2 Highways

Major highways in the vicinity include Interstate 70, 5.6 kilometers North; Interstate 270, 1,6 kilometers West; Interstate 64, 8.3 kilometers South; and, U S Highway 67, 1.7 kilometers East.

### 2.3.3 Rivers

The Missouri River is 8.6 kilometers Northwest, on the opposite side of a high ridge.

## 2.4 Geology and Soils

### 2.4.1 Faults

There are no known faults located within the ARC facility or in the commercial/industrial parks surrounding ARC.

### 2.42 Volcanism

There is no known evidence of volcanism in the recorded history of this area.

### 2.4.2 Mineral Resources and recovery.

There is no known evidence of recoverable mineral resources in the recorded history of this area.

## 2.5 Water Resources

### 2.5.1 Water Usage Sources

ARC does not draw water from or discharge to either surface or ground water sources. All water is obtained from a municipal system. All discharge is to a municipal system

### 2.5.2 Flood and Storm Water

A description of locations of storm water run-off and impoundment may be found in the attached maps.

### 2.5.3 Lakes

The closest lake is Creve Coeur Lake, approximately 6 kilometers West Northwest.

### 2.5.4 Estuaries and Oceans

None

## 2.6 Ecological Resources

The ARC campus is located in the approximate center of ¾ mile by ½ mile area industrial park, Lakeside Crossing, adjacent to other commercial properties. A site maps are included in previous sections and in the attachments. The Lakeside Crossing Park is itself surrounded on four sides by other commercial properties. The properties bounded by Interstate 270, Dorsett Road, Lindbergh Blvd (US 67) and Page Avenue (MO Highway D) are commercial and/or industrial, as are properties south of Page Avenue. Essentially all properties within one kilometer of ARC are commercial/industrial in nature.

This entire area is composed of asphalt or concrete streets, roads and parking lots. The landscaping is grass and low shrubs.

No threatened or endangered species have been identified in the Maryland Heights area.

There are no travel corridors for migratory terrestrial species in Maryland Heights.

The closest sport fishery would be located on the Missouri River that is 7.7 kilometers at its closest point.

There are no breeding or spawning areas on-site or in the near vicinity.

## 2.7 Meteorology, Climatology, and Air Quality

### 2.7.1 Climate

This region (MO-2) is classified as Northeast Prairie.

### 2.7.2 Weather Stations

ARC is located mid way between weather stations at Lambert International Airport (7.3 Kilometers Northeast) and Spirit of Saint Louis Airport (7 kilometers West).

### 2.7.3 Wind Rose

National Climatic Data Center
Lambert International Airport
Coverage 1/22/60 to 12/31/78

Percent Calm 0.05

| Wind From | Frequency | Speed Velocity (miles/hr) |
|---|---|---|
| N | 0.046 | 10.10 |
| NNE | 0.035 | 8.70 |
| NE | 0.028 | 8.00 |
| ENE | 0.029 | 8.40 |
| E | 0.051 | 8.50 |
| ESE | 0.060 | 8.50 |
| SE | 0.073 | 9.80 |
| SSE | 0.078 | 11.00 |
| S | 0.110 | 10.90 |
| SSW | 0.042 | 10.00 |
| SW | 0.046 | 9.40 |
| WSW | 0.056 | 9.80 |
| W | 0.093 | 10.50 |
| WNW | 0.093 | 12.50 |
| NW | 0.062 | 11.60 |
| NNW | 0.041 | 10.50 |

## 2.8 Noise

The ARC campus is located in the approximate center of ¾ mile by ½ mile area industrial park, Lakeside Crossing, adjacent to other commercial properties. A site maps are included in previous sections and in the attachments. The Lakeside Crossing Park is itself surrounded on four sides by other commercial properties. The properties bounded by Interstate 270, Dorsett Road, Lindbergh Blvd (US 67) and Page Avenue (MO Highway D) are commercial and/or industrial, as are properties south of Page Avenue. Essentially all properties within one kilometer of ARC are commercial/industrial in nature.

ARC has been in operation at this location for 18 years, no change in noise levels from previous operation is planned or envisioned.

## 2.9 Historic and Cultural Resources

There are no historic, archaeological or cultural resources located in or on the ARC site.

The area surrounding the site for approximately one kilometer in all directions is commercial/industrial in nature. Surrounding this are mixed commercial and residential urban and suburban areas.

## 2.10 Visual/Scenic Resources

ARC has been in existence at this site for 18 years. No changes in visual or scenic resources are planned or contemplated.

The area surrounding the site for approximately one kilometer in all directions is commercial/industrial in nature. Surrounding this are mixed commercial and residential urban and suburban areas.

## 2.11 Socioeconomic

ARC has been in existence at this site for 18 years. No changes in employment patterns are planned or contemplated.

The area surrounding the site for approximately one kilometer in all directions is commercial/industrial in nature. Surrounding this are mixed commercial and residential urban and suburban areas.

## 2.12 Public and Occupational Health

### 2.12.1 Major Sources of Background Radiation

NCRP Publication 93 gives the average dose from all background non-occupational, sources as 360 mrem.

### 2.12.2 Current Sources of Radioactive Materials

ARC airborne effluents result in less than 10 mrem per year to the nearest non-occupationally exposed individual.

ARC liquid effluents, discharged to a municipal sanitary sewer system are less than 1 Curie of $^{14}C$ and less than 5 Curies of $^{3}H$.

### 2.12.3 Historical Exposure to Radioactive Materials

ARC has been in existence at this site for 20 years. No significant changes in usage of Radioactive material is planned or envisaged.

### 2.12.4 Occupational Injury and Fatality Rates

During the twenty years of operation at this site, there have been no OSHA recordable injuries or fatalities.

### 2.12.5 Health Effects Studies

None have been conducted for this area of industrial commercial parks and properties.

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