American Radiolabeled Chemicals, Inc.

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30 July 2010

U.S. Nuclear Regulatory Commission, Region III
2443 Warrenville Road, Suite 210
Lisle, IL 60532-4351

ATTN: Kevin Null

LICENSE No: 24-21362-01

CONTROL No.318694

SUBJECT: RFAI concerning the Revision of Radiation Protection Program (RPP) and Standard Operating Procedures (SOP)

Gentlemen:

American Radiolabeled Chemicals, Inc (ARC) submits the following information as requested in your letter dated 27 May 2010

ARC will go through the referenced letter answering each question in order.

General Comments

1. All proposed changes to the RPP and/or any SOP are reviewed by the Radiation Safety Committee (RSC) prior to submittal to the NRC for approval. The Radiation Safety Officer (RSO), a member of the RSC, submits the RPP and SOP to the RSC. The RSO shall confirm to the NRC that The RPP and SOP has been submitted to the RSC prior to transmittal to the NRC

2. Revisions made to the RPP and/or SOP will be communicated to ARC employees who may be impacted by the revisions by means of the ARC monthly topical training sessions. These training sessions were instituted as part of our efforts to institute a Safety Conscious Work Environment (SCWE)

3. The contaminated soil is in the low picocuries per gram, below the screening level in a good portion of the samples. As such, the small amount of Tritium and C-14 does not impact the possession level of 12,000 Ci of Tritium and 400 Ci of C-14. The amount of tritium in the buried septic tank is in the low microcurie range.
   The Decommissioning Funding Plan (DFP) submitted with the renewal application (April 2008) contained funding for the annex laboratories which are not yet part of the licensed facility. A revision to the DFP accounting for funding for buried tank removal and, if necessary any soil removal to meet

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decommissioning criteria, will be prepared and submitted within the next sixty days.

4. Implementation of all SOPs is the responsibility of the RSO. A Copy of each NRC approved SOP will be given to each impacted individual. (For Example, office workers will not be given an SOP on Glassware cleaning; Lab techs will not be given Nuclide Ordering SOP)
ARC employees impacted by the revisions will be trained by means of the ARC monthly topical training sessions. These training sessions were instituted as part of our efforts to institute a Safety Conscious Work Environment (SCWE)

5. Where applicable, cross references to other SOPs have been placed in the appropriate procedures

6 A. A letter has been submitted discussing the Gaussian distribution and wake effects. This letter is re-submitted as Attachment A.

B. The information requested in this part will be, or has been, submitted under separate cover.
The question on sample analyses has been submitted as part of the in depth analyses by an NRC contractor conducted earlier this month.
Hood flow measurements are made every week and have been since the inception of the license. Records of these measurements have been inspected many times by the NRC
The particulate filters were removed, with NRC approval, from the exhaust systems several years ago as the particulate contribution to the exhaust activity was less than 2%. The same classes of compounds are manufactured today as were at that time in the last century.

Radiation Protection Program

1. See Revised RPP given as Attachment B, the erroneous "Direct" has been removed

2. See Revised RPP given as Attachment B, the erroneous "Direct" has been removed

3. See Revised RPP given as Attachment B

4. See Revised RPP given as Attachment B

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5. See Revised RPP given as Attachment B.

6. See Revised RPP given as Attachment B, the erroneous "direct" has been removed

6. a. Class 1 workers are usually graduate level chemist and/or physicists, however janitorial personnel scrubbing the floor with no one else on site would have to be a Class 1 worker. This is up to the RSC and the individual's supervisor. See Revised RPP given as Attachment B

6.b. A Class 2 worker would be a junior chemist, a lab tech, a maintenance tech, a janitor, a shipping clerk. Also any new hire who is being evaluated on the ability to work without direct supervision. Any class 2 worker could be promoted to class 1, This is up to the RSC and the individuals supervisor. See revised RPP given as Attachment B

6c. See 6.b. above

7. The additional duties handled by the RSO have been removed. See revised RPP given as Attachment B

8. ARC is a privately held company and the final authority for corrective action is the president/owner.

9. The Radiation Protection Staff at ARC consists of:

(i). RSO - CHP; MSc in Radiation Health(U Pitt) 47 years experience.

(ii)Health Physicist - BS in Health Physics (Purdue) 1 Year experience

(iii)HP Tech - Associate in Nuclear Technology(Linn State) 3 years experience.

At present the Health Physicist is acting as assistant to the RSO while being mentored for the future replacement as RSO. At this time ARC is not seeking approval of this individual for an official position named in the license.

a. See above

b. RSO is available by cell phone 24/7

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c. The three persons listed above are regarded as the minimum staffing.

d. The individuals above are familiar with the license, the regulations, the RPP (they helped write it); the SOPs (they worked on the revisions). A "qualified radioactive materials contractor" is familiar with the regulations but is completely unfamiliar with the license, the RPP or the SOPs.

10. See revised RPP given as Attachment B

11. See revised RPP given as Attachment B

12. When the radioactive product is packaged, labeled, the documentation is complete, and it has been placed for pick-up, it is in finished form. All forms prior to this are Unfinished.

13. See revised RPP given as Attachment B

14. See revised RPP given as Attachment B

15. See revised RPP given as Attachment B

16. The amount of training necessary for each of the two training groups (See SOPs 21 and 38 in Attachment C) is based on the professional judgment and 47 years experience of the RSO.

17. Examples given as Attachment D

17a Refresher Training, given as a formal presentation, is on an annual basis. See revised RPP given as Attachment B. In addition ARC conducts monthly training on important and/or emergent topics as part of our efforts to create a SCWE.

17b see above.
ARC confirms that records of attendance are maintained.

17c On the Job Training is not a formal curriculum based system. An individual is assigned a job; is monitored and mentored by the supervisor and/or expert in the field. When this individual feels the person is capable of working alone, he may request the RSC to upgrade the person. The RSC will record, in the Minutes, the action taken.

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17d See Attachment C for SOPs 21 and 38. See also revised RPP given as Attachment B

17e See revised RPP given as Attachment B; See attachment C for SOPs 21 and 38; see attachment D for examples.

18. See section 9 of the revised RPP given as Attachment B
See Also SOP 8 in attachment C

18a. See SOP 8, 21, and 38 in Attachment C

18b. See SOP 1, 7, 8, 17, 18, 19, 29, 32 in attachment C

Standard Operating Procedures (SOP)

1. SOP – 1: Dry Solid Waste Compaction

See SOP-1 in Attachment C
See SOP-21 and 38 in Attachment C
See RPP Section 6.0 and 9.0 in Attachment B
See SOP-16 and 33 in Attachment C

2. SOP – 2 *In vitro* Bioassay Program

See Letter from USNRC Region III to S K Gupta President ARC dated 30 March 2010 signed by Tamara E Bloomer transmitting Inspection Report 030-0567/10-01(DNMS).
This letter states that after in-depth review the In Vitro Bioassay Program is adequate and the open item is closed.

3. SOP-3 C-14 and H-3 Monitoring program

This information has been submitted to the NRC inspectors and NRC contractors engaged in an in-depth study of ARC's air sampling program. Until the results of that study are complete, ARC prefers to continue to use a procedure that was approved in the previous two license renewals.

4. SOP-4 HEPA and Pre-Filter Exchange Program

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Letters from ARC to Region III dated 20 Nov 2000; 5 March 2001; 17 Sep 2001; and 5 March 2002 demonstrate that less than 2% of the dose due to airborne effluent can be attributed to particulates. NRC contractors are engaged in an in-depth study of ARC's air sampling program. Until the results of that study are complete, ARC prefers to continue to use a procedure that was approved in the previous two license renewals.

It should be noted that on the facility description submitted in the previous license renewal (Approved by NRC 17 March 2003) does not show any filters on any air exhaust pathway.

5. SOP-5 Instrument Calibration Program

See attachment C

5a. Production purposes - Instrument is used to locate the radioactive material within the apparatus or locate it on a chromatogram etc. Essentially answers the question "is it here or not". Production meters are pulser checked annually or after repair.

5b Instruments calibrated by a third party are calibrated according to their procedures.

5c Mini pulser will be calibrated by third party,
Efficiency determinations will be performed using traceable sources.
Meter calibration form is attached to SOP
D/min is determined by dividing cpm by efficiency
D/m/unit area is determined by dividing dpm by effective detector area

6. SOP-6 Program for Picking-up, Receiving and opening of Incoming Radioactive Materials

See attachment C

7. SOP-7 Liquid waste disposal Program

See RPP Section 9 in attachment B
See attachment C, SOPs 7, 8, and 38

As this is a batch process, "as needed" is when the level alarm sounds, or the technician says the mop bucket is ready.

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All holdup tanks, except Building 300, have recirculation piping. Buckets are stirred in the presence of the sampler. The Bldg 300 tank will have recirc piping installed when it can be taken out of service.

As this waste water combines all sources from aqueous chemical waste, glass ware cleaning, floor mopping, to hand washing on a **daily** basis, setting an **annual** limit less than the regulatory limit would not be reasonably achievable.

As stated above, calibrations of the LSC are performed by the equipment vendor.

Additional training for all ARC laboratory personnel will be part of the monthly SCWE training modules

8 SOP -8 Radioactive Waste Program

This procedure has been reinstated.
See RPP section 9 in attachment B
See SOP 8 in attachment C

9 SOP- 9 Hood face velocity Maintenance Program

See attachment C

The "Vanometers" used are not adjustable if the vane or the knife edge is compromised the only recourse is a new instrument.

10. SOP-12 *InVivo* Bioassay program

Approximately 20 to 40 millicuries of non-volatile I-125 compounds are synthesized each month. All other "processing" of I-125 is subdividing and re-labeling. ARC intends to expand the number of Iodine Labeled compounds, but not until the purpose built lab space of the Building 300 annex can be used

I-131 compounds are not processed at all, pre-packaged units were re-labeled. ARC will be submitting an amendment request to delete I-131

It is ARCs contention that this is not a significant amount.

11. SOP-13 I-125 Air Monitoring Program

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See 10 above

12. SOP-14 Phosphorous -32 Air Monitoring Program

Approximately 30 to 40 millicuries TOTAL of non-volatile P-32 and P-33 compounds are synthesized each month. All other "processing" of P-32 is subdividing and re-labeling. ARC intends to expand the number of P-32 Labeled compounds, but not until the purpose built lab space of the Building 300 annex can be used

It is ARCs contention that this is not a significant amount.

13. SOP-15 Procurement and Use of Radioactive Materials

See Attachment C

14 SOP -16 Radioactive Contamination Control Program

See Attachment C

15. SOP -17 Decay in Storage

See Attachment C

16 SOP-18 Liquid Waste Evaporation Program

See Attachment C

17 SOP- 19 Extended Interim Storage of Low Level Waste

See Attachment C

18 SOP -20 Glassware Decontamination Program

See Attachment C

19 SOP-21 Training and Dose Estimates for Non Laboratory Personnel

See Attachment C
See also SOP-38 in attachment C

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20. SOP-23 Exhaust Stack Flow Rate Measurement Program

See attachment C

Daily walk thru (documented) contains a check that all hoods have inward flow. This is evidence that exhaust flow exists.

Measurement by HVAC vendor is with their instruments and according to their procedure. They then certify to ARC that measurements are correct.

21 SOP-24 Transportation of Radioactive Material Using Private Vehicles.

See attachment C

POV are used when the company vehicle is out of service.

22. SOP-25 Gamma Air Monitoring Program

At this time ARC does not emit significant amounts of any gamma emitter. With the approval of the new lab space in the 300 annex, this will most likely change as additional volume of work with gamma emitters is envisioned.

23. SOP-26 Beta Gamma TLD Monitoring Program

In the event that a need to monitor workers for external exposure, ARC will re-instate this SOP.

24. SOP-27 Skin Dose Assessment Program

See attachment C

25. Release of Material

See attachment C

Examples of Counting Protocols are given as Attachment E

Examples of Monthly SCWE sessions (instituted in May 2010) are given as Attachment F

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If you have any questions or require clarification on any of the information stated above, you may contact Regis A. Greenwood, CHP at 314-991-4545.

Sincerely

AMERICAN RADIOLABELLED CHEMICALS, INC

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

cc. NRC Correspondence File

Attachment A

May 25, 2010

Division of Nuclear Materials Safety
U.S. Nuclear Regulatory Commission, Region III
2443 Warrenville Road, Suite 210
Lisle, IL 60532-4351

ATTENTION Kevin Null

LICENSE No: 24-21362-01

SUBJECT: Reply to Questions Raised About Building Wake Effects.

Gentlemen:

American Radiolabeled Chemicals, Inc (ARC) is replying to questions raised in the transmittal letter (dated 3/13/09) for License amendment number 39.

ARC agrees that due to the effective stack height being less than 2.5 times the building height at some directions and wind velocities, entrainment in the wake behind the building(s) is indeed likely. ARC feels that this effect is immaterial due to the following conditions.

1. The closest residence is approximately 1 kilometer distant. Gaussian dispersion adequately describes conditions at that distance.

2. ARC is located in an industrial park. No individual (other than ARC chemists, who are radiation workers) spends more than 50 hours per week in the park.

3. ARC discharges stack effluent on a 24/7/365 basis. We have chemists in the labs from 0700 to 2300, seven days a week. The chemical reactions used to produce our product do not stop during the absence of chemist. For this reason the exhaust stacks run 24/7/365.

4. There is no occupancy of any of the areas likely to be affected by any wake entrainment, with the exception of ARC office workers in our building 400. ARC has been sampling the intake air to this building for approximately seven years of the original six month sampling program.

5. At no time has the dose to these individuals exceeded the constraint of 10 mrem in a year when an occupancy factor of 50/168 is used.

6. Regulatory Guide 4.20 in the Introduction (Section A) states:

   " A licensee shall show compliance with the annual dose limit in 20.1301 by (1) Demonstrating **by measurement** or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit..."

ARC maintains that the individuals described in 4 and 5 above are the individuals "likely to receive the highest dose..."

7. Regulatory Guide 4.20 in paragraph 1.5 states:

   "In determining the member of the public likely to receive the highest dose from airborne radioactive material released from licensed operations to the environment, licensees need not consider nonresidents within the facility boundary."

   This eliminates any member of the public who just happened to camp out in the middle of the street between buildings.

Thank for your attention to this matter

If you have any questions or require clarification on any of the information stated above, you may contact Regis A. Greenwood, CHP at 314-991-4545.

Sincerely

AMERICAN RADIOLABELLED CHEMICALS, INC

Surendra K. Gupta, PhD
President

ATTACHMENT

1. Two sample plan maps of ARC site

Attachment B

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

American Radiolabeled Chemicals
101 ARC Drive
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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

The Committee reviews proposed modifications to existing facilities and engineering plans for new facilities 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.

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 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.

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 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

Radionuclide	Class	*Inhalation* ALI uCi	*Ingestion* 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 (1E+2)	6E+1 thyroid 2E+2	3E-8	

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

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

(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 radio nuclides 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 radio nuclide 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 week end 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 β–γ - 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 upon leaving the laboratory.

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 work day.

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.

[redacted]

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. 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. The results of the exams shall be maintained for review.

6.2.3 Individuals will be tested at least every two years 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 2 years

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, and notices of violations

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

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 open 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

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 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.

9.2.7.2 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.

9.2.7.3 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.

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

[redacted]

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.

[redacted]

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.

[redacted]

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.

Attachment C

Supersedes: 4/30/08
Reviewed by RSC: 7/27/10

SUBJECT: DRY SOLID RADIOACTIVE WASTE COMPACTION PROGRAM

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

RESPONSIBILITY: Radiation Safety Officer

REFERENCES: SOP 16; SOP 33

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 appropriately.

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

1.5 Labeled transport containers 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.

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

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.

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

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

3.2.8 Place the compacted bags in the fiberboard waste container.

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

3.2.10 Survey the floor area and clean as may be required.

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

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

3.2.13 Place a temporary RAM label on the container. Fill in the label with the date and <100 mCi ^{14}C and <100 mCi ^{3}H.

3.2.14 Inform the RSO of the box number (the date the box was sealed).

2.2.15 Return the transfer containers to the appropriate laboratory building.

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

SUBJECT: INVITRO BIOASSAY PROGRAM

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: NRC Regulatory Guide 8.32
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 work day 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 1 ml water 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 shall attempt to determine the cause of the uptake and to propose corrective actions to minimize the potential for recurrence.

5.2 Chronic exposures - Long-term exceeding 50 mrem/week

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 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: 12/17/2004
Reviewed by RSC: 7/27/10

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

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 rotometer followed by 1 or 2 gas-washing bottles containing 1.0 molar sodium hydroxide, an entrainment eliminator, a second rotometer, and a limiting orifice all connected in series to a vacuum source.

1.2 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

Air sampling is required in areas within which air concentrations normally exist in concentrations in excess of 10% of permissible limits.

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.

4.6.3 H-3 Assay Data

1st NaOH dpm/ml
2nd NaOH dpm/ml

4.6.4 Output data

Sample mins
Average ml/min
Air Sample ml

4.6.5 C-14 Output Data

Collection Eff.
Conc. uCi/ml
% Permissible

4.6.6 H-3 Output Data

Collection Eff.
Conc. uCi/ml
% Permissible

4.6.7 Total % Permissible.

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.

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

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

4.6 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 or Counting Protocol 9 – Building 400 Air, as appropriate.

4.7 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.

4.6 Input/output data for spreadsheet worksheets

4.6.1 Input data

Date Started
Time Started
Date Finished
Time Finished
Initial ml/min
Final ml/min
1st Bottle NaOH ml
2nd Bottle NaOH ml

4.6.2 C-14 Assay Data

1st NaOH dpm/ml
2nd NaOH dpm/ml

ATTACHMENT ONE

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:
Reviewed by RSC: 7/27/2010

SUBJECT: HEPA AND PRE-FILTER EXCHANGE PROGRAM

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

SUBJECT: INSTRUMENT CALIBRATION PROGRAM

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.***

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 are calibrated by health physics personnel in accordance with the following procedure.

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 calibrated

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

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

3.4.6 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 calibrated. For this you will be using both the Pulser and the meter you are calibrating. 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 meters 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 calibrated must occur.

- Make first calibration 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 calibrated meter. This sticker will provide:

- the date of calibration
- the initials of who calibrated it.
- the C-14 efficiency.
- the count rate of the Cs-137 check source
- the new calibration due date

3.6.2 Print out the calibration 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.

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 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 sticker/tag.

4.6 If a meter reads outside this range, notify Health Physics to remove t from service for calibration.

4.7 Place the check source back in the Health Physics storage location.

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

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

RESPONSIBILITY: Radiation Safety Officer

REFERENCES: NUREG-1556 Volume 11, 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 a **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 300 cm^2 area. Wipes shall be assayed in an instrument calibrated to output dpm. (Counting Protocol #11 - 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	>2,200 dpm/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 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 dpm (Counting Protocol #11 - 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 I 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 Wipe the surface of the final source container and assay the wipe in the liquid scintillation counter.

2.15 Verify that the material received is the material which was ordered.

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

2.16.1. If contaminated, treat the materials as radioactive waste.

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

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

2.18 Enter the amount of the radionuclide(s) into the RAM inventory.

Attachment one

Incoming Package Survey.

INCOMING PACKAGE SURVEY

07/26/10
Date of receipt

10:30
Time of receipt

(Circle one) Excepted Package White I Yellow II Yellow III

Highest Contact Reading <0.1 mrem/hour

Location all

Highest reading at 1 meter <0.1 mrem/hour

Spreadable Contamination on outer surface See attached dpm/100sq. cm.

Curie Content See attached

Try attached only

Example

Describe contents

See attached

Reviewed by
Radiation Safety Officer
date

Survey Taken By: [signature] Date and Time 07/26/10 11:15

Supersedes: 07/07/02
Reviewed by RSC: 7/27/2010

SUBJECT: LIQUID WASTE DISPOSAL PROGRAM

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, 33

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 on an as-needed basis.

4.0 Procedure

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.

4.3 Enter the initial data in the liquid waste spreadsheet.

4.5.1 Date in Column A

4.5.2 pH in column B

4.5.3 Source Building in Column C

4.5.2 Volume in column G or H as appropriate

4.5.3 Sample size, usually 1 ml, in Column F

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

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

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

4.8.1 The volume of the wastewater in liters

4.8.2 The activity in mCi

4.8.3 The concentration in uCi/ml based on the facility water consumption

4.8.4 The running yearly total in curies

4.8.5 The running yearly percent permissible

4.5.6 The percent of the yearly discharge rate

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

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

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

4.9.3 The sum total monthly percent permissible for tritium plus ^{14}C5.5.

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.

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 2/22/08)

ANY OTHER PATHWAY MUST BE APPROVED AND DIRECTLY SUPERVISED BY THE RSO 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

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

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 open 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)

REFERENCES: RPP Section 9; SOP-01; SOP-07; SOP16; SOP17; SOP18; SOP19; SOP33; SOP-38

PROCEDURE:

Dry Active Waste (DAW)

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

1.1 Training

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

1.2 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 and clean as may be required.

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 <100 mCi ^{14}C and <100 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, recirculating the tank contents for 5 minutes will serve as sufficient stirring*

2.5.3 If the 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 uCi/l.

2.5.6 Enter the uCi/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 uCi/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

2.5.6.7 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 eam cleaner, pressure washer etc. (this path is not yet in service /12/10)

ANY OTHER PATHWAY MUST BE APPROVED AND DIRECTLY SUPERVISED BY THE RSO IN PERSON AND PHYSICALLY PRESENT.

2.5.9 Discharge Criteria

2.5.9.1 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.

2.5.9.2 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.

2.5.9.3 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.

2.5.9.4 If <u>at the end of the year</u> 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 which 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 he exits 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) 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 Laoratory 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

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

SUBJECT: HOOD FACE VELOCITY MAINTENANCE PROGRAM

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

RESPONSIBILITY: Radiation Safety Officer

REFERENCES: SOP-03; SOP-16; SOP-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

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

4.0 Corrective Action

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

The frequency for hood face velocity measurements is weekly.

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

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.

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 The activity ordered is added to 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. 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. 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. 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

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. A license amendment will be prepared and submitted. The new use shall not take place until the amendment is approved.

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: Reg Guide 8.21, Section C, para 1.4 – 1.8; Reg Guide 1.86, Table 1; and Nureg-1556 Vol. 12 appendix P; 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 which 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 Action level

At this level, areas and equipment are decontaminated at the next practical (usually immediately, but in all cases within 72 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 β–γ - 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 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

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 and the RSO 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 on an as-needed basis.

5.2 Surveys are performed to determine the "worst case" conditions in both restricted and unrestricted areas.

5.3 Direct frisk surveys 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 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.

6.6 Repeat the above step as necessary.

6.7 Use a survey meter calibrated for C-14 cpm and records 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

6.1 The LSC performance is ensured through a service agreement with the equipment vendor

6.2 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

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)

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

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

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

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

3.0 Procedure

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 which 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

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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.

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 3
SOP 8
SOP 16
SOP 33
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 Lab coats and heavy-duty rubber gloves 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) 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.

Supersedes: 4/29/2005
Approved by RSC: 7/27/2010

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.

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
SOP 2
SOP 8
SOP 16
SOP 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 Chemists are responsible for the initial cleaning of glassware before setting it aside for decontamination. Glassware should be free of volatile activity.

2.0 Lab Technician

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 **Before discharge this solution must be analyzed and discharge approved by the RSO.** 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 dish-washer detergent and run the machine. Discharge the dishwasher to the retention tank.

3.0 **An alcohol/NaOH solution may be used if the glassware is still not clean after the above steps. <u>This cleaning solution is very caustic and must be used with exterme caution</u>. Consult with a senior chemist before using this cleaning solution**.

4.0 Return the glassware to the chemist.

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

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 Kyle Gerard

2.2.2.1 Bachelor of Science from Purdue University with a major in Radiological Health Sciences.

2.2.3 Health Physics Technician April Jeffries

2.2.3.1 Associate Degree in Health Physics

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 Training provided and dose estimated by

_____	_____	_____
Name	Signature	Date

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 which 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

Measurements may be made by the HVAC Vendor using vendor owned equipment, or by the RSO (or designee).

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 air flow. 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 1.6 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 which 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.

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:

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

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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 ☐ ☐

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

.

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

REFERENCES: SOP-16; SOP-33; VARSKIN Mod 3

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 Officer

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 shall interview the radiation worker to determine how and when the contamination occurred.

4.2 The RSO should attempt to remove additional contamination before a skin dose assessment is made.

4.3 If the contaminated skin area is greater than 1 cm^2, divide the area into a 1 centimeter by 1 centimeter grid.

4.4 Place a plastic or metal shield with a 1 sq cm opening between the skin and the thin window detector probe in contact with 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 4.5 for each finger or for each of the 1 cm^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 which could result in additional dose.

5.2 The individual shall remain restricted until the doserate falls below 500 mRem/week.

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

5.4 >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

Calibration of the beta probe is performed through the use of ^{14}C secondary standards.

7.0 Quality assurance.

Quality assurance is performed by counting available ^{14}C reference standards. Results must be +-10% of the standard value.

SUBJECT: RELEASE OF MATERIAL

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.

2.2 Wipe test the outlined areas and take a few random wipes at other locations where contamination is likely.

2.2.1 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.

2.2.2 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.

2.3 Assay the wipes in a liquid scintillation counter (LSC) that automatically converts the count rate to net dpm/100 cm^2.

2.4 Decontaminate and rewipe any surface areas above the action levels.

2.5 Repeat the above step as necessary.

2.6 Attach all annotated print outs from the LSC to the survey form or sketch and enter the following information.

2.7 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

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

Supersedes: New
Reviewed by RSC: 7/27/2010

SUBJECT: Use of Protective Clothing and Equipment (PCE)

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.

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, ARC Drive, and all off site areas.

2.2 Controlled Areas

A Controlled area is 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.

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)

2.2.2.1 Areas inside the laboratories not listed as High contamination areas.

2.2.2.2 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

2.2.3 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.

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 with the exception of inspections or tours, 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.

5.0 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.

SUBJECT: TRAINING AND DOSE ESTIMATES FOR LABORATORY PERSONNEL

OBJECTIVE: This procedure is designed to provide ARC laboratory personnel 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

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 Kyle Gerard

2.2.2.1 Bachelor of Science from Purdue University with a major in Radiological Health Sciences.

2.2.3 Health Physics Technician April Jeffries

2.2.3.1 Associate Degree in Health Physics

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

The laboratory personnel will have refresher training annually.

4.0 Certification of training

I certify that I have received the training instructions listed in 2.0 above.

Name (please print)

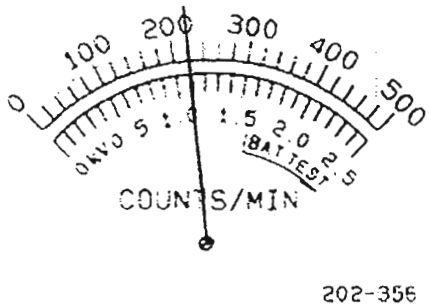
_____

_____
Signature

Attachment D

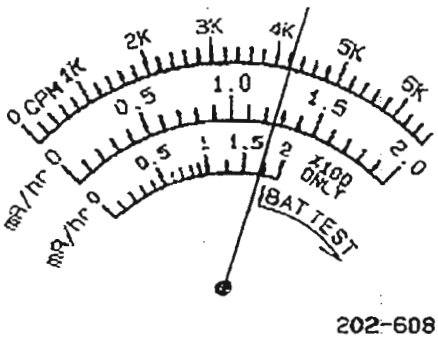
Name: [redacted] Date: [redacted]

1. What does the following meter face read on the X1 scale??



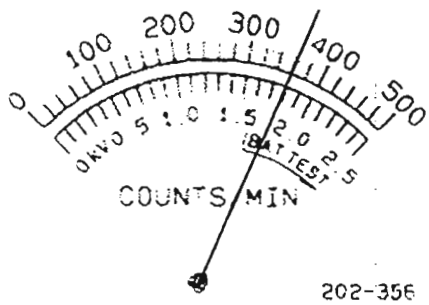
a) 210 counts per minute
b) 220 counts per minute
c) 22 counts per minute
d) 220 mR/hr

2. What does the following meter face read on the X0.1 scale?



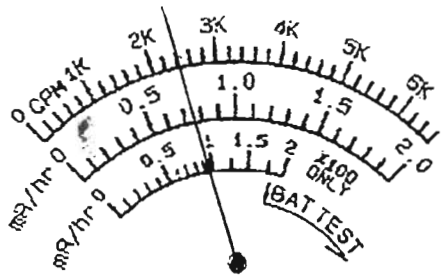
a) 40200 counts per minute
b) 0.5 mR/hr
c) 4200 counts per minute
d) 420 counts per minute

3. What does the following meter face read on the X10 scale?



a) 360 counts per minute
b) 3200 counts per minute
c) 32 counts per minute
d) 3600 counts per minute

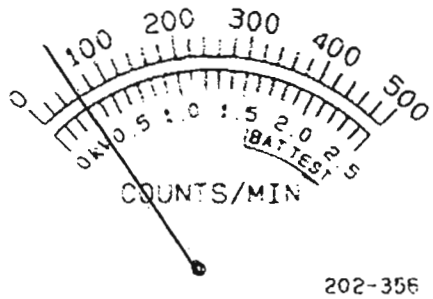
4. What does the following meter face read on the X100 scale?



202-608

a) 24000 counts per minute
b) 420000 counts per minute
c) 240000 counts per minute
d) 2.4 mR/hr

5. What does the following meter face read on the X1 scale



202-356

a) 60 counts per minute
b) 600 counts per minute
c) 60 counts per ~~minute~~ second
d) Battery Test Passed

Pass: [redacted]

Graded by: [redacted]

Training given by: [redacted]

[redacted]

Basics of Radiation and Radiation Safety

Name: [redacted] Date: [redacted]

1. True False Gamma rays should be shielded by a piece of paper.
2. True False A GM meter is used to tell what kind of radiation in present.
3. True False Bioassay is used to check for internal radiation
4. True False You can receive internal dose by breathing in material
5. True False Alpha radiation can pass through lead

6. What is a possible effect on cells from radiation:
   a) Nothing happens to the cell
   b) The cell dies
   c) The cell become mutated
   d) All of the above

7. Radiation is:
   a) Radioactive material where it is not supposed to be
   b) Energy
   c) 100% safe for any use
   d) Only found inside your body

8. The following is a type of high energy radiation emission:
   a) Beta
   b) Alpha
   c) Photosynthesis
   d) Gamma

9. How can radioactive material enter your body:
   a) Inhalation
   b) Absorption
   c) Ingestion
   d) All of the above

10. When removing your PPE what should be the last piece you take off:
    a) Shoe covers
    b) Lab coat
    c) Inner (Clean) gloves
    d) Sleeve covers

Pass: [redacted] Graded by: [redacted]

Radiation Protection Program
Entry Examination

Name(Print) [redacted] Signature [redacted]

1. ARC Employees receive what kind of exposure to radiation?

   a. Dose to living tissue from radioactive material inside the body.
   b. Dose from internal electromagnetic radiation.
   c. Dose to living tissue from radioactive material outside the body.
   d. Dose from external electromagnetic radiation.

2. ARC Employees are exposed to what kind of radiation in the course of their work?

   a. X-rays
   b. Gamma rays
   c. Beta Particles
   d. Alpha particles.

3. How could radioactive material enter your body?

   a. By breathing it in.
   b. From hand contamination transferred to food or drink.
   c. Through Cuts or breaks in the skin.
   d. All of the above.

4 Most tritium is eliminated from the body as tritiated water.. By what pathway is most of this tritiated water eliminated from the body?

   a. As water in urine
   b. As water in sweat.
   c. As water vapor in exhalation.
   d. As water in feces.

5. How is most of the carbon-14 eliminated from the body?

   a. As carbon compounds in urine
   b. As carbon compounds in sweat
   c. As carbon dioxide in exhalation
   d. As carbon compounds in feces.

6. What method does ARC use to determine dose to radiation workers?

a. Calculation from survey data.
b. Urine bioassay
c. Feces bioassay
d. Radiation sensitive badges.

7. Which individuals are required to participate in the bioassay program?

a. All individuals on the ARC site, whether ARC employees or not.
b. All ARC employees.
c. All ARC employees entering laboratory areas.
d. All ARC employees handling unfinished forms of radioactive material.

8. When leaving a laboratory area, what is the requirement for washing your hands?

a. Wash your hands if a survey detects contamination on them.
b. Wash your hands if you did not wear gloves in the laboratory.
c. Wash your hands every time you leave the laboratory.
d. Washing of hands is only necessary when a Class 1 worker tells you to wash.

9. What do you do <u>first</u>, if you spill radioactive material?

a. Stop the spread of the spill.
b. Notify the RSO.
c. Attempt to clean up the spill.
d. Restrict access to the spill.

10. What do you do <u>second</u>, if you spill radioactive material?

e. Stop the spread of the spill.
f. Notify the RSO.
g. Attempt to clean up the spill.
h. Restrict access to the spill.

11. When may a Class 2 radiation worker process radioactive material?

a. Only when a Class 1 radiation worker is present on the ARC site.
b. Only when the Class 2 worker's supervisor is present.
c. Only when a Class 1 worker is watching the Class 2 worker.
d. Only during regular working hours.

12. Liquid radioactive waste is discharged

a. Only by Class 1 workers through special sinks.
b. Only by the RSO through special sinks.
c. Only after assay to determine the amount of each nuclide, and checking against discharge limits.
d. Only on week-ends after all cleaning is completed.

13. The NRC limit on dose is 5 rem (or 5000 millirem) Deep Dose Equivalent. During what period of time may this be received?

a. During one calendar year.
b. During any one calendar quarter.
c. During any one month
d. During any consecutive seven days

14. ARC Inc has a guideline limiting employee's dose to 1250 millirem. During what period of time may this be received?

a. During one calendar year.
b. During any one calendar quarter.
c. During any one month
d. During any consecutive seven days

15. What are the isotopes of concern at ARC?

a. Iodine 131 and tritium
b. Iodine 131 and carbon -14
c. Phosphorus 33 and tritium.
d. Tritium and Carbon-14.

Training provided by: [redacted] Date: [redacted]

Attachment E

Ship/Receive LSC protocol

1 AUG 2010 12:06

USER PROGRAM REVIEW

User: 10 ID: SHIP RECEIVE
Count time: 1.00 CPM
Repeats: 1 HH Liquid
Replicates: 1
Cycle Reps: 1
Low Reject: 0

Isotope: WIDE NONE NONE
2 sig: 0.00
Bkgsub: 0.00
Factor:1.00000
Units: CPM CPM
Printer: Edit RS-232: Off

ACTIVE KEYS

MainC	HelpC	Select		Reset
PrevC	Print	Cancel		

REVIEW / EDIT

Id: SHIP RECEIVE

Comments: OUTPUT CPM PER WIPE

Counting Time: 1.00 min

Isotope 1: WIDE

Isotope 2: NONE

Edit Other Parameters

Enter program identification:

Bioassay LSC protocol

USER PROGRAM REVIEW

User: 2 ID: BIOASSAY

Count time:	5.00		DL DPM
Repeats:	1	HH	Liquid
Replicates:	1		
Cycle Reps:	1		
Low Reject:	0		Blanks
Isotope:	3H	14C	NONE
2 sig:	0.00	0.00	
Bkgsub:	0.00	0.00	
Factor:	0.00058	0.13800	
Units:	PERCENT	DPM	
Printer:	Std	RS-232:	Off

ACTIVE KEYS

MainC	HelpC	Select		Reset
PrevC	Print	Cancel		

REVIEW / EDIT

- Id: BIOASSAY
- Comments: PERCENT OF WEEK GUIDE
- Counting Time: 5.00 min
- Isotope 1: 3H
- Isotope 2: 14C
- Isotope 3: NONE
- Edit Other Parameters

3H	125I	14C	35S	32P
H3NEW	C14NEW			
MANUAL	WIDE	NONE		

Meter Calibration Report

American Radiolabeled Chemical Corporation
101 ARC Drive, St. Louis, MO 63146
Radiation Safety Office

Location:	Calibration Date:	
Meter Manufacturer:	Model#	SN#
Probe Type:	Model#	SN#
Probe Type:	Model#	SN#
Batteries:	High Voltage:	
Internal Adjustment:	Input Sensitivity:	

AS FOUND COLUMN C: AS LEFT

Meter Reading	Meter Switch	Meter Reading	Pulser Setting	C.F.	Pulser Output	Comparison
	Position	Scale in cpm	cpm x multiplier		cpm	

All Ranges Calibrated Electronically wuth Ludlum Model 500 Pulser SN 76571, Calibrated 08/06/02

Comments Cs-137 Portable check source 13000 cpm

Calibrated By:_____ Reviewed By: _____

Date: _____ Date:_____

From ECAL 07/25/03

Meter Efficiency Report

American Radiolabeled Chemical Corporation
101 ARC Drive, St. Louis, MO 63146
Radiation Safety Office

Location: Calibration Date:

Manufacturer: Model: S.N.:

Probe Type: Model: S.N.:
Probe Thpe: Model: S.N.:

Isotope	Current DPM	Gross CPM	(net CPM)/DPM	%Efficiency	NIST or Estimated

Attached operational check source should read (if applicable):

Conversion Factor (if applicable): CPM for mR/hr

Meter are calibrated electronically for COUNT rates, NOT DOSE rate. In a case where the meter scale is solely in dose rates, and equivalent count rate is found. This does NOT mean the counts indicated will give the dose indicated, but that the counts indicated will make the meter READ the indicated dose. For example, if the conversion factor for your miter is 400 CPM per Mr/h and your meter is reading 1.5mR/h, the count rate is 600 CPM. You still must convert from CPM to DPM using the following formula:

$$DPM = \frac{\text{Gross CPM - BK CPM}}{\text{net CPM/DPM}}$$

Typical Background = 40 CPM

Comments:

Eff S35 approx. = eff C14

Check Source

Calibrated By:_____ Reviewed By: _____

Date: _____ Date:_____

Form ECAL 9/99

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:

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:

ARC Car Survey Form

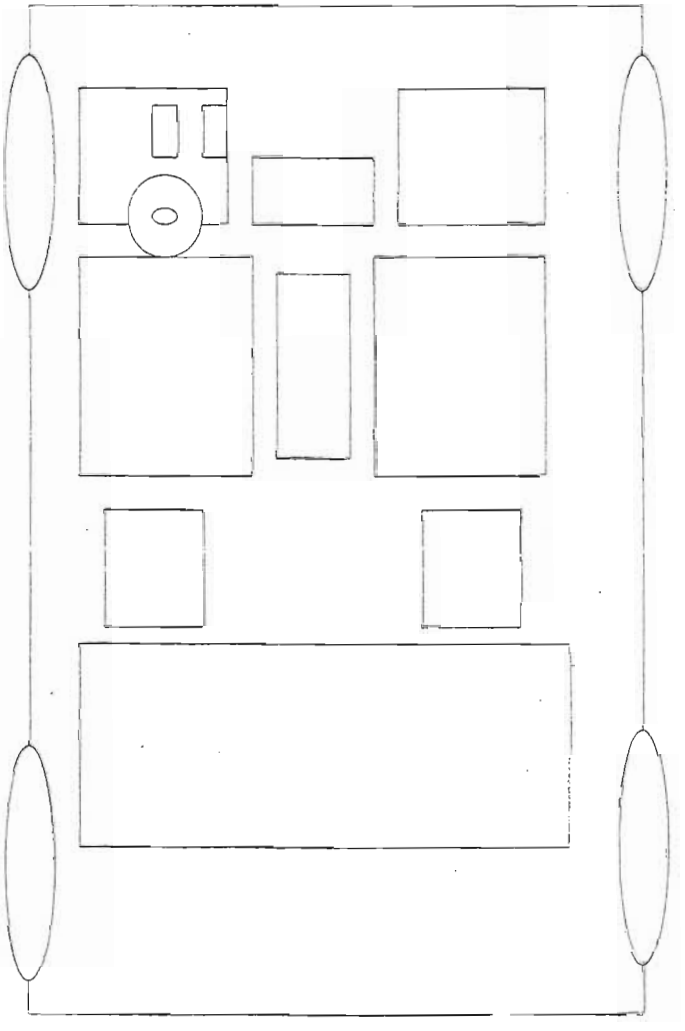
Date: _____ Time: _____

Car Owner: _____ Car Model: _____

Car Color: _____ Car Plate Number: _____

Meter: _____ Detector: _____

Detector Efficiency (C-14): _____ <Unit: cpm>



Background: _____

Surveyor: _____ Signature: _____

Jacket Survey Form

Preformed by:_____ Date:_____

Background:_____ Meter:_____

Name	Collar/ Zipper	Sleeves R / L		Pockets R / L		Inside	Outside

ARC Street Shoes Scan Survey Form

No.	Name	Left			Right		
		Sole	Outside	Inside	Sole	Outside	Inside
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							

Date: _____

Meter: _____

Background: _____**cpm**

By:_____

Attachment F

These are examples only, not part of an SOP, so that they may be modified when and if needed.

MAY 2010

Personal Protective Equipment

Risks In The Workplace

Bruises, cuts, and punctures

Blindness

Radiation exposure

Toxic exposure

Death

Risks in the Workplace (Continued)

Blood and toxic chemicals

Live electrical wires

Objects falling or fixed objects

Intense heat and power tools

Forklift dangers

You Can Protect Yourself

Safety glasses, goggles, and face shields

Shoe covers

Gloves

Sleeve covers

Lab coats, apron

Protect Your Eyesight

Contacts are not enough

Safety glasses guard against impact and can block beta radiation

Goggles provide a shield around your eyes

Care of Protective Eyewear

Protective eyewear will not withstand repeated impact or abuse

Replace glasses when lenses are broken or you cannot see through them for any reason

Replace knotted, twisted, worn or stretched out goggle straps

Clean after every use

Protect Your Hands with Gloves

Latex, nitrile, and vinyl

Protect hand from contamination

Chemical-resistant

Comfortably fitting

Protective Work Clothing

Protect from body contamination

Full bodysuit/lab coat/apron

Long pants

Lab specific shoes

Damaged Equipment Will Not Protect You

Cracked, cut, or old gloves

Ripped or old lab coats

Ripped or old aprons

Torn shoe covers/trouser covers

Broken, cracked, or contaminated eye protection

Summary

Only you can protect yourself:

- Damaged PPE will not protect you
- Change PPE regularly
- Lab coat: weekly
- Gloves: every use
- Trouser covers: weekly
- Aprons/safety glasses: as needed

Personal Protective Equipment
Quiz

1) List a type of activity in your facility that requires personal protective equipment.

_____

2) True or false?
   Contacts will protect your eyes from the danger of Chemical.

3) When you are working in the lab, which of the following is required?
   a. Safety Glasses
   b. Contacts
   c. Sunglasses

4) What is the proper way to clean your lab gloves?
   a. Abrasive soaps
   b. Cloth towels
   c. You should not reuse your gloves

5) True or false?
   You will always be able to see or smell hazardous particles in the air, before they become a risk to you.

6) When are you required to change lab coat?
   a. Annually
   b. Weekly
   c. Daily

7) Where in your facility is the personal protective equipment stored?

_____

8) True or false?
   There are chemicals on site that may cause burns, blindness, or even death.

9) True or false?
   It is ok step on the "clean" side of the change area with your yellow shoe covers.

10) When examining your personal protective equipment, what is an example of damaged equipment you should be looking for?

Name: _____

Date: _____

Graded by: _____

Pass: _____

Date: _____

June 2010

Hand surveys and safety:

It's important to wash and survey your hands EVERYTIME you exit the lab.

Proper washing includes using soap and warm water, it's important to scrub your hands but not so much as to cause redness or irritation because they may be a sign of small breaks in the skin which is another way for radioactive materials to enter the body. Washing your hands is very important; this is the only way to know that your hands aren't contaminated. The meters used for survey do not detect H3, only C14 and if you only survey then you have no idea if there is H3 contamination on your hands.

Proper hand survey should last around 20 seconds, With the GM pancake probe that we use in all change areas and lunchrooms you should survey 1-2 inches a second. Front and back of hand including wrists. (give demonstration) If sleeve covers aren't worn the wrists are often exposed skin. This survey should not have results higher than twice background.

If you find contamination on hands over twice background during your survey you are to call a member of Health Physics, currently Regis, Kyle, or April. They will assist you with the decontamination and take whatever information needed for an investigation or dose estimate.

Hand safety in our facility is mostly concentrated on contamination control. This is achieved by wearing the proper gloves. We have three types of gloves on site.

The clear powdered gloves are to be used when gowning in and out of the labs. We use these while donning or doffing our PPE. Never touch lab shoes or coats with bare hands. They can also be used if someone is going into the lab to observe someone or thing and will not be touching anything inside the lab.

The blue nitrile gloves are for general use, the most commonly worn glove. They offer better hand protection than the clear gloves but can be used in combination with them for added protection.

There are also yellow latex gloves available, these glove also cover your wrists and offer better protection that the clear gloves. These should be worn whenever necessary or if sleeve covers are not available.

When taking off your gloves it is important to never touch the potentially contamination outside of the glove. This is achieved by: (give demonstration)
By doing this you lessen the potential for contaminating yourself and the outside areas.

So again, wash and survey every time you leave the lab and make sure you wear the proper gloves for the job.

July 2010

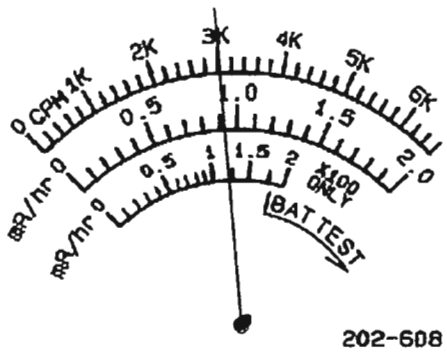
This test is given under the assumption that you know how to read a meter. If you have any questions please ask a member of radiation safety.

Tips:

1. "K" means 1000 (4K=4000)
2. Read the meter face first, write that number, then use the multiplier
3. If the multiplier has a one or more 0's to the right of the 1, add that many zeros to the number you read on the meter face.
4. If there is a 0 to the left of the 1 in the multiplier (0.1), take away one zero from the number you read on the meter face.
5. Each smaller tick mark between the numbers on the meter face counts as 20 counts per minute (CPM), or 200 counts per minute (CPM) if it's in the "K" (1000) scale.

Example:

What does the following meter face read at the X100 scale?

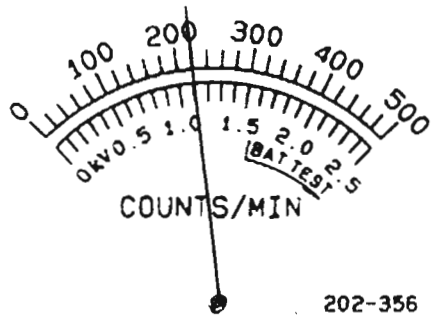


First read meter face: It's at 3K, K means 1000, so its 3000
Then use the multiplier, the question says X100.
Since there is two 0's in 100 add two 0's to the number from the meter face.
3000 becomes 300000.

The answer is 300000 counts per minute (CPM).

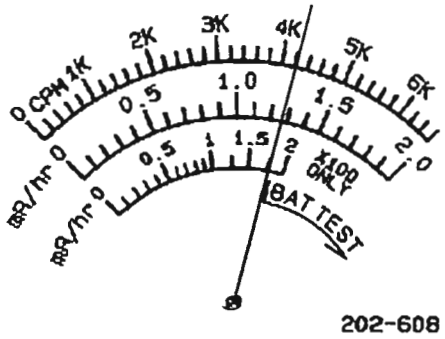
Name:_____ Date:_____

1. What does the following meter face read on the X1 scale??



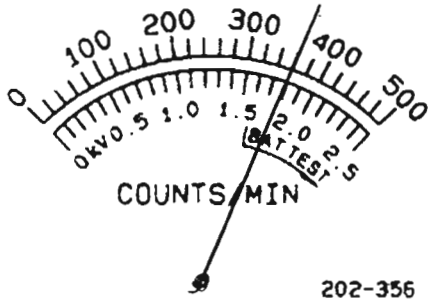
a) 210 counts per minute
b) 220 counts per minute
c) 22 counts per minute
d) 220 mR/hr

2. What does the following meter face read on the X0.1 scale?



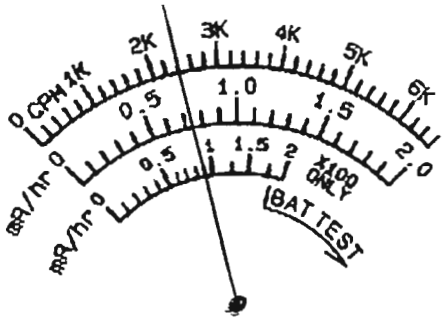
a) 40200 counts per minute
b) 0.5 mR/hr
c) 4200 counts per minute
d) 420 counts per minute

3. What does the following meter face read on the X10 scale?



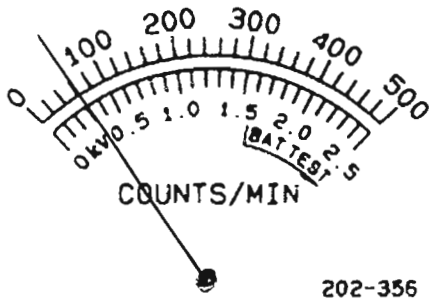
a) 360 counts per minute
b) 3200 counts per minute
c) 32 counts per minute
d) 3600 counts per minute

4. What does the following meter face read on the X100 scale?



a) 24000 counts per minute
b) 420000 counts per minute
c) 240000 counts per minute
d) 2.4 mR/hr

5. What does the following meter face read on the X1 scale



a) 60 counts per minute
b) 600 counts per minute
c) 60 counts per second
d) Battery Test Passed

Pass:_____

Graded by:_____

Training given by:_____

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