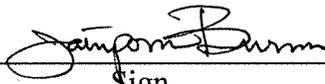
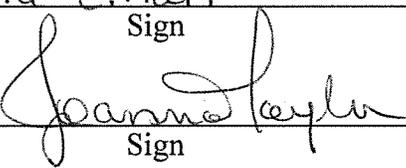


Center for Advanced Energy Studies
 Radiation Safety Procedure and Equipment and Method Stand
 Operating Procedures

	RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION	Identifier: RSP-20151202	Page 1 of 12
		Revision:	
		Date: 12-2-2015	

Radiation Safety Procedure " X-ray Diffraction"			
ACTIVITY LOCATION BY LAB ROOM NUMBER AML: 116			
Equipment Lead/Technique Lead, Laboratory Lead, and CAES Safety Officer Approvals			
	Print	Sign	
Equipment /Technique Lead:	Jatuporn Burns		Date: 1-30-16
	Print	Sign	
Laboratory Lead:	Darryl Butt	Via email	Date: 1-12-16
	Print	Sign	
Responsible User: ISU Rad Program# 128	Joanna Taylor		Date: 1-29-16
	Print	Sign	
CAES Safety Officer:	Kristi Moser-McIntire		Date: 2-2-16
MAJOR EQUIPMENT USED IN ACTIVITY			
Rigaku XRD Smartlabs			

Center for Advanced Energy Studies
 Radiation Safety Procedure and Equipment and Method Stand
 Operating Procedures

 RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION	Identifier: RSP-20151202	Page 2 of 12
	Revision: Date: 12-2-2015	

Training Requirements: *(All CAES general and Lab Specific trainings are required; this is to list additional training requirements.)*

- ISU Radiation Introduction Training (TAMS, under MaCS)
- MaCS General Rad Practice (RSP-002) (TAMS, under MaCS)
- AML Lab Orientation (Given by Co-Lab Lead)
- MaCS Rad Worker Training (TAMS, under MaCS)
- XRD Training (TAMS, under Advanced Materials Lab)
- XRD Hands On Training by Instrument Lead

Radiological Work Scope: To conduct a nondestructive analysis on solid radiological samples (Du, LEU, and irradiated metals) using the X-ray Diffraction (XRD) and the radiological protocols that must be followed when working with radiological materials in the XRD.

Operating Envelope:

Estimated Dose (person-mrem) anticipated for work activity: <100 mrem/year

	Radiation Levels at 30 cm	Dispersible Activities (ALI)
Unrestricted (need RSO approval)	< 20 mR/hr	< 0.1
Permission of Lab Lead and RSO	20-70 mR/hr	0.1-1.0
Reviewed by and/or Permission of Associate Directors and RSO	>70 mR/hr	>1.0
All samples must be below the requirements for two locked barriers (therefore, the sources must be below 100 times the 10 CFR 20 Appendix C activity limit anything above these limits must be secured behind two barriers and cannot be loaded into the XRD).		

Center for Advanced Energy Studies
Radiation Safety Procedure and Equipment and Method Stand
Operating Procedures

 <p>RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION</p>	Identifier: RSP-20151202 Revision: Date: 12-2-2015 Page 3 of 12
--	--

CAES Radiological Area Limits:

- **Restricted Area-** dose rate is > 2 mR/hr or if an area contains > 0.02 ALI (annual limit on intake) of dispersible radioactive material.
- **Radiation Area-** dose rate exceeding 5 mR/hr at 30 cm from source.
- **High Radiation Area-** dose rate exceeding 100 mR/hr at 30 cm from source.

Radiological Conditions:

- General area (mR/hr) beta/gamma: **< 2 mR/hr in a non-restricted area** (CAES gallery, non rad area in Advanced Materials Lab) and **< 5 mR/hr at 30 cm in radiation area.**
- General area (mR/hr) neutron: NA
- Contact (mR/hr) beta/gamma: Variable as a function of the source used.
- At 30 cm (mR/hr) beta/gamma: < 70 mR/hr
- Contamination (dpm/100 cm² beta/gamma): **< 70 dpm/100cm²**; if greater than 70 dpm/100cm² stop work, leave equipment in a safe status, contact CAES Safety Officer (CSO) and lab lead immediately, decontaminate, and re-survey
- Contamination (dpm/ 100 cm² alpha): **< 7 dpm/100cm²**; if greater than 7 dpm/100cm² stop work, leaving equipment in a safe status, contact the CSO immediately and laboratory lead decontaminate, and re-survey
- Contamination: Any radioactive contamination detected which demonstrates a quantity of radioactive material present that is greater than Lc ($2.33 \cdot \sqrt{\text{background}}$), will be brought to the attention of the CSO, Lab Lead, or alternate designee. The operational goal in accordance with good practice and ALARA is to not tolerate detectable removable contamination at any ISU facility.
- Airborne activity ($\mu\text{Ci/mL}$): N/A
- Derived airborne concentration (DAC): N/A
- Other: None

Contamination Protocol: (Describe who, when, what and how contamination is prevented and surveyed)

Center for Advanced Energy Studies
Radiation Safety Procedure and Equipment and Method Stand
Operating Procedures

 CAES Center for Advanced Energy Studies	RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION	Identifier: RSP-20151202	
		Revision:	
		Date: 12-2-2015	Page 4 of 12

Under the direction of the Responsible User and/or the CAES Safety Officer, contamination surveys will be performed periodically and after any operations that involve dispersible radioactive materials. Removable contamination surveys will be performed by the researchers or the equipment operators engaged in the project. A great deal of focus shall be given to the containment of dispersible radioactive materials and the prevention of radioactively contaminating capital equipment. Our goal is to maintain a radiological pristine environment. The appropriate use of absorbent disposable laboratory mats, fume hoods, and glove boxes is encouraged whenever feasible. Dispersible sources shall be stored in sealable containers. Surveys of personnel (frisking) shall be conducted frequently especially when removing PPE or after handling dispersible sources of radioactive material. Frequent personnel surveys will prevent the unintended spread of radioactive contamination.

Dosimetry Requirements:

Whole body beta/gamma dosimeter must be worn next to your body. Do not attach your dosimeter onto lanyard. It **must** be worn between your neck and waste and attached to your shirt.

Ring dosimetry must be worn with film side facing the palm of your hand.

Dosimetry Type: Whole body beta/gamma dosimeter Whole body neutron dosimeter

Multi-pack type:

Electronic dosimeter (ED) Extremity dosimetry (optional at discretion of performer)

Lab Lead/CAES Safety Officer Continuous End of work At job start Periodic

Coverage:

Responsible User (RU), CSO and/or the designee will provide coverage during the movement of any radiological material into and out of the XRD and conduct contamination surveys immediately following loading and unloading of rad samples.

PPE Requirements:

Lab Coat, Close-toed shoes, Safety Glasses, Ring Dosimetry, TLD, Two pairs of gloves (cloth gloves optional) of nitrile gloves.

When moving or working directly with the radiological material two pairs of gloves are required. The

 <p>RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION</p>	Identifier: RSP-20151202 Revision: Date: 12-2-2015 Page 5 of 12
--	--

inner nitrile gloves must be taped to your lab coat (remain clean at all times) and then 2nd pair of nitrile gloves worn over the first pair of nitrile gloves. Outer nitrile gloves should be changed often.

Contamination Control:

Always change-out and dispose of nitrile gloves in the rad waste container following the handling of potentially contaminated sources. Do not wear gloves or lab coat outside of any of the rad area. Perform personnel surveys promptly after removing PPE.

Survey Requirements:

- Follow ISU personnel survey requirements for entering and leaving all posted areas
- Use established ISU procedures for conducting contamination surveys
- Survey tools used to handle samples after each use.
- Perform detailed surveys of analysis equipment following the removal of each source.
- Detailed surveys will consist of a combination of removable contamination surveys and direct scans as appropriate to verify potentially affected areas are not contaminated.
- Promptly report any incidence of radioactive contamination to the RU, CSO, and laboratory lead.

Evaluation Points:

- Instruments must be surveyed for contamination before and after the analysis of each set of sample.
- Personnel contamination surveys (frisking) are to be performed before and after PPE is removed and before entering the PCM.

Limiting Conditions That Void the RCA:

- Removable contamination > 70 dpm/100 cm² beta/gamma or 7 dpm/100 cm² alpha is measured after initial attempts to remove contamination from contamination area or equipment
- Radiation levels > 2mR/hr in a non-restricted area (CAES gallery and in the non-rad area of Advanced Materials Lab).
- Personnel frisk identifies contamination at any time.

Center for Advanced Energy Studies
Radiation Safety Procedure and Equipment and Method Stand
Operating Procedures

 CAES Center for Advanced Energy Studies	RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION	Identifier: RSP-20151202	Page 6 of 12
		Revision: Date: 12-2-2015	

If any of these conditions are met, Stop Work, place job in safe condition, cease use of this RSP as written and notify the Lab Lead, CSO, and RU.

Best Practices:

- Follow good ALARA Practices when handling radiological sources.
- Minimize time in which radioactive sources are exposed.
- Use tongs and similar long-handled tools to handle samples and increase distance to source.
- Set up portable shielding as appropriate to minimize field during sample manipulation and loading. Consult with the CSO about additional shielding if any particular source produces an exposure rate of greater than 5 mRem in any one hour in the general work area. When shielding is being employed always evaluate and question the suitability of structure supports to avoid crushing injuries or damage to capital equipment.
- Perform frequent surveys of work areas. Remember: You are ultimately responsible for your own safety and that of your coworkers. Always maintain a questioning attitude.

Note: All XRD workers are required to survey their hands each time they open and place their hands in the XRD. This is for both non-rad and rad samples.

1. Notification and Sign Requirements

- a. Notify personnel in the Advanced Materials Lab that a rad sample will be moved from MaCS to Advanced Materials Lab and placed in the XRD.
- b. Place the sign “Caution Radiological Samples” on the XRD. Include researchers name, sample name, date, time, dose measurements at the XRD, XRD computer, and at PCM.

2. Don PPE

- a. Personnel working with the radiological material.
 - i. Must wear safety glasses
 - ii. Don first pair of gloves
 - iii. Don lab coat
 1. Duct tape first pair of gloves to lab coat.
 - iv. Don dosimeter:
 1. Dosimeter should be placed on the outside of the lab coat. Whole body dosimeters are required for all personnel working in MaCS and the radiological area in the Advanced Materials Lab.
 - v. Don second or outer pair of gloves

 <p>RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION</p>	Identifier: RSP-20151202 Revision: Date: 12-2-2015 Page 7 of 12
--	--

Note: Whenever there is suspect contamination, change outer gloves and dispose of in rad waste container.

3. Prep all work areas and load samples into XRD

- a. Cover work area(s) and the inside/bottom of XRD with towels/Kimiwipes.
- b. Position tools needed for XRD sample prep in the tray located on the bench next to the XRD.
- c. Conduct all non-rad work before removing the radiological samples from the safe and transferring from MaCS to Advanced Materials Lab.
 - i. Check for removable contamination inside of the XRD
 1. Collect smears from
 - a. Stage (Figure 1)
 - b. Inside XRD Door
 - ii. Cover stage with aluminum foil
 - d. Remove radiological samples from the safe.
 - e. Insure the sample rad readings are taken and compared to expected levels.
 - i. If they are not at expected value, put the samples back in the safe and immediately contact the CSO, Lad Lead, RU, or RSO.
 - f. Collect smear from the outside of the sample bag. When smear clears transfer sample to Advanced Materials Lab.
 - g. All radiological prep work is conduct on the radiological tray.
 - h. Using the tray move the samples to the XRD.
 - i. Have the non-rad person open the XRD door.
 - j. Load the samples into the XRD.
 - k. The non-rad person will close the XRD door.
 - l. Remove outside gloves and dispose of in rad waste container or direct survey hands.
 - m. Check for removable contamination on tools, sample holders, tray, lab bench, etc. by collecting smears.
 - i. Measure all smears (swipes) in the 3030 unless you are working with C-14 sample or other known low-energy beta emitter then measure them on the 3030 **and** on the liquid scintillation counter.
 - ii. Record data and calculate dpm data using the spreadsheet (Survey Sheet) on the desk top computer connected to the 3030.
 1. Record date, tasks, personnel, smear names, alpha and beta readings
 - n. Once the XRD door is closed, place a rad sticker on the XRD door. This indicates that a Rad sample is loaded in the XRD (as a visible warning).
 - o. Place the radiological dose information sign and the Caution Radiological sample outside the XRD.

 <p>RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION</p>	Identifier: RSP-20151202 Revision: Date: 12-2-2015 Page 8 of 12
--	--

- i. On the radiological dose information sign include:
 - 1. Sample Name, Date, Time, the name of the person taking the dose measurements.
 - 2. Measure Dose at
 - a. The outside of XRD
 - b. The XRD computer (location the researcher is sitting)
 - c. At PCM
- p. Record in the Lab notebook next to the 3030
 - i. Rad sample was moved from MaCS to AML.
 - ii. That a rad sample was loaded in the XRD.
 - iii. The researcher's name
 - iv. The name of the rad sample
 - v. The dose readings of the rad sample
 - vi. The smear results.

***NOTE:** Change outer pair of gloves and dispose of in rad waste container anytime you touch the sample or conduct a direct survey.*

***NOTE:** At anytime your gloved hands touch the sample/holder and then released to reach for equipment (tweezers, tools, etc) away from the rad area, change your outer pair of gloves and dispose of in rad waste container or conduct direct survey to minimize cross contamination possibilities. A good work practice for contamination control is to have an assistant hand you gloves and tools instead of reaching.*

4. Unload Rad Samples

- a. Notify personnel in the lab (refer to #1)
- b. Don (refer to #2)
- c. Collect your Rad tray for XRD.
- d. Have the non-rad person open the XRD.
- e. Remove the sample and place it on the rad tray.
- f. Move the tray to the lab bench and place the rad sample back in the sample container.
- g. Collect a smear from the outside the sample container.
 - i. When it smears clean transfer rad sample back to the MaCS safe.
- h. Collect smears from the XRD
 - i. Stage
 - ii. Inside XRD Door
 - iii. Tools, sample holders, tray, bench, etc.
- i. Record in the MaCS Log book (black book next to the 3030)

Center for Advanced Energy Studies
Radiation Safety Procedure and Equipment and Method Stand
Operating Procedures

 Center for Advanced Energy Studies	RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION	Identifier: RSP-20151202	Revision:
		Date: 12-2-2015	Page 9 of 12

- i. That a rad sample was moved out of the XRD and moved back to the safe in MaCS.
- ii. The name of the rad sample
- iii. The dose readings of the rad sample
- iv. The smear results.
- v. Dispose of aluminum foil that smeared clean in clean trash. If the aluminum foil on the XRD stage smears above the critical level then place in rad waste container and smear stage to ensure there is no contamination.
- vi. Direct survey stage to verify no fixed contamination.

Note: Contamination (dpm/100 cm² beta/gamma): < 70 dpm/100cm²; if greater than 70 dpm/100cm² stop work, contact the CSO and/or laboratory lead, decontaminate, and survey.

Contamination (dpm/ 100 cm² alpha): < 7 dpm/100cm²; if greater than 7 dpm/100cm² stop work leaving equipment in a safe status, contact the CSO and/or laboratory lead decontaminate, and re-survey.

All gloves, towels and other waste needs to be collected and placed on the carrying tray to carry to the Rad Waste Bin.

5. The XRD can be released as a non radiological instrument if all smears (surveys) are below the critical level. With the exception that every XRD user must survey their hands each time they open and place their hands in the XRD.
 - a. Release XRD
 - i. Remove Rad tape (dispose in rad trash)
 - ii. Remove rad sign

Center for Advanced Energy Studies
 Radiation Safety Procedure and Equipment and Method Stand
 Operating Procedures

 RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION	Identifier: RSP-20151202	Page 11 of 12
	Revision:	
	Date: 12-2-2015	

Qualifying Official: Indicate the basis for granting authorizing the Standard Operating Procedure by placing an "X" in one or more boxes as applicable.

Check-box 1 is for *mentoring (method/instrument usage that must be supported by Lab Lead or Instrument Lead and must be completed during CAES working hours (8:00 am to 5:00 pm))*.

Check-box 2 is for *demonstrated competency (non-mentored method/instrument usage by researchers during CAES normal working hours (8:00 am to 5:00 pm))*.

Check-box 3 is for *authorized off hour work (non-mentored method/instrument usage by researchers outside CAES normal working hours (8:00 am to 5:00 pm))*.

Only people whose names appear below may perform this activity.

Name of Qualified Personnel	#1	#2	#3	Signature of Qualifying Official	Date
1. Jatu Burns	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____	_____
2. _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
3. _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
4. _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
5. _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
6. _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
7. _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
8. _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
9. _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
10. _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____
Is re-qualification required?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	How often is requalification required? _____		

The Equipment/Method Lead and Laboratory Lead should ensure all hazards and potential hazards are considered and Operating Safety Procedure determinations are based on verifying that the selected Researcher(s) (1) have completed any required hazard specific training, (2)

 CAES Center for Advanced Energy Studies	RADIATION SAFETY PROCEDURE FOR X-RAY DIFFRACTION	Identifier: RSP-20151202	Page 12 of 12
		Revision: Date: 12-2-2015	

satisfied any special education, experience, or credentials that may be required to safely and effectively perform the activity and (3) are current on any qualifications/certifications required for the position/activity, if applicable. Researcher Controlled designation may also be granted by way of formal qualification provided that the qualification takes into account facility specific activities.

NOTE: Should the scope or complexity of the Researcher Controlled activity potentially result in risk(s) exceeding those encountered in a normal work environment then formal work planning should be done in accordance with CAES' standard for work control.

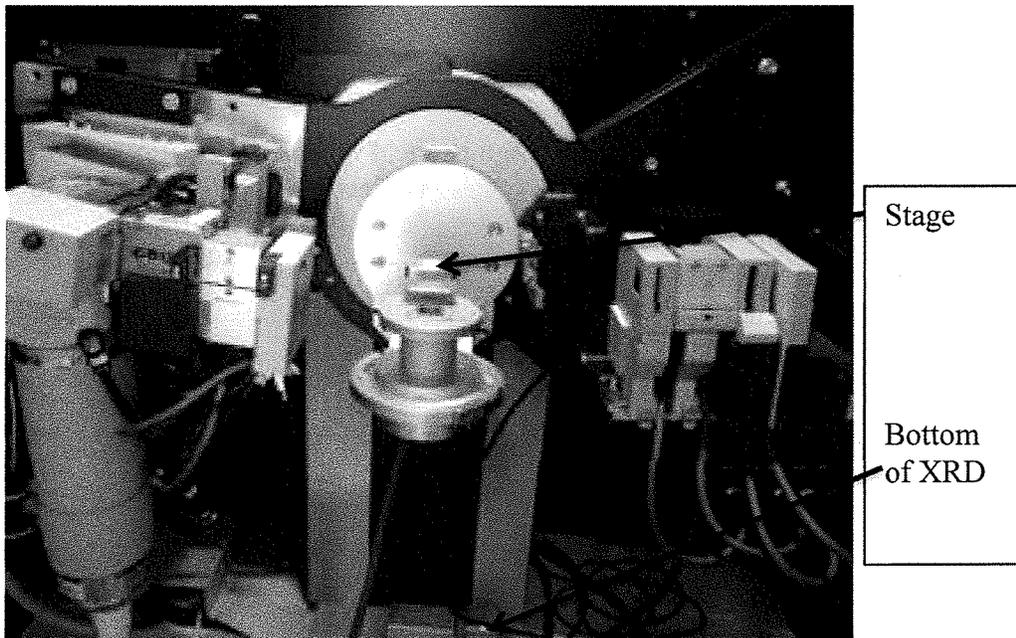


Figure 1. Inside of XRD.