DOELAP External Dosimetry Webinar

Dosimeter Fade

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DOELAP On-Site Assessment Requirements Checklist

- TD.15 Luminescent material fading under normal conditions must be documented and accounted for over the period of intended use (dosimeter issue cycle).

- OSL.15 OSL material fading under normal conditions has been documented and accounted for the period of intended use.
Principles of Thermoluminescence or Optically Stimulated Luminescence

- Thermoluminescence (TL) or Optical Stimulated Luminescence (OSL) is the ability of some materials to convert the energy from radiation to a radiation of a different wavelength, normally in the visible light range.
- In some materials, defects in the material exist or impurities are added that trap electrons in the band gap.
- Trapped electrons have more energy than those in the valence band.
- When stimulated by heat or light, the trapped electrons return to the valence band giving off energy in the form of visible light.
- Measurement of the emissions (glow curve) allows for a conversion to dose equivalent.
- Trapped electrons are liberated due to ambient heat/light.
 Fade Influences

- Integration of the ‘Dose’ portion of the glow curve
  - Timing Parameters - Panasonic
  - Region of Interest settings – Harshaw

- Heating intensity
  - Timing Parameters, Voltage, Bias Current - Panasonic
  - Ramp Rates - contact or hot gas – Harshaw
  - Ambient Temperatures (Lab storage vs Car dashboard)

- Sensitive element mass (Heat Capacity)
  - Amount of sensitive material, glue, substrate, moisture
  - Different manufactured lots may have different Heat Capacity
Good Heat Adjustment Techniques Reduce Fade Effects

1 hr & 24 hr Fade looks about the same.

A. Good peak separation

B. Start of dose integration after main peak starts rising

C. Dose peak fully integrated

D. End of dose integration at about the same height as the start of integration.

E. Post / Main 15 - 20%

Double Pre peak if irradiation to read is < 5 minutes
Good Heat Adjustment Techniques Reduce Fade Effects

1 hr Fade

A. Good peak separation
B. Valley close to the base
C. Start of dose integration right of center of valley
D. Dose peak fully integrated
E. Little or no post peaks

Shortly after irradiation, Pre & Main peak height should be ~ equal.
Good Heat Adjustment Techniques Reduce Fade Effects

24 hr Fade

A. 2-5% Pre/Main counts
B. Dose peak fully integrated
C. Little or no post peaks
Integrated Glow Curves - Acceptable Heating

5 minute Fade

24 hr Fade

LiBO
Integrated Glow Curves - Improper Heating

5 minute Fade

24 hr Fade

LiBO
Verification of Acceptable Heating

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<th>24 hr Fade</th>
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Fade Definitions

- **Fade** - Loss of signal due to ambient heat

- **t_S** – Shortest length of time between dosimeter irradiation and processing of the same dosimeter.

- **t_R** – Length of time between Irradiation and Calibration (16 – 48 hrs). Reference point for all other data points. Fade factor always considered 1.0. mR* = mrem

- **t_L** – Longest length of time between dosimeter irradiation and processing of the same dosimeter.

- **t_x** – Data point at any given location in time.
Fade Determination Methodologies

(Assumes no pre-fade issues)

- **Method #1**
  - Irradiate all dosimeters at the same time to a known dose (i.e. 500 mrem)
  - Read irradiated dosimeters (5-10) at each predetermined fade point ($t_x$) with control subtraction.
  - Be sure to read irradiated dosimeters at routine calibration fade time ($t_R$)
  - Calculate fade factor for each data point ($t_x / t_R$)
  - Plot points (Fade Factor vs: Fade time) and calculate equation(s)

- **Method #2**
  - Irradiated dosimeters (5-10) at each predetermined fade point ($t_x$) (i.e. 500 mrem)
  - Be sure to include irradiated dosimeters at routine calibration fade time ($t_R$)
  - Read all irradiated dosimeters at the same time with control subtraction. Read short term fade badges first.
  - Calculate fade factor for each data point ($t_x / t_R$)
  - Plot points (Fade Factor vs Fade time) and calculate equation(s)
 Fade Correction

Days

Fade Factor

$T_S$

$T_R$

$T_L$

Issue Period

period of intended use
UD-802 Long-term Fade (CaSO) Cs-137
Acute

\[ y = 0.9949x^{-0.012} \]

\[ R^2 = 0.9045 \]
UD-802 Fade
CaSO (Cs-137)

Daily Average = 1.003x^{-0.0109}

Acute = 0.9949x^{-0.0116}
As an Assessor - ‘Finding’ or no ‘Finding’

Items to consider....

- Does the processor account for Fade?
  - If no; what is the Technical Basis for not using Fade Correction

- How is Fade Correction applied?
  - Acute, Daily Average, Mid-Point, Inherent Batch Correction or combination
  - Is Technical Basis Sound

- Is the Fade Correction reasonable for the time of intended use?

- Is the Fade Correction calculated and used past the routine issue periods?

- How long ago was a Fade Study performed?
  - Any recent validity testing?
References

- Panasonic Users Manual; Chapter 8; 12/18/1990

- Determining the Fade Correction for Panasonic Dosimeters; International Dosimetry and Records Symposium; Rick Cummings, PhD, June 2014

- Determination of Fade, EDG-409, Argonne National Lab, May 2008

- Heating Adjustments of the Panasonic UD-710A TLD Reader, EDG-410, Argonne National Lab, September 2009
Questions ?
&
Discussion