New Developments in Direct Ion Storage

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Mirion Technologies
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Direct Ion Storage (DIS) Detector

- DIS Dosimeter:
  - Non Volatile Analog Memory Cell surrounded by a Gas Filled Ion Chamber
  - For photon radiation, initial interactions take place in the wall material and secondary electrons ionize the gas of the chamber
DIS technology - evolutions
Legacy personnel dosimeters
TLD, Film, OSL, RPL, CR39

Legacy Personal Dosimetry platforms ultimately require a return to a centralized processor for analysis, which delays important dose information to the administrator and wearer.
Instadose 1: read anytime

Introduction to Instadose 1
Instadose 1

Minimum Reportable Dose: 0.01 mSv
Lower Limit of Detection: 0.01 mSv
Useful Dose Range: 0.01 mSv - 10 Sv
Energy Response:
  Photon 5 keV - 6 MeV
  Beta $^{85m}$Kr and Sr/$^{90}$Y (Instadose 2)

Accreditations/Approvals/Licenses: NVLAP (Lab Code: 100555-0), UK (HSE), UAE (FANR), Australia, New Zealand, Nigeria and Ghana
Instadose 1: Energy Response Curve

NVLAP Reads (2012 October - December)

Introduction to Instadose 1
Instadose 2

- Bluetooth Low Energy Technology transmits dose
- Configurable calendar is used to set automatic read dates
- Dose data is stored until the data is communicated
- Manual reads can be perform pressing the button on the back
Instadose 2: The insides
Instadose 2: technology

- Utilizes BLE technology to communicate the “raw” read dose from the dosimeter to a communication interface

- Communication Interface (CI) relays the “raw” read dose to Mirion’s servers where dose is calculated using Mirion’s algorithm.

- The CI can be an iPhone 4S/5, iPad, instalink, or instalink USB for a PC

- “Read” consists of two parts (detector read and communication to server)

- No sensitive information is passed from dosimeter through the CI and the CI will not save/store any information. If there is no clear path to Mirion’s servers, the read will not be taken
Instadose 2: reads

- How/When are “reads” performed?
  - Configurable automatic read dates
  - The dosimeter automatically performs a read and communicates to the Mirion’s server
    - All dosimeters that initially do not connect will attempt to communicate every hour for 24 hours
  - If the dosimeter cannot communicate with Mirion’s server the dose reading is stored on the dosimeter
    - Data will be sent during next successful connection
  - Manual read and communication can be done anytime by pressing button on back of dosimeter when near communication station
### Table 1a. Test categories, test irradiation ranges, and tolerance levels

<table>
<thead>
<tr>
<th>Test irradiation range</th>
<th>Tolerance level (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test irradiation range</td>
<td>Deep</td>
</tr>
<tr>
<td>------------------------</td>
<td>------</td>
</tr>
</tbody>
</table>

**I. Accidents, photons**

A. General (B and C, random)  
B. $^{137}$Cs  
C. M150  

<table>
<thead>
<tr>
<th>0.05 to 5 Gy</th>
</tr>
</thead>
<tbody>
<tr>
<td>(5 to 500 rad)</td>
</tr>
<tr>
<td>0.24</td>
</tr>
</tbody>
</table>

**II. Photons/photon mixtures**

A. General $^a$ (E $\leq$ 20 keV; $\perp$ if $\beta$)  
B. High E ($^{137}$Cs, $^{60}$Co; $\theta$)  
C. Medium E $^1$ (E $> 70$ keV, $\leq 60^\circ$)  
D. Plutonium specific$^a$ (see Appendix A, Section A2)

<table>
<thead>
<tr>
<th>0.5 to 50 mSv</th>
<th>0.30</th>
<th>0.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.05 to 5 rem)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**III. Betas**

A. General (B and C, random)  
B. High E ($^{85}$Sr,$^{85}$Y)  
C. Low E ($^{85}$Kr)  
D. Uranium slab

<table>
<thead>
<tr>
<th>2.5 to 250 mSv</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.25 to 25 rem)</td>
</tr>
</tbody>
</table>

**IV. Photon/beta$^b$ mixtures**

<table>
<thead>
<tr>
<th>Shallow</th>
<th>Deep</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 to 300 mSv</td>
<td>0.5 to 50 mSv</td>
</tr>
<tr>
<td>(0.30 to 30 rem)</td>
<td>(0.05 to 5 rem)</td>
</tr>
<tr>
<td>...</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>

**V. Neutron/photon mixtures$^c$**

A. General (B and C, random)  
B. $^{252}$Cf + II  
C. $^{252}$Cf(D$_2$O) + II

| 0.30 | ... |
Instadose 2: technical details

- Instadose 2 has passed NVLAP categories I – IV of ANSI standard N13.11 – 2009 with excellent results

<table>
<thead>
<tr>
<th>Category</th>
<th>Bias</th>
<th>StDev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1</td>
<td>0.014</td>
<td>0.06</td>
</tr>
<tr>
<td>Category 2 - Deep</td>
<td>-0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Category 2 - Shallow</td>
<td>-0.014</td>
<td>0.06</td>
</tr>
<tr>
<td>Category 3</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>Category 4 - Deep</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>Category 4 - Shallow</td>
<td>0.11</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Instadose 2: energy response curve

- Response/Delivered
- Energy (keV)

- Deep - Algo
- Shallow - Algo
Instadose 2 Angular Testing

Horizontal Orient.

Vertical Orient.
Instadose 2: angular response (20 keV)

M30 Horizontal - To Dose

M30 Vertical - To Dose
Instadose 2: angular response – 35 keV

M60 Horizontal - To Dose

M60 Vertical - To Dose
Instadose 2: angular response – 75 keV

M150 Horizontal - To Dose

M150 Vertical - To Dose
Instadose 2: angular response – 662 keV
Instadose 2 – Testing in Progress

• IEC 62387 Type Testing
  – Lower Limit of Detection*
  – Dose Linearity*
  – Side radiation testing
  – Temperature testing
  – Humidity testing
  – Light Exposure testing
  – Fading/Self irradiation testing
  – Background radiation testing
  – Drop Testing*

• FCC/CE testing
Instadose 2 at base of Mount Everest

Questions?