ANSI/HPS N13.37
Draft RG 4.13
Environmental Dosimetry

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Regulatory Requirement

• 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

• 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
ANSI Standards

Have 2 basic parts:

1. **Performance testing standards** to ensure dosimetry system is adequate (performed by processor)

2. **Data analysis methods** (performed by end-user)
Testing Protocols
ANSI N545 and old RG 4.13 Rev. 1

• **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?

• **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 (MQD)**
  – measure 20 mrem within 7%
Background dose rates (nominal values)

- USA background dose rate is ~12 - 25 mrem/qtr

- Each plant’s background dose rate can vary from ~12 – 25 mrem/qtr among its own monitoring stations
  - higher near rocks and ash piles
  - lower near lakes, rivers

- **But the dose rate any one location is ~ constant**

- For demonstration purposes, assume 15 mrem/qtr
Old Data Analysis Methods
ANSI N545 & RG 4.13 Rev.1 (1977)

• ANSI N545 method is based on either:
  – Comparing control and indicator stations
    (Invariant with location)
  or
  – Comparing each location’s current readings to its own historical readings
    (Invariant with time)

• ANSI N545 didn’t give specific methods
Common Analysis Errors

• To determine field dose:
  – Some plants report “gross” dosimeter data
  – Some plants subtract “control” dosimeter
  – Control dosimeters
    – Receive transit dose and storage dose
    – Storage dose is ~ 7 mrem/qtr in the lead storage shield

• Note: There are 2 uses of the word “control”
  – Control station (at ~ 10 miles)
  – Control dosimeter (in lead shield)
Error #1
impact of subtracting the entire control dosimeter reading

- Gross field dosimeter = 60 mrem/yr (assuming no transit dose)
- Control dosimeter (7 mrem/qtr x 4 qtr) = 28 mrem/yr
- Net field dosimeter = 60 - 28 = 32 mrem
- Percent error = [(60 - 32) / 60] x 100% ~ 47% error
Error #2
impact of not subtracting anything, just reporting gross readings

• Avg was 32 mrem/qtr (vs 15 mrem/qtr)
• Didn’t explain why readings were high
• Percent error \( \frac{32 - 15}{15} \times 100\% = 113\% \) error
REMP Reports

• Typically provide:
  
  – Listing of TLD or OSL data
  
  – Limited comparisons of indicator stations to control stations
  
  – Averaging of inner ring, outer rings, and control stations

  • Averaging may lead to an unintended consequence of obscuring outliers
Example 1

Comparing indicators to controls

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.

• In 2008, incorrect assumption could be made: 108.8 - 60.4 = 48.4 mR*
• In 2013, indicator 96.0, control 61.3
• 96.0 – 61.3 = 34.7 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)

• Could be seen as 80 – 60 = 20 “mR”
Calculating net dose

• Two sources of data for analysis:
  – Field dosimeter gross readings
  – Control dosimeters in lead storage shield
Field Dosimeter
(Gross readings)

• Has TWO (2) dose components:
  – #1 Net field dose (actual field dose)
  – #2 Transit dose

• “Net” = “gross” – “transit”

• Transit dose ≠ control dosimeter reading

• Transit dose must be “calculated”
Transit Dose
how to calculate transit dose

• Control dosimeter has 2 dose components
  – Transit dose (from annealing to deployment and from removal to annealing)
  – Storage dose in lead shield (~ 7 mrem/qtr)

• So, transit dose
  
  = control dosimeter - storage dose, or
  
  = control dosimeter - 7 mrem/qtr
Plant report (2012) subtracted the entire control dosimeter reading.

Licensee Analysis: “All OSLD measurements were below 10 mR/month, with a range of -0.3 to 6.5 mR per standard month .... 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).”
Same plant’s next yr’s report
no subtraction

Licensee Analysis: “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” 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 from 2012?)
New Data Analysis Method based on ANSI/HPS N13.37 & RG 4.13

- Assume background is constant at each location
  - Compare each locations data to its own baseline background dose rate
  - Analysis can identify facility-related dose (FRD)
    - ~ 5 mrem/qtr or greater
    - ~ 10 mrem/yr or greater
    - Otherwise, report FRD as non-detected
How to Re-analyze Data?

1. review old data (at each location):
   – Identify “good” historical data set (approx. 5-10 years of recent data)

2. make data corrections (if transit dose was not accurately determined)
Baseline Background Dose Rate

3. Calculate base-line background dose rate for each location

4. Calculate standard deviation for each location

5. Then use the SD at the 90th percentile as the dosimetry system’s overall SD

- 1 sigma should be ~ 1.5 mrem
- 3 sigma should be ~ 5 mrem
Minimum Differential Dose (MDD)

- MDD is “detectable” dose (above background)
  
  \[ = 3 \text{ sigma} \times (3 \times \text{the average of the 90}^{\text{th}} \text{ percentile standard deviation}) \]

- The MDD should be:
  
  \[ \sim 5 \text{ mrem/qtr} \]
  \[ \sim 10 \text{ mrem/yr} \]

  \[ \text{Sq root of sum of squares} = 5^2 + 5^2 + 5^2 + 5^2 = 100 \]
  \[ \text{Sq. root of} \ 100 = 10 \]
Facility-Related Dose (FRD)

• Each quarter, determine if there is any “detectable” facility-related dose

• FRD = net field dose - baseline - MDD

• Minimum detectable is:
  - ~ 5 mrem/qtr
  - ~ 10 mrem/year
  - Otherwise, report FRD as “non-detected”
Dose to MOP

- Extrapolate from the monitored location to the nearest resident
- Report any dose above 1 mrem
- Otherwise, report dose as non-detected
ANSI and RG 4.13 (draft) recommend

- Annual audits of the end-user by independent assessors
- Annual blind spike testing
- Triennial audits of the processor
- Note: a processor laboratory accreditation program may be needed if the results of the quality assurance program routinely identify unsatisfactory results.
Blind Spiking

- Annual spiking of 15 dosimeters
- Exposed to 50 – 200 mrem of Cs-137
- \( P = \text{performance quotient} \)
  \[ P = \frac{\text{measured} - \text{spiked}}{\text{spiked dose}} \]
- mean \( P \) value should not exceed 0.15
- standard deviation should not exceed 0.15
References

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


Developing an Emergency Risk Communication (ERC)/Joint Information Center (JIC) Plan for

Information Center (JIC) plan for a radiological emergency. The purpose of an ERC/JIC plan is to ensure the delivery of understandable, timely, accurate, consistent, and credible information to the public, the media, and other stakeholders during a radiological emergency.
2.2 Sample Checklist of Elements in a Comprehensive Emergency Risk Communication Plan

- Identify all anticipated scenarios for which emergency risk communication plans are needed, including worst cases and low probability, high consequence events.
- Describe emergency risk communication roles and responsibilities for different emergency scenarios.
- Designate staff who will assume emergency communication roles and responsibilities.
- Designate who will lead the emergency risk communication effort.
- Designate who within the organization will be responsible and accountable for implementing designated emergency communication actions and activities.
- Identify who will need to be consulted during the emergency risk communication process.
- Identify who will need to be informed about emergency risk communication actions and activities.
- Designate who will be the lead communication spokesperson and backup spokespersons for different emergency risk communication scenarios.
Guidance on Developing Effective Radiological Risk Communication Messages: Effective Message Mapping and Risk Communication with the Public in Nuclear Plant Emergency Planning Zones
Message Mapping

Message mapping is a science-based message development process by which users can:

- anticipate questions of stakeholders (interested, affected, or influential parties) before they are raised;
- decide what questions they want or need to answer and what questions should be answered by other organizations;
- develop responses to stakeholder questions in a clear, concise, and accessible format;
- promote dialogue about messages both inside and outside the organization;
- provide spokespersons with a user-friendly guide to a set of vetted organizational messages;
- ensure the organization has consistent messages;
- ensure the organization speaks with a single voice or with many voices in harmony.

This document provides guidance for nuclear power plant licensees and local response organizations on message development for radiological emergencies. Message development skills are critical to successful radiological risk communication to the public, the media, and other stakeholders. Message development skills are particularly critical to successful emergency communications with those living in close proximity to a nuclear power plant.

This document contains principles, strategies, and tools for producing messages before, during, and after a radiological emergency that are understandable, timely, accurate, consistent, and credible. The document contains nearly 400 questions the public and media may ask during a radiological emergency.
Questions and Discussion