





# Dade Moeller®

Training Academy

## Radiation Safety Officer

May 9 – May 13, 2016

Instructors: Ray Johnson, MS, PE, FHPS, CHP, RSO; Alan Fellman, PhD, CHP, RSO; Lee Myers, PhD

This course is intended to provide a minimum of 40 hours of required and elective classes to meet provisions of 10 CFR 33.15. Required classes are already checked.  
Please select elective classes for a total of 40 or more hours.

### Day 1 Monday May 9, 2016

Class Selected	Start Time	Class Titles (electives in <i>bold, italics</i> )	Class Hours
<input checked="" type="checkbox"/>	8:00	Introduction, Course Overview, Views on Radiation	3.0
<input checked="" type="checkbox"/>	11:00	Radiation and Radioactivity, Radioactive Decay	1.0
	12:00	Lunch (provided)	
<input checked="" type="checkbox"/>	1:00	Radiation Units, Sources of Radiation	2.0
<input checked="" type="checkbox"/>	3:00	Radon, Interaction With Matter	1.0
<input checked="" type="checkbox"/>	4:00	Health Effects	1.5
<input checked="" type="checkbox"/>	5:30	Daily Review	0.5
<input type="checkbox"/>	6:00	<b><i>Effective Communications for the RSO (optional)</i></b>	1.5
	7:30	Adjourn for the day	

### Day 2 Tuesday May 10, 2016

Class Selected	Start Time	Class Titles (electives in <i>bold, italics</i> )	Class Hours
<input checked="" type="checkbox"/>	8:00	Radiation Protection Standards, 10 CFR Part 19 and 20	3.0
<input checked="" type="checkbox"/>	11:00	Essential Highlights of 10 CFR Part 2, 30, 31, 33	1.0
	12:00	Lunch (provided)	
<input checked="" type="checkbox"/>	1:00	External Radiation Protection and Shielding	1.5
<input type="checkbox"/>	2:30	<b><i>Sealed Sources &amp; Industrial Gauges</i></b>	2.0
<input checked="" type="checkbox"/>	2:30	<b><i>Internal Radiation Protection</i></b>	2.0
<input checked="" type="checkbox"/>	4:30	Emergency Response	1.0
<input checked="" type="checkbox"/>	5:30	Daily Review	0.5
<input type="checkbox"/>	6:00	<b><i>Math Review &amp; Radiation Safety Problem Solving (optional)</i></b>	1.5
<input type="checkbox"/>	7:30	Adjourn for the day	

**Day 3                      Wednesday                      May 11, 2016**

Class Selected	Start Time	Class Titles (electives in <i>bold, italics</i> )	Class Hours
<input checked="" type="checkbox"/>	8:00	Radiation Survey Instruments	4.0
	12:00	Lunch (provided)	
<input checked="" type="checkbox"/>	12:30	Instruments Lab, Applications & Troubleshooting	2.0
<input checked="" type="checkbox"/>	2:30	License Applications and Amendments	1.0
<input type="checkbox"/>	<b>3:30</b>	<b><i>Security of Radioactive Sources – Increased Controls</i></b>	<b>1.5</b>
<input type="checkbox"/>	<b>3:30</b>	<b><i>Radiation Safety Surveys</i></b>	<b>1.5</b>
<input checked="" type="checkbox"/>	5:00	Daily Review	0.5
<input type="checkbox"/>	<b>5:30</b>	<b><i>Hands On Laboratory Survey and PPE Exercise (optional)</i></b>	<b>1.5</b>
	7:00	Adjourn for the day	

**Day 4                      Thursday                      May 12, 2016**

Class Selected	Start Time	Class Titles (electives in <i>bold, italics</i> )	Class Hours
<input checked="" type="checkbox"/>	8:00	Interpreting Radiation Measurements and Quality Assurance	1.5
<input checked="" type="checkbox"/>	9:30	Transportation of Radioactive Materials Overview and Package Receiving	2.5
	12:00	Lunch (provided)	
<input checked="" type="checkbox"/>	1:00	Developing a Training Program	1.5
<input checked="" type="checkbox"/>	2:30	Practical Record-Keeping For RSOs	1.0
<input type="checkbox"/>	<b>3:30</b>	<b><i>Radioactive Waste Management, Mixed Wastes</i></b>	<b>2.0</b>
<input type="checkbox"/>	<b>3:30</b>	<b><i>X-Ray Safety</i></b>	<b>2.0</b>
<input checked="" type="checkbox"/>	5:30	Daily Review	0.5
	6:00	Adjourn for the day	

**Day 5                      Friday                      May 13, 2016**

Class Selected	Start Time	Class Titles (electives in <i>bold, italics</i> )	Class Hours
<input checked="" type="checkbox"/>	8:00	Legal Implications: Radiation Litigation	1.5
<input checked="" type="checkbox"/>	9:30	First Steps as New RSOs	1.0
<input checked="" type="checkbox"/>	10:30	Radiation Safety Program Management, Preparing for Regulatory Inspections	1.5
	12:00	Presentation of Certificates and Adjourn 40-hour course	
<input type="checkbox"/>	<b>12:30</b>	<b><i>DOT HAZMAT Certification Option – Additional Fee</i></b>	<b>4.0</b>
	5:00	Adjourn optional module	



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## ***RADIATION SAFETY OFFICER***

### ***Radiation Fundamentals***

#### **Introduction**

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Tools for Radiation Safety Awareness Presentation Slides .....	13

#### **Additional Items on CD**

- Responsibilities of the RSO
- Radiation Safety Training Guide (Complete)



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## ***RADIATION SAFETY OFFICER***

### ***Radiation Fundamentals***

#### **Section A**

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#### **Additional Items on CD**

- Atomic Structure
- Radioactivity
- Units of Radioactive Decay
- Interaction of Radiation with Matter
- EPA – A Citizen’s Guide to Radon



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## ***RADIATION SAFETY OFFICER***

### ***Radiation Fundamentals***

#### **Section B**

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Exposure to Radiation and What it Means.....	9

#### **Additional Items on CD**

- Regulatory Guide 8.13  
Instruction Concerning Prenatal Radiation Exposure
- Regulatory Guide 8.29  
Instruction Concerning Risks From Occupational Radiation Exposure
- BEIR VII  
Health Risks from Exposure to Low Levels of Ionizing Radiation



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## ***RADIATION SAFETY OFFICER***

### ***Radiation Risk Communication***

Effective Communication for RSO's,  
Managers, Instructors

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**Additional Items on CD**



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## ***RADIATION SAFETY OFFICER***

### ***Radiation Protection Standards***

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#### **Additional Items on CD**

- Maryland License Application Form
- Maryland Pre-Licensing Visit
- Notice to Employees for Each Individual Agreement State
- NRC Enforcement Policy
- NRC Form 3
- NRC Form 5





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## ***RADIATION SAFETY OFFICER***

### ***External Radiation Protection & Shielding***

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#### **Additional Items on CD**

- Document - External Exposure
- NRC Regulatory Issue Summary 2004-01, "Method for Evaluating Effective Dose Equivalent from External Radiation Sources Using Two Dosimeters"
- Occupational Radiation Exposure Report
- NRC Regulatory Issue Summary 2002-06, "Evaluating Occupational Dose for Individuals to NRC-Licensed Material and Medical X-rays"
- NRC Regulatory Guide 8.40, "Methods for Measuring Effective Dose Equivalent from External Exposure"



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## ***RADIATION SAFETY OFFICER***

### ***Industrial Gauges***

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#### Topics

Fixed and Portable Nuclear Gauges Presentation Slides

Registry of Sealed Source and Device Certificates

Sealed Source Leak Test and Inventory Record

#### **Additional Items on CD**

- Gauge Reference Material
- Fixed Gauge Audit Check List
- Portable Gauge Audit Check List
- Sample Gauge Bill of Lading



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## ***RADIATION SAFETY OFFICER***

### ***Internal Radiation Protection***

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#### **Additional Items on CD**

- Document – Internal Exposure



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## ***RADIATION SAFETY OFFICER***

### ***Emergency Response***

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#### **Additional Items on CD**



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## ***RADIATION SAFETY OFFICER***

### ***Math Review / Problem Solving***

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**Additional Items on CD**



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## ***RADIATION SAFETY OFFICER***

### ***Instruments***

Radiation Survey & Laboratory Measurements

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#### Topics

Instruments Presentation Slides

#### **Additional Items on CD**

- Radiation Instrument Training: Six Challenges for Emergency Responders
- Principles of Radiation Detection
- Survey Instruments



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## ***RADIATION SAFETY OFFICER***

### ***Instruments Lab***

#### ***Applications & Troubleshooting***

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#### **Additional Items on CD**

- Radiation Instrument Training for New RSO's



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## ***RADIATION SAFETY OFFICER***

### ***License Applications and Amendments***

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#### **Additional Items on CD**

- NRC Form 313
- NRC Form 314





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## ***RADIATION SAFETY OFFICER***

### ***Security of Radioactive Materials***

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- International Misuse of RAM
- Increased Controls
- Questions & Answers
- Supplemental Questions & Answers



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## ***RADIATION SAFETY OFFICER***

### ***Radiation Safety Surveys***

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#### **Additional Items on CD**

- Article - Use of Smears for Assessing Removable Contamination
- Comprehensive Radiation Safety Surveys
- Good Radioisotope Laboratory Safety Practices
- Information that should be submitted to the NRC Staff for  
Decommissioning and Termination of Licensed Facilities
- Properties of Commonly Used Radionuclides
- Radiation Safety Survey Examples
- Radiation Safety Survey Forms
- Regulatory Guide 4.22  
Decommissioning Planning During Operations
- Regulatory Guide 8.23  
Radiation Safety Surveys at Medical Institutions



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## ***RADIATION SAFETY OFFICER***

### ***Laboratory Surveys and PPE Exercise***

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#### **Additional Items on CD**

- Sample of Radiation Safety Survey



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## ***RADIATION SAFETY OFFICER***

### ***Radiation Statistics & Quality Assurance***

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#### **Additional Items on CD**

- Introduction to Statistical Principles
- Nuclear Counting Statistics
- Low-Level Counting Considerations
- Statistical Considerations of Radioactivity Measurements
- Radiation Statistics Attachments
  - Monthly Chi-Square Worksheet
  - Table of Chi-Squared
- Quality Assurance - the Key to Successful Programs
- It Only Costs a Little More to Go First Class
- Quality Assurance Attachment



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## ***RADIATION SAFETY OFFICER***

### ***Transportation***

#### **Shipment & Receipt of Radioactive Material**

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- Appendix A – Nomenclature and SI Units
- Sample DOT HAZMAT employee certification
- 3-year-training and ICAO
- DOT Emergency Response Guide, 2012
- CRCPD Package transport info 01-2012
- DOT-security-forms
- DOT Letter of Interpretation concerning emergency call services
- Enhanced Security Requirements



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## ***RADIATION SAFETY OFFICER***

### ***Developing a Training Program***

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<u>Topics</u>	<u>Page</u>
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#### **Additional Items on CD**

- Why Provide Radiation Safety Awareness Training for Ancillary Personnel



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## ***RADIATION SAFETY OFFICER***

### ***Practical Recordkeeping for RSO's***

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#### **Additional Items on CD**

- Radioactivity Decay Calculation Worksheet
- 2005 Liquid Radioactive Materials Disposal Data Worksheet
- NRC Form 541 "Uniform Low-Level Radioactive Waste Manifest
- Radiation Safety Computer System



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## ***RADIATION SAFETY OFFICER***

### ***Radioactive Waste Management***

**Mixed Wastes, Waste Manifests**

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NRC Waste Manifest Forms.....	14

#### **Additional Items on CD**

- Listing of NRC Position Statements on Rad Waste Management
- NRC Information Notice 99-33: - Management of Wastes Contaminated with Radioactive Materials
- NRC Information Notice 94-07 - Solubility Criteria for Liquid Effluent Releases to Sanitary Sewerage
- Standard Practices for Sampling with a Composite Liquid Waste Sampler Instructions for Completing NRC's Low-Level Radioactive Waste Manifest
- NRC Regulatory Issue Summary 2004-17, Revision 1 Revised Decay-in-Storage Provisions for the Storage of Radioactive Waste Containing Byproduct Material
- NRC Regulatory Issue Summary 2011-09, Available Resources Associated With Extended Storage Of Low-Level Radioactive Waste





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## ***RADIATION SAFETY OFFICER***

### ***X-ray Safety***

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#### Topics

X-Ray Safety Presentation Slides

#### **Additional Items on CD**

- Analytical X-ray Safety Workbook
- State of Alabama Forms for Registration of Radiation Services
- CRCPD-SSR Part B - Registration of Radiation Machine Facilities and Services
- CRCPD-SSR Part E - Radiation Safety Requirements for Industrial Radiographic Operations
- CRCPD-SSR Part F - Use of X-rays in the Healing Arts
- CRCPD-SSR Part H - Radiation Safety Requirements for Analytical X-ray Equipment



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## ***RADIATION SAFETY OFFICER***

### ***Radiation Litigation***

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**Additional Items on CD**



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## ***RADIATION SAFETY OFFICER***

### ***Radiation Safety Program Administration***

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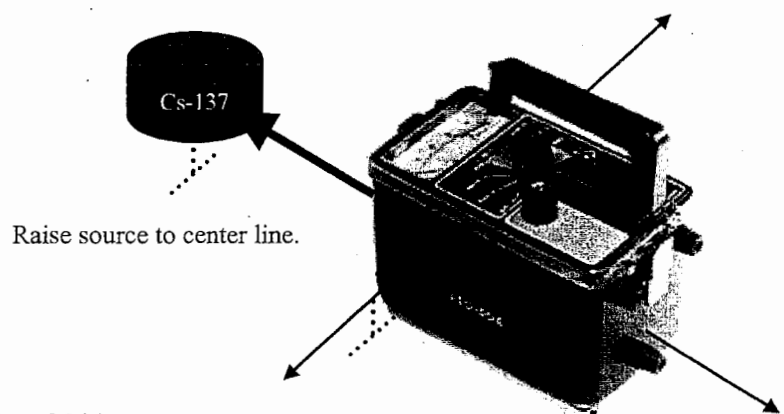
#### **Additional Items on CD**

- Sample Radiation Safety Program Manual
- Preparing for an Inspection
- Inspections and Audits Attachments
  - Checklist for Annual Dosimetry Report
  - Sample Audit Report
  - Record Keeping Requirements

## Exposure Meters

### 1.0 Equipment

- 1.1 Ludlum Model 9-3 ion chamber
- 1.2 Bicon ion chamber RSO-50E
- 1.3 Inovision 451P pressurized ion chamber
- 1.4 Ludlum Model 19A NaI micro R meter
- 1.5 Ludlum Model 5 GM meter
- 1.6 Bicon Microrem meter
- 1.7 Cs-137 source(s)
- 1.8 Ruler – centimeters (cm)



### 2.0 Determine the activity of the Cs-137 source

- 2.1 Use the gamma dose constant,  $\Gamma = 3.8 \text{ mR-cm}^2/\text{hr-}\mu\text{Ci}$

$$\frac{mR}{hr} = \frac{\Gamma \mu Ci}{cm^2} \quad \text{or} \quad \mu Ci = \frac{mR/hr \times cm^2}{\Gamma}$$

- 2.2 Repeat measurements and calculations with both meters at distances of 5, 10, 15, and 20 cm from the source to the center of the detector.
- 2.3 The source activity is between 5 and 15  $\mu\text{Ci}$ .
- 2.4 Let's see which group can best estimate the real activity! The source activity is determined by multiplying the exposure rate by a factor at the top of the chart for each distance.

(3)


## Exposure Meters

Take measurement then perform activity calculation:

$$\text{exposure rate } \frac{\text{mR}}{\text{hr}} \times \frac{1}{\text{distance}} = \frac{A}{\text{constant}}$$

3.9  
10  
15  
20

Meter		5 cm	10 cm	15 cm	20 cm
Multiplication Factor to get $\mu\text{Ci}$ =		(mR/hr)(6.58)	(mR/hr)(26.32)	(mR/hr)(59.21)	(mR/hr)(105.3)
Ludlum Model 9-3 Ion Chamber	mR/hr	2.4	0.8	0.4	0.2
	$\mu\text{Ci}$	15.8	21.1	23.7	21.06
Bicron Ion Chamber RSO-50E	mR/hr	3.2	1.1	0.4	0.25
	$\mu\text{Ci}$	21.1	28.95	23.7	26.3
Inovision 451P Pressurized Ion Chamber	mR/hr	1.75	0.53	0.22	0.14
	$\mu\text{Ci}$	11.5	13.95	13.03	14.74
Ludlum Model 19A Micro R meter	mR/hr		0.30	0.15	0.09
	$\mu\text{Ci}$		7.9	8.88	9.48
Bicron Microrem Meter	mR/hr	<del>1.0</del> 1.0	0.72	0.25	0.18
	$\mu\text{Ci}$	6.58	18.95	14.8	18.95
Ludlum Model 5 GM Meter	mR/hr	2.0	0.4	0.25	0.14
	$\mu\text{Ci}$	13.16	15.8	14.8	14.7

  Institute Site	<p><b>Radiation Protection</b></p> <p>IDMS Reference: L2, Section 5.4</p>	<p>Effective: 28 October 2016</p> <p>Supersedes: 11 December 2015</p> <p><b>SS-SAF-L2-014</b></p> <p>Page 1 of 19</p> <table><tr><td>Review Frequency</td><td>3 years</td></tr><tr><td>Last Review</td><td>28 October 2016</td></tr><tr><td>Next Review</td><td>28 October 2019</td></tr></table>	Review Frequency	3 years	Last Review	28 October 2016	Next Review	28 October 2019
Review Frequency	3 years							
Last Review	28 October 2016							
Next Review	28 October 2019							

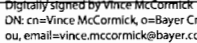
## 1.0 Purpose

Ensure the protection of site personnel and keep personnel radiation exposure as low as reasonably achievable, as well as ensure compliance with United States Nuclear Regulatory Commission and state regulatory/license requirements.

## 2.0 Scope

Applies to all activities involving radioactive sources at the Bayer Institute Site (This includes the use of X-ray generating equipment and contract radiographers).

## 3.0 Process Table

Area(s) of Application: Bayer Institute Facilities and Bayer Institute Managed Projects	
Author: John Owen	Reviewer(s) HSE Representatives, IH Sampler, SF&H, PCT Technologist
Approver: Vince McCormick	<div>  </div> Vince McCormick <small>DN: cn=Vince McCormick, o=Bayer CropScience, ou, email=vince.mccormick@bayer.com, c=US Date: 2016.10.18 09:19:33 -0400</small>
Type of Document:	Procedure
Other Relevant Documents:	IDMS Element 5.4, 10 CFR – Atomic Energy, 49 CFR – Transportation, Consolidated Guidance About Materials Licenses – NUREG-1556 Vol. 4, IDMS Element 5.7 Dow Radioactive Source Emergency procedure

## 4.0 Responsibilities

### 4.1 Functional Manager

#### 4.1.1 Notify the RSO / HSE Representative when:

- 4.1.1.1 Any alterations from the original design are contemplated in the use of equipment containing radioactive material.
- 4.1.1.2 Equipment containing radioactive material is no longer needed.
- 4.1.1.3 Maintenance work on equipment associated with the radiation source is scheduled.
- 4.1.1.4 X-ray generating equipment is to be installed so that proper records and monitoring can be maintained.
- 4.1.1.5 There is to be any change in location of X-ray generating equipment.

#### 4.1.2 Ensures that radiation sources are not damaged or altered.

#### 4.1.3 Assures that vessels using radioactive sources are checked for safe radiation levels before entry is made into the equipment. Only personnel specially appointed and trained by the RSO can perform radiation surveys, wipe tests, or lockouts. See [Appendix F](#) for contact list.

#### 4.1.4 Ensures that the radiation device is not handled, moved, worked upon, altered, or otherwise manipulated by anyone except as authorized by the RSO. A Class "B" Safe Work Permit is required.

#### 4.1.5 Ensures completion of Lock Out / Tag Out of a radioactive source by trained personnel.

#### 4.1.6 Posts and maintains proper warning signs per HSE Department requirements.

### 4.2 Radiation Safety Officer (RSO)

#### 4.2.1 Coordinates wipe tests / surveys / shutter checks programs and ensures that radioactive materials are safe for installation, operation, and potential hazards to health.

#### 4.2.2 Reports results of each monitoring survey to appropriate personnel if the survey detects unsatisfactory radiation levels.

#### 4.2.3 Maintains the original NRC license, amendments, and SSDR certificates.

*This is an electronic document. Any printed copy other than the signed original is uncontrolled and is not the official copy.*



Institute Site

## Radiation Protection

IDMS Reference: L2, Section 5.4

Effective: 28 October 2016  
Supersedes: 11 December 2015  
**SS-SAF-L2-014**  
Page 2 of 19


Review Frequency	3 years
Last Review	28 October 2016
Next Review	28 October 2019

- 4.2.4 Stores and maintains signs and radiation monitoring equipment in good working condition.
- 4.2.5 Keeps one set of keys to the radioactive materials storage building and ensures that the building is kept locked. This building is used exclusively for the storage of radioactive materials. The building may be opened only in the presence of the RSO or his / her designee. No material will be placed in or removed from the building without prior approval from the RSO or his/her delegate.
- 4.2.6 Escorts NRC representative(s) at the site.
- 4.2.7 Maintains inventory records showing the receipt, transfer, export, disposal, and monitoring of equipment containing radioactive sources.
- 4.2.8 Reviews NRC program updates and bulletins, incorporates changes into site procedure.
- 4.2.9 Primary point of communication to and from NRC.
- 4.2.10 Stops activities involving licensed material that the RSO considers unsafe.
- 4.2.11 Develops, maintains, and implements up-to-date operating and emergency procedures.
- 4.2.12 Radiation safety program audits including development, implementation, and documentation of timely corrective actions are performed at intervals not to exceed 12 months.
- 4.2.13 Notify NRC, as soon as possible, of changes in the designation of the RSO.
- 4.2.14 Ensure that proposed Authorized Users are qualified to work independently with each type of gauge with which they may work. Ensure that proposed RSOs are qualified to work independently with and are knowledgeable of the radiation safety aspects of all types of gauges to be possessed by the applicant.
- 4.3 HSE Reps
  - 4.3.1 Ensures the proper posting of adequate warning signs, NRC notices and documents required by 10 CFR 19.11 or posting a notice indicating where these documents can be examined. All sources require "Radioactive Material" signage for general awareness. Sources that read > 5 mR/hr at 1 ft require "Radiation Area" signage.
  - 4.3.2 Performs wipe surveys every 3 years (or 6 months per certain lab equipment), sends, and retains documentation.
  - 4.3.3 Keeps one set of keys to radioactive sources and ensures that sources are locked out (with a minimum of a purple lock) in the closed position when they are being moved or otherwise manipulated. Purple colored locks will only be used for radiation sources and will be provided by the RSO.
  - 4.3.4 Controls the size and type of sources as well as the locations where radiography is allowed.
  - 4.3.5 Interfaces with contract radiographer and provides Industrial Radiography Documentation form ([Appendix B](#)) to the contract Industrial Radiographer to complete.
- 4.4 I / Es (instrument and electricians) for sealed sources in processes
  - 4.4.1 Performs semi-annual shutter checks and inventory (inventory automatically noted when shutter check is preformed).
  - 4.4.2 Performs lockouts / unlocks as needed.

## 5.0 Definitions

- 5.1 By-product Material – any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to radiation incidental to the process of producing or utilizing special nuclear material.
- 5.2 Ionizing Radiation – any electromagnetic radiation capable of creating ionization in materials. This includes x-rays, gamma rays, alpha radiation, beta radiation, and neutrons.
- 5.3 Qualified Person – Persons who attended the Radiation Course, qualified for lockouts, shutter checks, and wipe tests
- 5.4 Radiography – the examination of the structure of materials by non-destructive methods, utilizing the radiation from sealed sources of by-product materials, or x-ray generating equipment. This process is used to provide a permanent visible record of metal and weld quality for equipment used in high pressure and/or lethal service.
- 5.5 RSO (Radiation Safety Officer) – the designated HSE Representative who coordinates and supervises the Radiation Safety Program of the Bayer Institute Site. The RSO may delegate his/her responsibilities to other qualified HSE Representatives.

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- 5.6 Sealed Source – any by-product material that is encased in a capsule designed to prevent leakage or escape of the material.
- 5.7 US NRC – United States Nuclear Regulatory Commission.
- 5.8 X-ray Generating Equipment – a device that electrically generates X-ray radiation as opposed to one that uses radioactive material to produce X-ray radiation.

## 6.0 Procedure

### 6.1 Purchasing Radioactive Materials

	Step	Step Description	Responsible
1	Procurement	<ul style="list-style-type: none"> <li>Request for radioactive material and devices that produce ionizing radiation to be brought on site.</li> <li>Prior to processing, review and approve radioactive materials and devices ensuring the Site is authorized to possess the type and quantity of radioactive material requested. If needed, obtain a license amendment from the NRC before purchasing a particular type and quantity of radioactive material that is not authorized under the current Site license.</li> <li>Initiate a formal request for the purchase of radioactive materials after RSO approval.</li> <li>Notify the HSE Representative at least 24 hours in advance when contract equipment that generates an X-ray or emits radiation from radioactive material is requested to be used in the site.</li> </ul>	Procurement / Engineering  RSO  Procurement  Engineering / Unit Engineer
2	Incoming Shipments	<ul style="list-style-type: none"> <li>Immediately notify the RSO/HSE Representative upon receipt of packages containing radioactive materials. Ensures under <b>NO</b> circumstances that the packages are to be opened until they are checked by the RSO/HSE Representative.</li> <li>Inspect the packages containing radioactive materials prior to the carrier leaving. Immediately upon receipt of any package of licensed material, each package must be visually inspected for any signs of shipping damage such as crushed or punctured containers or signs of dampness. Damaged packages must be monitored for radioactive contamination and radiation levels.</li> <li>Receive the package containing radioactive materials once inspected.</li> </ul>	Receiving Dept.  RSO / HSE Rep.  Receiving Dept.
3	Outgoing Shipments	<ul style="list-style-type: none"> <li>Notify the RSO / HSE Representative in order to arrange proper shipment of radioactive material.</li> <li>Provide assistance as necessary and sign shipping documents.</li> </ul>	Authorized User  RSO / HSE Rep.
4	Intraplant Transportation	<ul style="list-style-type: none"> <li>Notify the RSO / HSE Representative in order to arrange movement of radioactive material within the Site.</li> <li>Ensure radiation level for equipment containing radioactive material is maintained at or below 5 mrem/hr (0.05msv/hr) at all locations 30 cm (1 ft) from the source holder surface.</li> </ul>	Authorized User  RSO / HSE Rep.
5	Security of Radioactive Material	<ul style="list-style-type: none"> <li>Secure radioactive material from unauthorized use and handling at all times by ensuring the source is installed in its intended installation, locking in a secure facility such as the Site radiation storage area, or continually supervising.</li> </ul>	HSE Rep. / RSO / Authorized User





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	Step	Step Description	Responsible
		<ul style="list-style-type: none"> <li>Perform and document a radiation survey of this building semi-annually.</li> <li>Ensure the positioning of radioactive material placed in the storage building is such that it minimizes radiation level as low as reasonably achievable.</li> <li>Apply security seals to shipments of radioactive materials as required by applicable transportation regulations.</li> <li>Ensure proper documentation of receipts and shipments of radioactive material and store the documents in a permanent file until termination of the Site USNRC license.</li> <li>Inspect radioactive sources at least semi-annually using the form in <u>Appendix A</u>. Sources which are extremely inaccessible (requiring a reach-over crane lift or scaffold construction) will be surveyed and tested during routine maintenance shutdowns and the interval may exceed 6 months.</li> <li>Maintain an inventory of all radioactive materials and radiation emitting devices and physically verify inventory semi-annually. Since the leak tests require an individual to locate and work with the sealed source, records of leak tests will be used as part of the semi-annual inventory.</li> </ul>	
6	Radiography (pre-plan)	<ul style="list-style-type: none"> <li>Pre-plan the radiographic job with the RSO / HSE Representative</li> <li>Notify the RSO / HSE Representative of the date/time the radiographers will arrive on site.</li> <li>Notify the Security Department if radiographic job is to be conducted during off-hours or weekend.</li> </ul>	User Department  User Department  User Department
7	Radiography	<ul style="list-style-type: none"> <li>Meet radiographers prior to the start of radiographic activities whenever possible or establish in advance the conditions for performing the particular job.</li> <li>Survey the established safe perimeter during initial radiographic exposure to ensure adequacy of the restricted area whenever possible.</li> <li>Assure compliance with USNRC regulations and provide evidence of compliance on request.</li> <li>Comply with site safety requirements and procedures.</li> <li>Complete the "Industrial Radiography Documentation" form: (<u>Appendix B</u>) and return it to the RSO / HSE Rep. (or left at the Gate Guard House after hours when leaving plant)</li> <li>Immediately notify the RSO / HSE Rep. of suspected or known emergency conditions that might result in an excess radiation exposure to site employees.</li> <li>Cease operation during any Site emergency and, if possible, return the source to its shielded position</li> </ul>	RSO / HSE Rep.  RSO / HSE Rep.  Contract Radiographers

### 6.2 Radiation Survey Instruments

6.2.1 A minimum of two general-purpose gamma ray survey instruments will be maintained for use in making radiation surveys at the Site.

6.2.2 The instruments will have a minimum range of 0.2 mR/hr



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- 6.2.3 The instruments will be calibrated annually by persons specifically authorized by the USNRC or an Agreement State to perform these calibrations.
- 6.2.4 Any replacement instruments will have equivalent ranges and capabilities.
- 6.3 Installation and Survey
  - 6.3.1 All sealed sources will be in source holders as supplied by the Process Nuclear Gauge Manufacturer.
  - 6.3.2 All source holders will be securely mounted to permanent structures such that the source-detector geometry is fixed.
  - 6.3.3 All gaps in the radiation beam path large enough to permit likely insertion of a major human body part will incorporate physical barriers to prevent such insertion.
  - 6.3.4 Appropriate warning signs will be posted, including signs at each man-way or entry point on the vessel.
  - 6.3.5 A radiation survey will be performed at 30 cm (12 inch) from all surfaces of the source holder and radiation beam path. The form shown in Appendix A will be used to document the survey and to record the radiation field measured at specific points around the gauge. Radiation levels must be less than 5 mrem/hr (0.05 msv/hr) at all locations, 30 cm from the source holder surface, and less than 2 mrem/hr (0.02 msv/hr) at 30 cm from all other surfaces.
  - 6.3.6 All locations within 12 ft. of the source holder where personnel are routinely present will be evaluated as per the instructions on the form to assure that no member of the general public is likely to receive a radiation dose of more than 10 mrem (1msv) in any year from this source
- 6.4 Leak Testing (wipe survey)
  - 6.4.1 Frequency of Leak Testing
    - 6.4.1.1 Routine leak testing will be performed by HSE Reps. Level / flow detection gauges are on a 3-year leak test cycle as per the manufacturer's recommendation and the terms and conditions of the Plant USNRC license. Any source in an extremely inaccessible location will be surveyed and tested during scheduled routine maintenance shut-downs of the operating unit. Records kept in the area HSE office.
    - 6.4.1.2 The HSE Rep for the lab will wipe test the 2 lab sources - Model 940-230-G1 CMS-200 at a 36 months leak test and Model 6890 Series GC at a 6 month leak test. Records kept in the area HSE office.
    - 6.4.1.3 Leak testing will be done in accordance with license requirements and manufacturers' recommendations. Leak and contamination test smears will be analyzed by a person specifically authorized by the USNRC or an Agreement State to analyze these tests.
    - 6.4.1.4 Radioactive materials in storage will be leak tested and surveyed before being removed from storage or immediately after installation.
    - 6.4.1.5 Test for contamination will be performed upon receipt and prior to shipment of any radioactive materials.
  - 6.4.2 Test Procedure
    - 6.4.2.1 Leak tests on laboratory analytical devices are made by swabbing the exhaust port from the instrument as close to the radiation source as convenient or if that is not possible, by swabbing seams and seals of the subassembly containing the radioactive material. When operating, cleaning, or performing maintenance on these cells:
      - 6.4.2.1.1 Radiation sources must not be removed from the instrument and the subassembly containing the radioactive material must not be opened. Do not break the seals on the screws that hold the caps in place.
      - 6.4.2.1.2 Any work to be done on the ionization detector cells must be performed by the vendor's authorized service representative only. The HSE Representative must be notified prior to this work.
    - 6.4.2.2 Leak tests on process nuclear gauges are made by swabbing seams or seal on the source holder, with particular attention to places where one might expect leaking radioactive material to first appear.
    - 6.4.2.3 Packages containing radioactive material are to be tested for contamination upon receipt and prior to shipment. Such tests will include three areas of at least 100 cm<sup>2</sup> at random locations on the package surface.



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### 6.5 Shutter Checks

- 6.5.1 Shutter checks are required to be done every 6 months for all sealed sources and must be documented in SAP (who, when, and which source was tested).
- 6.5.2 To test the shutter mechanism, move the actuator back and forth several times between the off and on position. The actuator should move easily but not freely. There will be some resistance to movement due to the bearing friction and inertia of the mechanism. Use one of the two methods below to insure that the shutter mechanism is operational:
  - 6.5.2.1 METHOD A – using a Geiger counter, measure the back of the detector housing. Field intensity should be low when the shutter is in the off position, conversely when the shutter is on, the field intensity should increase.
  - 6.5.2.2 METHOD B – use the control room electronics and monitor from the front panel display or use an auxiliary monitor (recorder) and turn shutter to the off position. Indication should go to the high process value on the display or recorder. Open shutter and reading should return to normal.

### 6.6 Disposal


- 6.6.1 Disposal of radioactive materials or devices containing radioactive sources that become unserviceable or unnecessary at the Bayer Institute Site will be arranged by the RSO / HSE Rep.
- 6.6.2 The RSO / HSE Rep. will arrange disposal of radioactive materials and, if necessary, advise on packaging requirements. The preferred method of disposal is by return to the original vendor.
- 6.6.3 A copy of shipping papers and radioactive material disposal records is to be maintained by the RSO / HSE Rep.
- 6.6.4 X-ray generating machines can be scrapped after they are altered so they cannot be reactivated. A letter describing the method and date of disposal must be sent to the RSO / HSE Rep.
- 6.6.5 If an X-ray machine is to be transferred to another unit or site, the RSO / HSE Rep. must be notified prior to transfer.
- 6.6.6 Radioactive materials will only be disposed of by transfer to a person specifically licensed to receive the material in question. Return to the original vendor is the preferred method of disposal.

### 6.7 Personal Monitoring

- 6.7.1 That Institute has no high radiation areas. In addition, radioactive sources used for gauging and analytical work are situated such that the potential for exceeding dose limitations is extremely remote. All radiation exposures will always be kept As Low As Reasonably Achievable (ALARA). Experience has shown that use of process nuclear gauges does not produce radiation exposure significantly greater than background to personnel working around them; therefore, personnel monitoring is not required. Procedures given in Appendix A: "Process Gauge Radiation Survey Form" will be used to assure that no one in the general public will receive more than 1.0 mSv (100 mrem) per year from the use of these sources.
- 6.7.2 Restricted areas established for the purpose of conducting radiographic weld testing are monitored by the RSO / HSE Rep. and/or the radiographer to ensure that no one enters them while high radiation levels are present. Therefore, personnel monitoring equipment is not used routinely in the Bayer Institute Site (except by radiographers and their assistants). The following dosimetry devices may be used:
  - 6.7.2.1 Film Badges, TLDs, or other similar approved devices for measuring and recording the integrated dose received by an individual.
  - 6.7.2.2 Pocket Dosimeters (self-reading)
  - 6.7.2.3 Alarming Rate Meters

### 6.8 Radiation Signage

- 6.8.1 Proper signs cannot be determined until the external radiation fields are measured.
- 6.8.2 A "Caution Radiation Area" sign is posted when any accessible area around your storage unit is equal to or greater than 5 mR/hr at 12" from the surface. Most storage areas and gauges do not reach such values. Usually most licensees post a "Caution Radioactive Materials" sign which indicate there is a small radiation field present but not at or greater than 5 mR/hr. If you take a measurement of the radiation field and it is greater than 2 mR/hr

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at 12" (this is the general public limit for unrestricted access) than you must restrict the area. The "Caution Radioactive Materials" sign is adequate in this instance.

- 6.8.3 If the source is below the 2 mR/hr at 12" than no sign is warranted by the NRC, however the site will still post the "Caution Radioactive Materials" sign to keep exposures As Low As Reasonably Achievable (ALARA).


## 6.9 Emergency Procedures

- 6.9.1 Any site incident that may result in damage or loss of radioactive material will be handled under the following emergency procedures:

- 6.9.1.1 The potential for significant exposure from most process nuclear gauges is very slight under the worst likely scenario. When dealing with an emergency which might involve a process nuclear gauge, the first concern is to take steps necessary to bring the situation under control. When the situation is under control, then steps must be taken to assess the damage to the radioactive material in the process nuclear gauge. Radiography sources are much larger and do represent a substantial risk under emergency situations. Personnel working in the vicinity of a radiography source exposed to fire, explosion, or other incidents that might result in the loss of radioactive material from the source holder will be evacuated at least 100 feet from the damaged source
- 6.9.1.2 The RSO / HSE Rep. must be informed immediately of the incident involving the radioactive material.
- 6.9.1.3 The RSO / HSE Rep. will assess the situation immediately and obtain needed assistance in dealing with the situation.
- 6.9.1.4 Other than responding to specific instructions received from the individual user (i.e., contract radiographer) or RSO, the only action that should be taken by Site personnel is to restrict the area containing the damaged radioactive source with rope and warning signs and to deny access to personnel. The restricted area should extend a minimum of 50 feet in all directions from the source for emergency personnel and 100 feet for non-essential personnel
- 6.9.1.5 The RSO / HSE Rep. will perform tests, measurements and hazard evaluations to ensure the safety of personnel. Any firefighting, damage control, or rescue efforts requiring entry into the restricted area must be coordinated through the above-mentioned personnel.
- 6.9.1.6 After the emergency is over, the RSO will determine by calculation or measurement, the potential radiation exposure of all involved personnel.

## 6.10 Notification of Incidents

- 6.10.1 Immediate Notification: Immediate notification will be made to the NRC Operations Center and the Administrator of the appropriate USNRC Regional Office of any incident involving equipment containing sealed source nuclear material which may have caused or threatens to cause:
- 6.10.1.1 Exposure of the whole body of any individual to 25 rem or more of radiation; exposure of the skin of the whole body of any individual to 150 rem or more of radiation or exposure of the feet, ankles, hands, or forearms of any individual to 375 rem or more of radiation.
- 6.10.1.2 The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits.
- 6.10.1.3 A loss of one working week or more of the operation of any facilities affected.
- 6.10.1.4 Damage to property in excess of \$200,000.
- 6.10.2 Twenty-Four Hour Notification: Within 24 hours notification will be made to the NRC Operations Center and the Administrator of the Appropriate NRC Regional Office of any incident involving licensed material which may have caused or threatens to cause:
- 6.10.2.1 Exposure of the whole body of any individual to 5 rem or more of radiation; exposure of the skin of the whole body of any individual to 30 rem or more of radiation; or exposure of the feet, ankles, hands, or forearms to 75 rem or more of radiation.
- 6.10.2.2 The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits.
- 6.10.2.3 A loss of one day or more of the operation of any facilities affected.

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6.10.2.4 Damage to property in excess of \$2,000

#### 6.10.3 Reports of Over Exposures and Excessive Levels and Concentration

6.10.3.1 In addition to any notification required, a report will be made in writing within 30 days to the NRC Document Control Desk with a copy to the appropriate NRC Regional Office of:

6.10.3.1.1 Each exposure of an individual to radiation in excess of the applicable limits.

6.10.3.1.2 Each exposure of an individual to radioactive material in excess of the applicable limits.

6.10.3.1.3 Levels of radiation or concentrations of radioactive material in a restricted area in excess of any other applicable limit in the license.

6.10.3.1.4 Any incident for which immediate or 24-hour notification is required.

6.10.3.2 Each report required under 6.8.3.1 of this section will describe the extent of exposure of persons to radiation or to radioactive material, including estimates of each individual's exposure as required by 6.8.3.3 of this section; levels of radiation and concentrations of radioactive material involved; the cause of the exposure levels or concentrations; and corrective steps taken or planned to prevent recurrence.

6.10.3.3 Any report filed with the Commission pursuant to this section must include for each individual exposed the name, social security number and date of birth, an estimate of the individual's exposure. The report will be prepared so that this information is stated in a separate part of the report.


## 7.0 Key Process Records

Record Generated	File Location	Required Retention Time	Disposition
Training Records	Learning Management System	3 years	Delete
Inventory checks, including source type and size, date received, manufacturer model number, and serial number	Radiation folder on network S:\HSEQ\Health Safety\Radiation	3 years	Delete
Leak tests (or wipe survey)	Radiation folder on network S:\HSEQ\Health Safety\Radiation	30 years	Delete
Shutter checks	SAP	5 years	Delete
Radiation Survey Results	Radiation folder on network S:\HSEQ\Health Safety\Radiation	30 years	Delete
Industrial Radiography Form	Radiation folder on network S:\HSEQ\Health Safety\Radiation	30 years	Delete
Site Rad License and SSDRs / Disposal/Source Transfer Records	Radiation folder on network S:\HSEQ\Health Safety\Radiation	While license is in force	Delete
General Audits and Radiation Program Annual Audits	Radiation folder on network S:\HSEQ\Health Safety\Radiation	3 years	Delete
Radiation Survey Instrument Calibration Records	Radiation folder on network S:\HSEQ\Health Safety\Radiation	3 years	Delete

## 8.0 Personnel Training Requirements

Role	Level of Required Training	Frequency
RSO	Radiation Safety Officer	Initial and on procedure change
HSE Representative	Authorized User / Operating Gauges	Initial and on procedure change
I / Es	Authorized User / Operating Gauges	Initial and on procedure change

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## 9.0 Appendices

- 9.1 Appendix A: Process Gauge Radiation Survey Form
- 9.2 Appendix B: Industrial Radiography Documentation
- 9.3 Appendix C: Radiation Program Annual Audit Checklist
- 9.4 Appendix D: Sealed Source Lockout Procedure
- 9.5 Appendix E: Emergency Procedures for Damage to, Theft or Loss
- 9.6 Appendix F: Qualified Persons
- 9.7 Appendix G: Removal of a Sourceholder Procedure

## 10.0 Revision History


Effective Date	Revised by	Revisions Made
06/27/2007	Cindi Lester	Modified format to IDMS standard format. Updated staff titles. Removed requirement for HSE Department to accompany intraplant transport of radioactive materials subject to the site's USNRC license. Removed requirement to provide a Class "B" Safe Work Permit prior to transporting radioactive materials. In Appendix B, changed Building 303 to Building 2.
08/11/2009	Ed Gazdik	Change or clarified role requirements, training requirements, routine maintenance. Expanded key process records section. Added signage requirements and shutter check section. Refined radiation survey form, omitted 0 inch assessment. Revised record retention times to match license. Amended site radiation license for permission to remove and relocate sources. Added Appendix G, Removal of a Sourceholder Procedure.
12/13/2010	Cindi Lester/John Owen	Periodic review completed with wording changes to align the procedure with the appropriate standards. <ul style="list-style-type: none"> <li>4.2 Radiation Safety Officer responsibilities expanded to include words from the standard. No actual new responsibilities result. This is just an expansion of the explanation.</li> <li>6.1 step 2 was expanded, "Damaged packages must be monitored for radioactive contamination and radiation levels."</li> <li>Updated Appendix F</li> </ul>
06/26/2013	John Owen	Reviewed procedure. Updated titles to agree with the new organizational design. Aligned the procedure with existing site practices.
02/27/2015	John Owen	Added column "Disposition" to Section 7.0 and added Section 11.0 Distribution
08/31/2015	John Owen	Removed Dow Intranet from Section 11 due to the change of control for the site. Updated record retentions based on Doug Nye input.
12/11/2015	Doug Nye	Changed first paragraph of Appendix G to read: Removal of the source holder and repairs are to be made by the manufacturer or their authorized agent. The RSO or RSO alternate must verify that proper procedures are being followed during removal of the source holder or during repairs. Removed Section D of appendix G

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Effective Date	Revised by	Revisions Made
10/28/2016	John Owen	Reviewed and corrected titles (i.e., BCS and CropScience are no longer valid). Updated Appendix F to indicate that Joe Murphy is now the RSO and Linda Tennant is the backup RSO. There are no changes in any of the requirements or tasks associated with this procedure. The review is prompted by the retirement of the former RSO, Doug Nye.

#### 11.0 Distribution

Copy	Location
Master Copy	IDMS, Level 2, Section 5.4

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### APPENDIX A

### PROCESS GAUGE RADIATION SURVEY FORM

SOURCE INFORMATION		SERIAL NUMBER	SURVEY DATE
ISOTOPE	ACTIVITY (MCI)	TYPE HOLDER	SURVEY FREQUENCY
PLANT	BUILDING/UNIT	ROOM/VESSEL	PERSON RESPONSIBLE
SWP	SHUTTER OPERATION CHECKED	SIGNS	MOUNTING BOLTS CHECKED

### SURVEY INFORMATION

TYPE METER USED		SERIAL NO.	LAST CALIBRATION
SOURCE POSITION ON OFF		WIPE TEST	SURVEYED BY

METER READINGS		SKETCH
LOCATION	MREM/HR	
12" - TOP		
12" - BOTTOM		
12" - RIGHT		
12" - LEFT		
12" - NEAR*		
12" - DETECT.		

\*The NEAR side is defined as the side of the radiation source away from the vessel.

Is there an area where personnel regularly perform tasks within 12 ft. of this source?	Yes	No
What is the highest radiation field at the elevation of a person's torso at the above location?	mrem/hr	
What fraction of a day will a person be present at the above location (occupation factor)?		
Is the product of the Occupation Factor and the dose rate more than 0.05?	Yes	No
If the answer to the above question is yes, then this radiation source installation needs to be evaluated for further shielding.		
Remarks:		
Radiation Safety Officer:		





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## **APPENDIX B**

Bayer Institute Plant

**Return To:**  
HSE Rep., Bldg 2

## **INDUSTRIAL RADIOGRAPHY DOCUMENTATION**

NRC License Number: \_\_\_\_\_ Date: \_\_\_\_\_ Time In: \_\_\_\_\_ Time Out: \_\_\_\_\_

Contract Firm Name: \_\_\_\_\_  
Address: \_\_\_\_\_

Projector Mfg.: \_\_\_\_\_ Model No.: \_\_\_\_\_ Serial No.: \_\_\_\_\_  
Source Mfg.: \_\_\_\_\_ Model No.: \_\_\_\_\_ Serial No.: \_\_\_\_\_  
Source Material: \_\_\_\_\_ Current Strength: \_\_\_\_\_ ci

Name of Radiographers: \_\_\_\_\_  
No. of Exposures: \_\_\_\_\_ Exposure Duration: \_\_\_\_\_

### **Please Check YES or NO for the following:**

- | YES   | NO    |   |
|-------|-------|---|
| _____ | _____ | 1. Do you have in your possession a registration specific license?  |
| _____ | _____ | 2. Do you have in your possession an Operating and Emergency Procedure?   |
| _____ | _____ | 3. Does your vehicle need a Yellow II or III Placard?   |
| _____ | _____ | 4. For each source do you keep record of places and times of radiographic activities?   |
| _____ | _____ | 5. Do radiographic exposure devices measure less than 50 millirem per hour at six (6) inches away from any exterior surface of the device?  |
| _____ | _____ | 6. Is the radiographic exposure device provided with a lock and outer locked container to prevent unauthorized or accidental removal?   |
| _____ | _____ | 7. Are locked radiographic exposure devices and storage containers physically secured to prevent tampering or removal by unauthorized personnel?  |
| _____ | _____ | 8. Are the following items concerning survey instruments adhered to:<br>(a) Calibrated and operable radiation survey instruments are available.<br>(b) Survey instruments are calibrated at intervals not exceeding three (3) months.<br>(c) The instrument has range from two millirems/hr. to 1,000 millirems/hr. |
| _____ | _____ | 9. Are pocket dosimeters, alarm rate meters and film badges or thermoluminescent dosimeters (TLDs) worn by all personnel acting as radiographers or radiographers' assistants?  |
| _____ | _____ | 10. During radiographic operations, is direct surveillance of the area maintained to protect against unauthorized entry?  |
| _____ | _____ | 11. Is the area properly posted with radiation area or high radiation area signs?   |
| _____ | _____ | 12. Is a physical radiation survey made after each radiographic exposure to determine whether the sealed source actually has been returned to its shielded position?  |
| _____ | _____ | 13. Is a physical radiation survey and record made to determine whether the source is in the shielded position prior to securing the device and storage container?  |


**IMPORTANT:** After performing the radiography, this form must be completed (all sections) and returned to the Radiation Safety Officer or left at the Main Gate Guard House before departing the Plant.

**I HEREBY DECLARE UNDER PENALTY OF LAW THAT THE ABOVE STATEMENTS ARE TRUE TO MY KNOWLEDGE AND I HAVE MADE CERTAIN THAT THE RADIOACTIVE SOURCE IS CLOSED (SHIELDED POSITION) AND PROPERLY SECURED IN OUR VEHICLE PRIOR TO DEPARTING THE INSTITUTE PLANT.**

Signature of Radiographer Preparing Form

Signature of RPO/Designee

*This is an electronic document. Any printed copy other than the signed original is uncontrolled and is not the official copy.*

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# APPENDIX B (cont'd)

Bayer Institute Plant

## INDUSTRIAL RADIOGRAPHY - SUPPLEMENTAL INFORMATION

Plant Location/Job: \_\_\_\_\_

Plant Contact (Name and Title): \_\_\_\_\_

Was beam collimated? \_\_\_\_\_ Was shielding used? \_\_\_\_\_

Describe beam direction: \_\_\_\_\_

Describe shielding: \_\_\_\_\_

Were barrier ropes and warning signs used? \_\_\_\_\_

Did anyone, excluding the radiographer(s), enter restricted area during exposure?

\_\_\_\_\_


If "Yes", who was it and why? \_\_\_\_\_

Miscellaneous Information: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Sketch area and show perimeter measurement results:

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**APPENDIX C**  
**Radiation Program Annual Audit Checklist**

**Suggested Fixed Gauge Audit Checklist**

Licensee's name \_\_\_\_\_ License No. \_\_\_\_\_  
Auditor \_\_\_\_\_ Date \_\_\_\_\_

**Audit History**

- A. Were previous audits conducted within 12 months of this current audit?
- B. Were the deficiencies identified, if any, addressed?

**Organization and Scope of Program**

- A. Was the site license amended if:
  1. The mailing address or places of use changed?
  2. If the RSO was changed
- B. Was the NRC notified if:
  1. Ownership changed?
  2. The designated contact person for NRC changed?
- C. Sealed Sources and Devices
  1. Does the license authorize the radionuclides contained in the gauges and the specific uses for the gauges?
  2. Are the gauges as described in the Sealed Source and Device (SSD) Registration Certificate?
  3. Are copies of (or access to) SSD Certificates available?
  4. Have manufacturers' or distributors manuals for operation and maintenance?

**Training and Instructions to Workers**

- A. Were all workers who are likely to exceed 1 mSv (100 mrem) in a year trained/refresher training provided? Records available?
- B. Did I/Es receive training before using/operating gauges? Records available?
- C. Do the I/Es know the site emergency procedures?
- D. Were any I/Es observed operating the gauges?
- E. Has the Emergency Response Team received appropriate training?

**Radiation Survey Instruments**


- A. Are the site survey meters calibrated and operating properly?
- B. Are calibration records available?

**Gauge Inventory**

- A. Is a record kept showing the receipt of each gauge?
- B. Are all gauges physically inventoried every six months?
- C. Are records of inventory results with appropriate information maintained?

**Personnel Radiation Protection**

- A. Are ALARA considerations incorporated into the radiation protection program?
- B. Were prospective evaluations performed showing that unmonitored individuals receive 10% of limit?
- C. Did unmonitored individuals' activities change during the year which could put them over 10% of limit? If so, was a new evaluation performed?
- D. Was any dosimetry performed within the past 12 months?
  1. Is the dosimetry supplier NVLAP approved?

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2. Are dosimetry reports reviewed by the RSO when they are received?
3. Are the records NRC Forms or equivalent?
  - a. NRC-Form 4 "Cumulative Occupational Exposure History" completed?
  - b. NRC-Form 5 "Occupational Exposure Record for a Monitoring Period" completed?
4. Did any worker declare her pregnancy, and if so, were records kept of embryo/fetus dose?
- E. Are records of exposures, surveys, monitoring, and evaluations available?

#### Public Dose

- A. Is public access to gauges controlled in a manner to keep doses below 1 mSv (100 mrem) in a year?
- B. Has a survey or evaluation been performed? Have there been any additions or changes to the storage, security, or use of surrounding areas that would necessitate a new survey or evaluation?
- C. Is gauge access controlled in a manner that would prevent unauthorized use or removal?

#### Operating and Emergency Procedures

- A. Have operating and emergency procedures been developed?
- B. Do employees have access to operating and emergency procedures (including lockout procedures and emergency telephone numbers)?
- C. Is a lock-out warning sign posted at each entryway to an area where it is possible to be exposed to the beam?
- D. Did any emergencies occur?
  1. Were corrective actions completed?
  2. Was NRC notification or reporting required?

#### Leak Tests

- A. Was each sealed source leak tested at the prescribed interval?
- B. Are records of results available?
- C. Were any sources found leaking and if yes, was NRC notified?

#### Maintenance of Gauges

- A. Are manufacturer's or distributors procedures followed for routine cleaning and lubrication of gauge?
- B. Was each shutter tested for proper operation every 6 months or at other prescribed intervals?
- C. Are repair and maintenance of components related to the radiological safety of the gauge performed by the manufacturer or person specifically authorized by the NRC or an Agreement State?
- D. Are labels, signs, and postings identifying gauges containing radioactive material, radiation areas, and lock-out procedures/warnings clean and legible?

#### Notification and Reports

- A. Did any reportable incidents occur? Were reports made?
- B. Were corrective actions completed?
- C. Is the management/RSO aware of telephone number for the NRC Emergency Operations Center? [(301) 816-5100]

#### Posting and Labeling


- A. NRC-Form 3 "Notice to Workers" posted?
- B. NRC regulations, license documents posted or a notice posted?

#### Record Keeping for Decommissioning

Records kept of information important to decommissioning?

#### Bulletins and Information Notices

- A. NRC Bulletins, NRC Information Notices, NMSS Newsletters, received?
- B. Appropriate training and action taken in response?

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**APPENDIX D**  
**Sealed Source Lockout Procedure**  
**(Includes Unlock Procedure)**

The procedure to be followed for a source lockout whether for a vessel entry permit or simply because a vessel will be opened is as follows:


**LOCKOUT PROCEDURE**

1. Call one of the following "lock-out only" personnel: (Appendix F)
2. The qualified person checks in with operations and obtains required permits, PPE, tools and documentation.
3. The qualified person locates all nuclear sources on equipment.
4. The qualified person verifies functioning of his/her survey meter by checking the calibration sticker, performing a battery check, and by using the check source mounted on the side.
5. After noting the "open shutter" meter reading and then closing the shutter the qualified person installs a RSO approved ganglock or padlock and PCS tag.
6. The qualified person verifies with the survey meter that closing the shutter has actually blocked the beam. Survey meter readings should drop to < 1/10 of the open shutter reading (< 5.0 mR/hr. in front of the source or 0.02 - 0.2 mR/hr., essentially background radiation levels at the detector). Indicate before (open shutter) and after (closed shutter) survey meter readings and location where measurements were taken on the lockout tag. The readings should preferably be taken at the detector.
7. The qualified person approves the area for work after which other tags may be installed on the ganglock and other vessel entry requirements may be completed as necessary along with opening the vessel only after the source is locked out.

**UNLOCK PROCEDURE**

The procedure to be followed to unlock a source is as follows:

1. Complete vessel entry including closing the vessel and remove all Operations, Maintenance and Contractor locks and tags.
2. Call one of the nuclear qualified personnel.
3. The qualified person checks in with operations and obtains required permits, PPE, tools and documentation.
4. The qualified person removes his/her tag, padlock and ganglock, opens the shutter, and verifies the equipment is back in working order.

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**APPENDIX E**  
**Emergency Procedures for Damage to, Theft or Loss of 137Cs Source Housings**  
(Including Determination of Rope Off Distance)

1. If damage (visually evident, whether still mounted or not) has occurred to a 137Cs source housing used for certain level and density measurements (see site survey attached) immediately evacuate all personnel to a distance of at least 100 feet in all directions and rope off the area with red tape to those dimensions until a more accurate determination can be made
2. Immediately notify - RSO, D. Nye - Alternate RSO, or HSE Rep.
3. If one of the "Qualified Individuals" is available a more accurate determination of the rope off distance may be made by using the known quantity of source material involved (see site survey attached) and using the calculation as follows to ensure a safe area accessible to personnel of less than two mR/hr and verify with a survey meter.

Given:

D = dose rate in mr/hr. imposed at 2 mr/hr.

mCi = millicurie value of source from site survey

d = distance to source in feet

K = constant, 0.505 for Cesium 137


$$\frac{K \cdot mCi}{D} \cdot 1000 = d$$

4. One of the "Qualified Individuals" will make a determination whether
  - a. damage, theft, or loss has indeed occurred;
  - b. if the source shutter can be safely closed (if open);
  - c. what is to be done with the source in question?;
  - d. what reporting to the NRC, if any, needs to be done?;
  - D1. immediate (within four hours) to the NRC Operations Center (301) 816-5100 for incidents where exposure cannot be prevented due to fire, explosion, etc.
  - D2. twenty-four hour to the NRC Operations Center (301) 816-5100 for any other incidents.
  - D3. follow-up written report within 30 days to:

U.S. Nuclear Regulatory Commission  
Document Control Desk  
Washington, DC 20555


and

U.S. Nuclear Regulatory Commission  
Region I  
475 Allendale Road  
King of Prussia, PA 19406

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**APPENDIX F**  
**Qualified Persons**

- Joe Murphy – RSO x 6717
- Linda Tennant – Backup RSO x 6161

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## APPENDIX G

### Removal of a Sourceholder Procedure

Removal of the source holder and repairs are to made by the manufacturer or their authorized agent. The RSO or RSO alternate must verify that proper procedures are being followed during removal of the source holder or during repairs.

#### Safe Handling Procedure

- A. Physical Exam of Unit
  - a. Integrity of external surface. External surface is smooth and has not been damaged
    - 1) Corroded and rusted units which have been in service under extreme environmental conditions may require special removal and shipping/handling procedures
  - b. Shutter mechanism OFF and locked. Shutter must be closed and locked in the OFF position (see lockout procedure, Appendix D)
- B. Radiation Survey
  - a. Ensure survey meter is calibrated and operable
  - b. Survey unit omni-directionally at 1 foot before starting removal
    - 1) Radiation field should be comparable to installation survey or less than 5 mrem/hr at 1 foot omni-directionally
- C. Leak Test
  - a. Perform leak test if unit is being prepared for shipment
  - b. See leak test instructions in site procedure