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ANSI/HPS N13.37
Draft RG 4.13
Environmental Dosimetry

June 25, 2014
Wednesday 08:00 AM

Steve Garry
Sr. Health Physicist,
Radiation Protection and Consequences Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation

Regulatory requirement

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- 10 CFR 20.1501 (c) requires that instruments be calibrated periodically for the radiation measured

- Do you have your environmental dosimeter calibration test records?

RG 4.13
Environmental Dosimetry

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- RG 4.13 provides guidance on how to do environmental dosimetry calibrations
- RG 4.13
  - Rev. 1 (1977) endorses ANSI N545
  - Rev. 2 (2014 (draft) endorses ANSI/HPS 13.37

Testing Protocols

RG 4.13 Rev. 1 (1977)

- Uniformity test – how does each dosimeter compare to other dosimeters?
  – within 7.5% at 22 mrem?
- Reproducibility test - can a dosimeter repeat its measurements?
  – within 3% at 22 mrem? (very difficult)
- Commitments – Did you commit to RG 4.13, Rev. 1?

ANSI/HPS N13.37

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- Uniformity test
  - – Each dosimeter within 7.5% of average
  - – Average of all dosimeters within 5%
- Reproducibility test
  - – Each dosimeter within 7.5% (vs old 3%)
  - – Average of dosimeters within 5%
- Minimum Quantifiable Dose (MDD) – measure 20 mrem within 7%

Old Data Analysis

ANSI N545 & RG 4.13 Rev.1 (1977)

- ANSI N545 method is based on either:
  - Comparing control and indicator stations <u>(Invariant with location)</u>

  or

  - Comparing current readings from each location to <u>its own</u> historical readings <u>(Invariant with time)</u>

Common Errors

- To calculate field dose:
  - Just list dosimeter data
  - Just subtract control dosimeter
- Note: There are TWO uses of “control”
  - Control station (at ~ 10 miles)
  - Control dosimeter (in lead shield)

REMP Reports

- Typically provide:
  - Listing of TLD or OSL data
  - Averaging of inner ring, outer rings, and control stations, masking data from true outliers
  - Make poor comparisons of indicator stations to control stations
- Most data analysis incomplete:
  - Data just listed, not analyzed
  - Some analyses “just wrong”

Example 1
– reporting high reading vs. control

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3.10 DIRECT GAMMA RADIATION

In 2008, 162 TLDs were analyzed, 150 at indicator locations and 12 at control locations. TLDs are collected and analyzed quarterly. The highest annual mean exposure for an indicator location was 108.8 milliroentgen. The annual mean exposure for the control locations was 60.4 milliroentgen.

- 108.8 - 60.4 = 48.4 mR*

  * used mR vs mrem

Example 2 – ring averaging

- From 1984 – 2011
  - Inner ring avg. – 80.1 mR (~80 inner)
  - Outer ring avg. – 71.6 mR (~70 outer)
  - Control avg. – 61.3 mR (~60 control)
- From 2002 – 2011
  - Inner ring – 79.8 mR (~80 inner)
  - Outer ring – 73.2 mR (~70 outer)
  - Control – 57.5 mR (~60 control)
- 80 – 60 = 20 "mR"
- Plus, masking any individual location

Background dose rates (nominal values)

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- USA background dose rate is 12 - 25 mrem/qtr
- Each plant background dose rate varies from
  ~12 – 25 mrem/qtr at its own monitoring stations
  ~ near ash piles, rocks (higher)
  ~ near lakes, rivers (lower)
- **<u>But the dose rate any one location is ~ constant</u>**

For purposes of discussion and analysis, assume a baseline of 15 mrem/qtr (60 mrem/yr)

Type 1 error
subtract the entire control

- "Net" ≠ (IS NOT) "gross" - "control"

- Example of Faulty Analysis:
  - Gross Field dosimeter (assume no transit dose) = 60 mrem/yr
  - Control Dosimeter (7 mrem/qtr x 4 qtr) = 28 mrem/yr
  - Net Field Badge reported = 60 - 28 = 32 mrem
- Percent error = (60 - 32) / 60 **or ~ 47% error**

Type 1 Example

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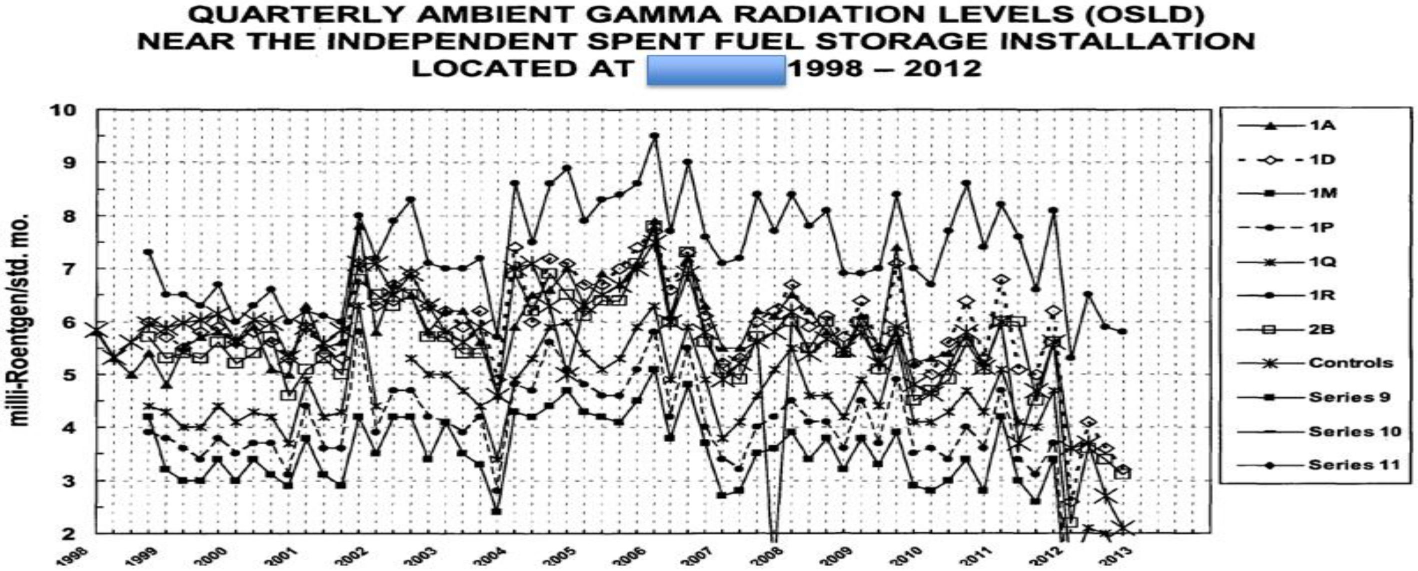
2012 - subtract the entire control

mR
8
6
4
2



<u>Analysis</u>: *“All OSLD measurements were below 10 mR/month, with a range of -0.3 to 6.5 mR per standard month”*

Type 2 Error
don’t subtract anything, just report gross readings

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- “Net” $\neq$ (IS NOT) just “gross”
- Example of faulty analysis:
  - Avg was 32 mrem/qtr (vs 15 mrem/qtr)
  - Didn’t explain why readings were high
  - Percent error (32 – 15)/15 x 100% **= 113% error**

Type 2 example

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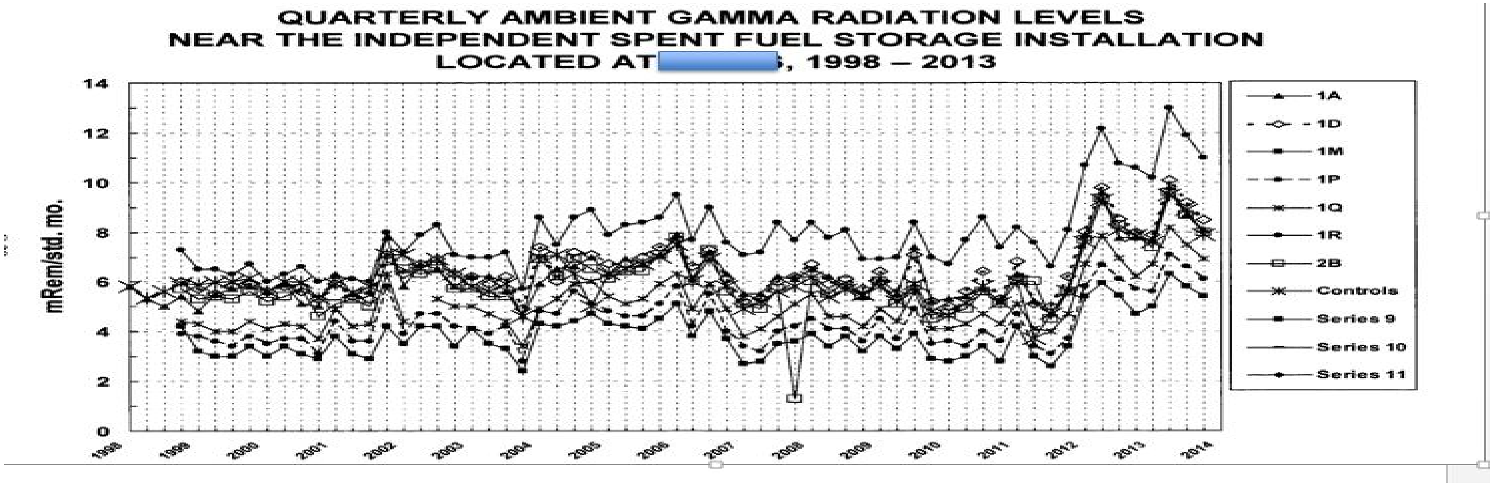
2013 - no subtraction

mR
14
10
8
6
2
0



<u>Analysis</u>: *Most OSLD measurements were below 10 mR per standard month, with a range of 5.0 to 13.0 mR per standard month.*

*The large reduction **<u>(increase?)</u>** in multiple direct radiation locations for 2013 is a result of the difference in technology used for radiation measurement (from TLD to OSLD)*

Copy and Paste??

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- 2012 – *The large reduction in multiple direct radiation locations for 2012 is a result of the difference in technology used for radiation measurement (from TLD to OSLD)*

- 2013 – For the 2013 report, even though the results increased notably, the exact same analysis/comment was used

- DIDN"T UPDATE 2012 the REPORT (other than change year)

New Data Analysis Method

(Use ANSI/HPS N13.37 & RG 4.13)

- Use “Invariant With Time” method
  - AT EACH LOCATION, analyze data
  - Compare current quarter data <u>to its own baseline background dose rate</u>
  - Identify facility-related dose
    - ~ 5 mrem/qtr
    - ~ 10 mrem/yr facility-related dose
    - Otherwise, report non-detected increase

How?

First, establish your baseline dose rate

- Obtain “good” historical data at each location (approx. 5-10 years of recent data)
- Make data corrections for control dosimeter errors
- Calculate average and 3 standard deviations for each location

Must first correct old errors

- Each "field dosimeter" has 2 dose components:
  1) "net" field dose during deployment
  2) transit dose
     – From time of anneal to deployment
     – From time of field collection to readout
- "Net" = "gross" – "transit"
- Must calculate "transit" dose

Transit Dose

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- Start with control dosimeter in lead shield
- It has 2 dose components
  - Transit dose (back and forth)
  - Storage dose in lead shield (~ 7 mrem/qtr)
- So transit dose = control dosimeter - storage dose, or
- Transit = control dosimeter - 7 mrem/qtr

Correct Method

First Step - Correct historical data

- See how old data was calculated
- If needed, re-calculate “net” field dose
  (assuming old methods subtracted entire control badge dose)
- Normalize old data to 91 days

Baseline background dose rate

- Calculate base-line background dose rate and standard deviation (90th percentile) for each location

- Then calculate "average" standard deviation for your dosimetry system
  - 1 sigma should be ~1.5 mrem
  - 3 sigma should be ~ 5 mrem

Minimum Differential Dose (MDD)

- MDD is “detectable” dose (above background)

  = 3X the dosimetry system’s 90th percentile standard deviation

- The MDD should be:

  ~ 5 mrem/qtr

  ~ 10 mrem/yr

  Sq root of sum of squares = $5^2 + 5^2 + 5^2 + 5^2 = 100$

  Sq. root of 100 = 10

Facility-related dose (FRD)

- Each quarter, determine if there is any "detectable" facility-related dose
- FRD = net field dose - baseline - MDD
- Minimum detectable is ~ 10 mrem/year
- Otherwise, report FRD as "non-detectable"

Dose to MOP

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- Extrapolate from the monitored location to the nearest resident
- Report any dose above 1 mrem
- Otherwise, report dose as non-detected

References:

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- ANSI/HPS N13.37, “Environmental Dosimetry – Criteria for System Design and Implementation”

- “Update on ANSI N13.37- 2014 Environmental Dosimetry Standard, June 4, 2014, 33rd International Dosimetry and Records Symposium, M. Lantz

- Draft RG 4.13, “DG-4019, “Environmental Dosimetry – Performance Specifications, Testing, and Data Analysis,” ML14161A666)

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Questions and Discussion

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