Current Uranium Recovery Health Physics Topics

September 2017

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Purpose

- The purpose of this meeting is to discuss generic health physics topics that are common to more than one operating uranium recovery licensee.

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Introduction

- This is a Category 2 meeting under the Commission's policy statement on "Enhancing Public Participation in NRC Meetings" (67 FR 36920).

- The purpose of this type of meeting is for NRC to obtain feedback from the regulated community and other external stakeholders on issues that could potentially affect more than one licensee. NRC anticipates that the public would obtain factual information and provide the agency with feedback on the analysis of the issues, alternatives and/or decisions.

Introduction

Participant introductions

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Meeting Agenda

- Overview of Past HP meetings and workshops
- Today's HP topics
- Review action items
- Follow-up process
- Adjourn

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8-year History of NRC-UR Health Physics Meetings

- December 2009 (NRC ADAMS Accession No. ML093510816)
- January 2011 (https://www.nrc.gov/materials/uranium-recovery/public-meetings/ur-workshops/rburrows-nrc.pdf)
- April 2011 (ML111250213)
- December 2013 (ML14014A342)
- April 2014 (ML14112A309)
- September 2016 (ML16270A042)

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Today's topics

- As follow-up to the September 2016 meeting, NRC staff contacted licensees to develop the scope of today's topics.
- This slide presentation is intended to guide the dialogue.
- Please ask questions or provide comments.

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Today’s discussion topics

- Radiation surveys
- Meteorological data
- Effluent quantities
- Public dose calculations
- NRC/DOT transportation requirements

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Radiation surveys

- **Requirement:** For three types of operational surveys:
  1. area contamination surveys;
  2. personnel exit surveys; and
  3. equipment release for unrestricted use...

  licensees must survey beta-emitting radionuclides, in addition to alpha-emitting radionuclides.

- **Issue:** Measurement of total (fixed plus removable) beta-emitting radionuclides on surfaces can be difficult in areas with elevated gamma radiation.

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Radiation surveys

- NRC staff is not aware of a generic technical basis for measuring only alpha-emitters at UR facilities to infer the quantities of beta-emitters that may be present.

- For example, the ISR process separates radionuclides at various stages, which can disrupt radionuclide equilibrium
  - e.g., sand filters, IX columns, reverse osmosis, filter presses

- Therefore, licensees measure both alpha-emitters and beta-emitters to meet survey requirements.

Radiation surveys

- NRC has approved several ISR programs that address measurements of beta-emitters:
  - Nichols Ranch (ML14087A244)
  - Ross (ML15295A045)
  - Lost Creek (ML15279A572)

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Radiation surveys

- Lessons learned from NRC staff reviews: licensees should ensure surveys of beta-emitting radionuclides are sufficiently sensitive to quantify beta-emitting radionuclides.

- Specific license conditions request NRC staff verification or approval that instrument minimum detectable concentrations (MDCs) are below regulatory limits.

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Radiation surveys

- Items in restricted areas where gamma radiation levels are elevated may be moved to controlled areas to improve measurement sensitivity (i.e., lower the minimum detectable activity).

- Before moving potentially-contaminated items outside restricted areas, licensees should make a reasonable effort to eliminate residual contamination (Policy & Guidance Directive 83-23).

- 10 CFR 20.1802 requires control and constant surveillance of licensed material in controlled or unrestricted areas.

Radiation surveys

- As discussed in the September 2016 HP issues meeting with industry, NRC guidance addresses the problem of detecting beta-emitting radionuclides on surfaces where area gamma radiation levels are elevated:
  - NUREG-1757, Vol. 2, Rev. 1, Appendix O
  - Example in 2011 ORISE confirmatory survey at Humboldt Bay (ML11209B538)

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Radiation surveys

- NUREG-1757*, Vol. 2, Rev. 1, Appendix O

Describes use of beta shields on radiation detectors to assess surface contamination in areas with elevated gamma radiation.

*NUREG-1757, "Consolidated Decommissioning Guidance," Volume 2, "Characterization, Survey, and Determination of Radiological Criteria (Revision 1)

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Radiation surveys

$$Net\ Beta\ \left(\frac{dpm}{100\ cm^2}\right) = \frac{U - S - R_m}{\varepsilon_{Total} x\ G}$$

U= Unshielded measurement, cpm

S= Shielded measurement, cpm

R_m = Material-specific background measurement

[*optional: Assuming* R_m *=zero is conservative*]

$\varepsilon_{Total} = \varepsilon_i \ x\ \varepsilon_s$

G = geometry factor (area of detector)

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Radiation surveys

- R_m is the material-specific background
- $R_m = R_u - R_s$

  where

  R_u = *unshielded (gross) background count rate (gamma + beta)*

  R_s = *shielded background count rate (gamma only)*

  At locations for specific materials (concrete, metal) within unaffected areas

  ¼" plexiglass shield will reduce Pa-234m beta 100x

- *R_m is unlikely to be significant for most materials*
- *May be assumed R_m = zero*

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Radiation surveys

- Counting efficiency (ε_{Total}) should account for instrument efficiency (ε_i) and source efficiency (ε_s) (NUREG-1575*)

$$\varepsilon_{Total} = \varepsilon_i \times \varepsilon_s$$

where

ε_i is the 2π instrument efficiency

ε_s is the site-specific <u>or</u> ISO 7503-1** recommended source efficiency

**NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)"*

*** ISO 7503-1:1988, "Evaluation of surface contamination – Part 1: Beta-emitters (max. beta energy greater than 0.15 MeV) and alpha-emitters"*

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Radiation surveys

- ISO 7503-1-recommended source efficiencies:

ε_s = 0.25 for alpha particles and low-energy beta-emitters (i.e., $0.15 < E_{\beta max} < 0.4$ MeV)

ε_s = 0.5 for higher-energy beta-emitters (i.e., $E_{\beta max} > 0.4$ MeV)

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Radiation surveys

- Example:
  - *Surface contaminated with aged natural uranium only*
  - *Survey instrument calibrated with Th-230 and Sr-90 only*

Radionuclides	Emission Type	Max. Energy (MeV)	ε_i	ε_s	ε_T
U-238	Alpha	4.2	0.50	0.25	0.13
Th-234	Beta	0.193	0	0.25	0
Pa-234m	Beta	2.290	0.50	0.50	0.25
U-234	Alpha	4.8	0.50	0.25	0.13
U-235	Alpha	4.7	0.50	0.25	0.13
Th-231	Beta	0.391	0	0.25	0

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Radiation surveys

- Example:
  - *Calculated weighted total efficiency for beta-emitters*

Radionuclides	ε_T	W, Fraction	W x ε_T		
Th-234	0	0.489	0		
Pa-234m	0.25	0.489	0.12		
Th-231	0	0.022	0		
TOTAL			0.12		

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Radiation surveys

Example

$$Net\ Beta\left(\frac{dpm}{100\ cm^2}\right) = \frac{U - S - R_m}{\varepsilon_{Total} \times\ G}$$

U= 1,500 cpm $\beta\gamma$; S= 1,000 cpm $\beta\gamma$; R_m = 20 cpm $\beta\gamma$

$\varepsilon_{Total,\ weighted} = \varepsilon_i \times \varepsilon_s$ = 0.12 dpm/cpm

G = A / 100 cm^2, where probe area A = 100 cm^2

Net Beta = 4,000 dpm βγ per 100 cm^2

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Radiation surveys

Discussion

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Meteorological data

- **Requirement:** Under site-specific license conditions, some licensees must continue to collect on-site meteorological data until NRC verifies licensees have obtained representative data.

- **Issue:** NRC guidance in RG 3.63 does not provide detailed guidance on how to determine whether 12 months of on-site data is representative.

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Meteorological data

- NRC staff regulatory position:
  - The NRC staff has no guidance licensees can use to demonstrate that meteorological data from an off-site, remote weather station (e.g., >10 miles away) is *spatially representative* of on-site conditions.
  - So, a minimum of 12 months of on-site data ensures *spatial representativeness*
    - This information ensures (1) correct placement of environmental monitoring stations; and (2) correct assessment using MILDOS-AREA of individual likely to receive highest dose.

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Meteorological data

- Current NRC staff position:
  - Acceptable statistical methods for demonstrating *temporal representativeness* of on-site met. data are:
    - testing summary statistics, such as the mean from the short-term and long-term data (Chapter 5 of Brooks and Carruthers, 1953), and
    - testing similarity or validity of the data using Student’s T-test, χ^2 test for distribution, Kolmogorov-Smirnov test for distribution.

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Meteorological data

- Since 2014, NRC has approved or verified meteorological data as *spatially and temporally representative* at the following sites:
  - Ross (ML15197A102)
  - Reno Creek (ML16364A227)

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Meteorological data

- On-site record of 5 years, with 3 or more whole years of consecutive annual cycles, can be used instead of RG 3.63 Regulatory Position C.1.
- Based on other NRC guidance on meteorological data (e.g., NUREG-0800, RG 1.23, ANSI ANS 2.15, etc.).
- Other Regulatory Positions of RG 3.63 apply:
  - E.g., 90% recovery for each parameter, and at least 75% for joint data (speed, direction, and stability). (based on RG 3.63, Regulatory Position C.4.).

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Meteorological data

Discussion

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Effluent Quantities

- **Requirement**: 10 CFR 40.65 "...must specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six month of operation... If quantities of radioactive materials released during the reporting period are significantly above the licensee's design objectives previously reviewed as part of the licensing action, the report shall cover this specifically..."

- **Issue**: Until recently, licensees had not specified effluent quantities and did not report values in semi-annual reports

Effluent Quantities

- Since 2014, NRC has approved several operational ISR programs that measure effluent quantities or calculate effluents from measured operational parameters:
  - Nichols Ranch (ML14087A244)
  - Ross (ML15302A405)
  - Lost Creek (ML15279A572)
  - Crow Butte (ML15345A256)
  - Reno Creek (ML16364A227)
  - Willow Creek (ML17144A198)

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Effluent Quantities

- NRC staff continues to review 10 CFR 40.65 semi-annual effluent reports from licensees with approved plans

- To date, the NRC staff has not identified generic concerns with effluent quantity measurement methods or calculations.

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Effluent Quantities

- Should licensees decide that monitoring from some release sources (diffuse or point sources) is no longer practicable, the licensee may estimate the magnitude of unmonitored effluents.
  - E.g., wellheads, header houses, deep disposal well houses
  - Bases for estimates should be documented

- RG 8.37, "ALARA Levels for Effluents from Materials Facilities," Position 3.3 states, "When practicable, unmonitored effluents should not exceed 30% of the total estimated effluent releases."

Effluent Quantities

- No Part 40 definition of *principal radionuclides*.

- NRC guidance in Regulatory Guide 4.16, "Monitoring and Reporting Radioactive Materials in Liquid and Gaseous Effluents from Nuclear Fuel Cycle Facilities," (for non-UR fuel cycle facilities) states *principal radionuclides* are those which constitute at least 1% of the effluent quantity or 1% of the dose from a specific effluent stream.

Effluent Quantities

- The phrase, “design objectives previously approved as part of the licensing action,” is interpreted by NRC staff to mean the effluent quantities estimated in the license application and its amendments.

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Effluent Quantities
(Example only)

Facility	Design objective Max. Annual Rn-222, Ci	2016 Air Effluent Quantity
"Generic ISR"	400	8.5

If quantities released are significantly above licensee's design objectives, the licensee must "cover this specifically" in the semi-annual report. (10 CFR 40.65).

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Effluent Quantities

Discussion

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Public dose calculations

- **Requirement**: 10 CFR 20.1302 demonstration of compliance with annual public dose limit

- **Issue**: In past semi-annual effluent reports and/or annual ALARA audit reports, licensees have used radionuclide concentrations measured at incorrect locations (e.g., RG 4.14 environmental monitoring air sample locations), and compared these values to incorrect 10 CFR 20, Appendix B, effluent concentrations.

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Public dose calculations

- 10 CFR 20.1302(b) describes two methods:
  - (b)(1): measurement or calculation that TEDE to <u>individual likely to receive highest dose</u> does not exceed annual public dose limit;

    <u>OR</u>
  - (b)(2): Appendix B values at <u>boundary of unrestricted area</u> are not exceeded <u>AND</u> external dose to individual continuously present in unrestricted areas is below 2 mrem in an hour and 50 mrem in a year.

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Public dose calculations

- NRC has approved many operational ISR programs for correctly calculating public dose:
  - Nichols Ranch (ML14087A244)
  - Ross (ML15302A405)
  - Lost Creek (ML15279A572)
  - Crow Butte (ML15345A256)
  - Reno Creek (ML16364A227)
  - Willow Creek (ML17144A198)

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Public dose calculations

- Regarding “Appendix B” method:
  - Concentrations must be determined at boundary of unrestricted area (i.e., outside restricted and controlled areas)
  - Appendix B effluent concentration for “radon-222 with daughters present” applies, unless NRC has approved an alternative limit (20.1302(c)).

    [Rn-222, with daughters present: 1E-10 µCi/mL]

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Public dose calculations

- *Controlled area* means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

- *Restricted area* means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

- *Unrestricted area* means an area, access to which is neither limited nor controlled by the licensee

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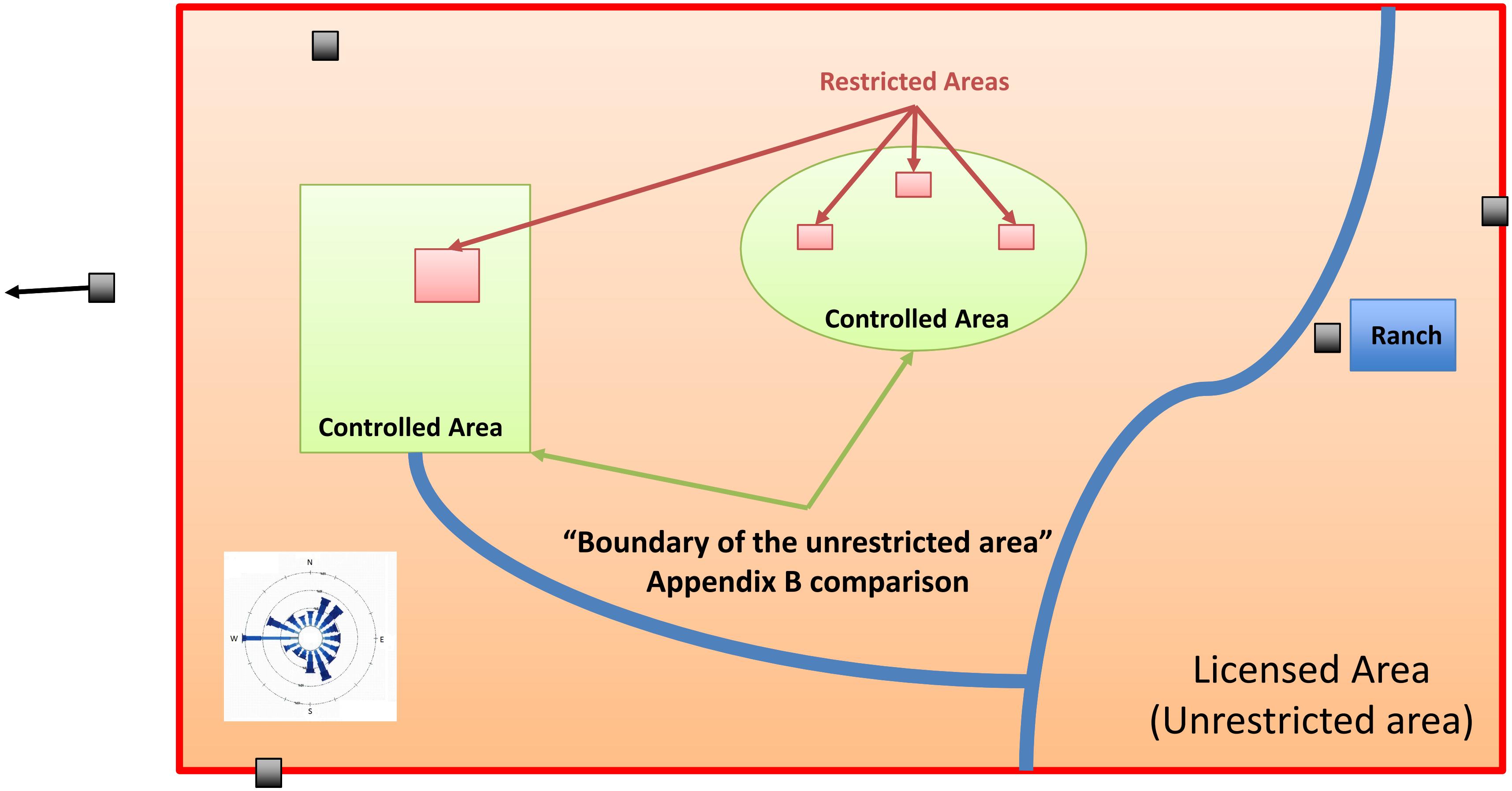
Public dose calculations



= RG 4.14 air sampling location

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Public dose calculations

- Regarding compliance with 20.1302(b)(1):

Draft FMSE-ISG-01 (ML13310A198) provides acceptable methods and parameter values to calculate internal dose (CEDE) from radon concentration measurements.

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Public dose calculations

- <u>Example</u> dose calculation:
  - The occupant of an on-site (or near site) ranch is determined to be the individual likely to receive the highest dose.
  - The licensee evaluates and documents that all individuals are present at the ranch less than 50% of the year (< 4,380 hours).
  - Particulate air sampler, radon track-etch device, and optically-stimulated luminescence dosimeters (OSLs) are deployed at the ranch.
  - Quarterly composite air samples; semi-annual radon measurements; quarterly OSL measurements at ranch and background location.

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Public dose calculations

Quarterly composite air samples (RG 4.14) (µCi/mL)										
Ranch										
	Nat-U	**Th-230**		**Th-230, unc**	**Ra-226**		**Ra-226, unc**	**Pb-210**		**Pb-210, unc**
1st Q	1.00E-16	2.00E-16	±	2.00E-17	2.00E-16	±	2.00E-17	2.00E-14	±	2.00E-15
2nd Q	2.00E-16	5.00E-17	±	5.00E-18	5.00E-17	±	5.00E-18	5.00E-15	±	5.00E-16
3rd Q	5.00E-17	1.00E-16	±	1.00E-17	1.00E-16	±	1.00E-17	1.00E-14	±	1.00E-15
4th Q	1.00E-16	1.00E-16	±	1.00E-17	1.00E-16	±	1.00E-17	1.00E-14	±	1.00E-15
Background										
	Nat-U	**Th-230**		**Th-230, unc**	**Ra-226**		**Ra-226, unc**	**Pb-210**		**Pb-210, unc**
1st Q	1.50E-16	1.50E-16	±	7.50E-17	1.50E-16	±	7.50E-17	1.50E-14	±	7.50E-15
2nd Q	1.50E-16	1.00E-16	±	5.00E-17	1.00E-16	±	5.00E-17	1.00E-14	±	5.00E-15
3rd Q	5.00E-17	2.00E-16	±	1.00E-16	2.00E-16	±	1.00E-16	2.00E-14	±	1.00E-14
4th Q	5.00E-17	2.00E-16	±	1.00E-16	2.00E-16	±	1.00E-16	2.00E-14	±	1.00E-14
Net Concentration (Ranch minus Background)										
	Nat-U	**Th-230**		**Th-230, unc**	**Ra-226**		**Ra-226, unc**	**Pb-210**		**Pb-210, unc**
1st Q	-5.00E-17	5.00E-17			5.00E-17			5.00E-15		
2nd Q	5.00E-17	-5.00E-17			-5.00E-17			-5.00E-15		
3rd Q	0.00E+00	-1.00E-16			-1.00E-16			-1.00E-14		
4th Q	5.00E-17	-1.00E-16			-1.00E-16			-1.00E-14		
Average	1.25E-17	-5.00E-17			-5.00E-17			-5.00E-15		
	1.25E-17	**0**			**0**			**0**		

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Public dose calculations

Semi-annual radon concentration measurements (µCi/mL)								
		Ranch			**Background**			**Net**
		Rn-222	**±**	**Rn-222, unc**	**Rn-222**	**±**	**Rn-222, unc**	**Rn-222**
	1st Q – 2nd Q	1.5E-09	±	1.0E-10	1.3E-09	±	4.0E-11	2.0E-10
	3rd Q – 4th Q	1.5E-09	±	7.5E-11	1.2E-09	±	5.5E-11	3.0E-10
							Average	2.5E-10

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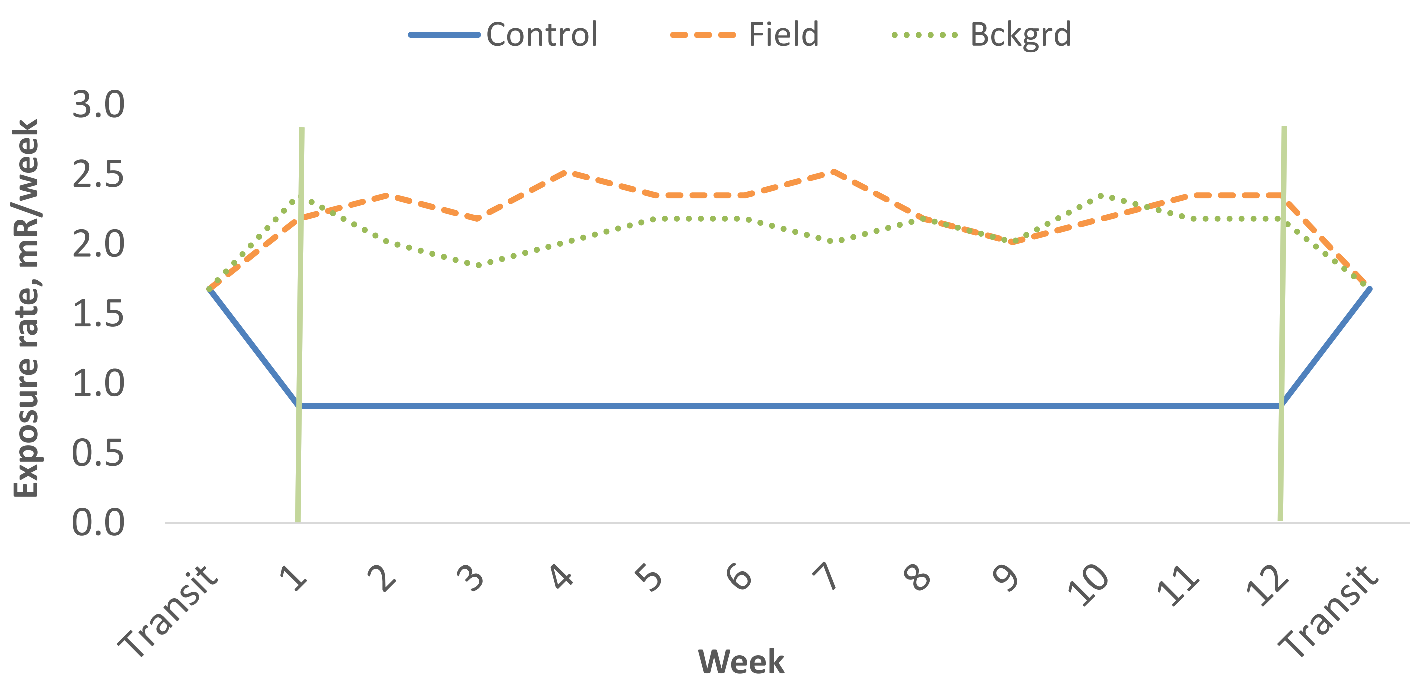
Public dose calculations

Environmental dosimeters

- RG 4.13, Rev. 1, “Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetery: Environmental Applications,” is referenced in RG 4.14.
- RG 4.13, Rev. 1 endorses ANSI N545-1975, with exceptions.
- Field and reporting procedures in ANSI N545-1975 are generally acceptable.
- However, ANSI N545-1975 does not provide detailed statistical procedures for data reduction.
- ANSI N545-1975 has been replaced by ANSI HPS N13.37-2014.
- DG-4019 (Proposed Revision 2 to RG 4.13), “Environmental Dosimetry-Performance Specifications, Testing, and Data Analysis,” was published for comment in June 2014.

Public dose calculations

Example weekly exposure of dosimeters during a quarterly monitoring period



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Public dose calculations

(based on ANSI N545-1975 methodology)

	Control (mR)	$Field_i$ (mR)	Bckgrd (mR)	Receptor Net (mR)
Measured Exposure	14	31	29	
– Storage Exposure	10 *			
= Transit Exposure	4	4	4	
Net Field Exposure		27	25	2 **

* Calculated from known, measured dose rate inside an on-site shielded storage container

** If calculated receptor exposure is negative, report as zero.

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Public dose calculations

- Particulate radionuclide internal dose (CEDE)
- Calculated for radionuclides with positive net concentrations only (in this example, only natural uranium):

$$CEDE_U = C_{average} \times \left.\frac{50\ mrem/year}{effluent\ concentration}\right|_{App.\ B} \times occupancy\ factor$$

$$CEDE_U = 1.25x10^{-17}\ \frac{\mu Ci}{mL} \times \frac{50\ mrem/year}{9x10^{-13}\left.\frac{\mu Ci}{mL}\right|_{Class\ W}} \times 0.5 = 3.5\text{x}10^{-4}\text{mrem/year}$$

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Public dose calculations

- Radon-222 and progeny internal dose (CEDE)
- Calculated for positive net concentrations only
- From Draft ISG, Equation 1 (ML13310A198)

$$CEDE_{Rn} = 500\ \frac{mrem}{pCi/L} \times C_{average} \times equilibrium\ factor\ \times occupancy\ factor$$

$$CEDE_{Rn} = 500\ \frac{mrem}{pCi/L} \times 2.5 \times 10^{-10}\ \frac{\mu Ci}{mL} \times 10^{9} \frac{pCi \cdot mL}{\mu Ci \cdot L} \times 0.5\ \times 0.5 = 31\ mrem/year$$

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Public dose calculations

- External dose (EDEX)
- Calculated for positive net exposures only

$$EDEX = \ Annual\ net\ exposure, \frac{mR}{year} \times occupancy\ factor \times conversion$$

$$EDEX = 2\ \frac{mR}{year} \times 0.5 \times 1 \frac{mrem}{mR} = 1\ mrem/year$$

Public dose calculations

- Example calculation:

$$TEDE = \{\Sigma CEDE\} + EDEX$$

$$TEDE = \{3.5 \times 10^{-4} + 31\} + 1 = 32 \text{ mrem/year}$$

32 mrem/year < 100 mrem/year ✓

Note: only radon-222 and its short-lived progeny would be principal radionuclides under RG 4.16.

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Public dose calculations

Discussion

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Transportation requirements

- Recent violations at several sites
- NRC staff will provide an overview of some transportation requirements relevant to UR facilities
- This discussion is not a complete overview of transportation requirements and is not the general or function-specific training required by 49 CFR.

Transportation requirements

- 10 CFR 71.5(a) requires NRC licensees who transport licensed material outside the site of usage, as specified in the NRC license, or where transport is on public highways, or who deliver licensed material to a carrier for transport, shall comply with DOT regulations in 49 CFR 107, 171-180, and 390-397.
- 71.14(b) provides an exemption from <u>Part 71</u> for low-level materials (<Type A quantity; and LSA and SCO < 1 rem/hr at 3 m; LSA-I and SCO-I)

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Transportation requirements

- UR facilities generally meet the exemption criteria for low-level materials in 10 CFR 71.14
- This means NRC Part 71 requirements would not normally apply to UR shipments
- Therefore, NRC requirements for low-level materials are generally contained in DOT's 49 CFR.

Transportation requirements

- Exempt quantities and concentrations
- Excepted packages
  - Limited quantity
  - Empty packaging
- Low specific activity (LSA) material

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Transportation requirements

- Exemption limits:
  – Question: Are both the exempt consignment activity limits AND exempt material activity limits exceeded?
  – If Yes, the shipment is regulated in transport
  – If either or both are not exceeded, then the shipment is not regulated in transport

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Transportation requirements

- Exemption limits (*example*)

Material	Quantity	Mass
Nat. U	5 µCi (185,000 Bq)	500 kg

1. Convert to concentration: 0.4 Bq/g
2. Exempt material activity limit: 1 Bq/g
3. Not regulated in transport because exempt material activity limit is not exceeded, even though exempt consignment activity limit (1000 Bq for Nat. U) is exceeded.

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Transportation requirements

Excepted packages common in UR:

Limited quantities

Empty packaging

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Transportation requirements

Limited Quantity

Requirements	49 CFR 173.421 and §173.422
Package activity	Table 4 (e.g., < 10^{-3} A_2 for normal form solids)
Specification packaging	Excepted
Package design requirements	173.24, 173.410
Radiation level	< 0.005 mSv/h (< 0.5 mrem/hr)
External Contamination	173.443(a) (revised July 13, 2015)
Specification communication	UN2910 on outside of package
Non-spec. communication	“Radioactive” “RQ” if RQ is exceeded
Reporting of incidents	171.15, 171.16
Training	Yes
Shipping Papers	Req’d if material is a hazardous substance (≥RQ)

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Transportation requirements

Empty Packaging

Requirements	49 CFR 173.428
Package activity	Emptied as far as practical
Specification packaging	Excepted
Package design requirements	173.421(b), (c) and (e) and no leakage
Radiation level	< 0.005 mSv/h (< 0.5 mrem/hr)
Internal Contamination	< 100 times 173.443(a)
External Contamination	173.443(a)
Specification communication	None
Non-spec. communication	Previous labels obliterated “Empty” UN2908 “RQ” if RQ is exceeded
Reporting of incidents	171.15, 171.16
Training	Yes
Shipping Papers	Req’d if material is a haz. substance (≥RQ)

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Transportation requirements

- Low Specific Activity (LSA) material is limited specific activity and non-fissile material. LSA must be in one of three groups:

LSA-I

LSA-II

LSA-III

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Transportation requirements

LSA-I

(i) Uranium and thorium ores, concentrates of uranium and thorium ores, and other ores containing naturally occurring radionuclides which are intended to be processed for the use of these radionuclides; or

(ii) Natural uranium, depleted uranium, natural thorium or their compounds or mixtures, provided they are unirradiated and in solid or liquid form [e.g., Yellowcake]; or

(iii) Radioactive material for which the A_2 value is unlimited [e.g., U(nat)]; or

(iv) Other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the values for activity concentration specified in § 173.436 or calculated in accordance with § 173.433, or 30 times the default values listed in Table 8 of § 173.433.

[e.g., 30 x 1 Bq/g U(nat) = 30 Bq/g U(nat) = 810 pCi/g U(nat)]

[e.g., 30 x 10 Bq/g Ra-226 = 300 Bq/g Ra-226 = 8100 pCi/g Ra-226]

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Transportation requirements

LSA-II

≤ 10^{-4} A_2/g for solids and gases

≤ 10^{-5} A_2/g for liquids

e.g., Ra-226, $A_2 = 3 \times 10^{-3}$ TBq

Therefore, LSA-II solid upper limit for Ra-226:

$10^{-4} \times 3 \times 10^{-3}$ $\underline{\text{TBq}}$/g = 3×10^{5} $\underline{\text{Bq}}$/g = 8,100,000 pCi/g

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Transportation requirements

- Surface contaminated object (SCO) is a solid object which has radioactive material distributed on its surface. SCO exists in two phases:

SCO-I

SCO-II

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Transportation requirements

SCO-I

Non-fixed contamination on accessible surfaces

≤ 24,000 dpm / 100 cm^2 βγ and low toxicity α

≤ 2,400 dpm / 100 cm^2 all other α [e.g., Ra-226]

Fixed contamination on accessible surfaces

≤ 240,000,000 dpm / 100 cm^2 βγ and low toxicity α

≤ 24,000,000 dpm / 100 cm^2 all other α

Non-fixed plus fixed contamination on <u>in</u>accessible surfaces

≤ 240,000,000 dpm / 100 cm^2 βγ and low toxicity α

≤ 24,000,000 dpm / 100 cm^2 all other α

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Transportation requirements

SCO-II

Non-fixed contamination on accessible surfaces

≤ 240,000,000 dpm / 100 cm^2 βγ and low toxicity α

≤ 240,000 dpm / 100 cm^2 all other α

Fixed contamination on accessible surfaces

≤ 4,800,000,000 dpm / 100 cm^2 βγ and low toxicity α

≤ 480,000,000 dpm / 100 cm^2 all other α

Non-fixed plus fixed contamination on <u>in</u>accessible surfaces

≤ 4,800,000,000 dpm / 100 cm^2 βγ and low toxicity α

≤ 480,000,000 dpm / 100 cm^2 all other α

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Transportation requirements

For Exclusive Use – Domestic only (§173.427)

Requirements	173.427
Specific activity	≤ 173.403, *Definitions*
Consignment Limit	Table 5 – [e.g., no limits for conveyance, other than by inland waterway, of LSA-I, and LSA-II non-combustible solid. SCO < 100 A_2 for conveyance other than by inland waterway.]
Package design	173.24, 173.410, 173.411
Radiation level	< 1 rem/hr at 3 m (10 feet) from unshielded material; and package meets 173.441b, c, and e [e.g., < 200 mrem/hr at any pt, TI < 10, or additional controls are required.]
External Contamination	173.443(a)
Specification communication	Placards, shipping papers, subsidiary hazard label; Excepted from marking and labeling if < A_2
Non-spec. communication	"Radioactive – LSA" "Radioactive – SCO" "RQ" if required UN2912 (LSA-I), UN3321 (LSA-I), UN3322 (LSA-I), UN2913 (SCO-I or SCO-II)
Reporting of incidents	171.15, 171.16
Training	Yes
Shipping Papers	Req'd if material is a hazardous substance (≥RQ)
Additional requirements	When conveyance is the package, no leakage; package bracing; carrier instructions

Transportation requirements

Exclusive Use – Domestic (§173.427(b) and (c))

- LSA-I and SCO-I material may be transported <u>unpackaged</u> under specified conditions, otherwise...
- LSA and SCO packaged in Type IP-1, -2, or -3; DOT 7A Type A; Type B(U) or B(M); or, if less than A_2, in general design pkg (173.410).

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Discussion and Review of Action Items