The Berkeley Approved Dosimetry Service

Extremity and Eye Dose Assessment at UK Nuclear Power Stations
EURADOS AM2016 – Milan 10 January 2016

Presented by Andrew McWhan
A different point of view?

- Historical Context
- Dosemeter design
- Dose Summation
- Dose levels
- Conclusions
Berkeley Power Station

Berkeley ADS has been here for 50 years

- Construction started January 1957
- Home of Berkeley Nuclear Laboratory
- Berkeley ADS (R & D + services) started 1960
- Fuel removed 1992
The Berkeley ADS

Thermo Fisher Scientific EPDs – the approved dosemeter – whole body, skin & eye/extremity
Extremity & eye TLDs –

35,000 issued / year – glove box, decommissioning pond work & vessel entry
CLIENT LOCATIONS (as at Jan 2016):

- EDF + (8 Sites, 6000 workers)
- Magnox (12 Sites - 4000)
- Babcock (Devonport - 1500)
- Cavendish (Dounreay - 1500)

25% business growth since 2006
Hunt A&B, Chapelcross, Torness, DRDL, Balfour, Hink C (EDF new build), DSRL & RSRL
One dosemeter or two?
### EPD Key Dates

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>1990</td>
<td>EPD Strategy Group convened</td>
</tr>
<tr>
<td>1997</td>
<td>EPD application to HSE</td>
</tr>
<tr>
<td>2000</td>
<td>Oldbury PS – 1st site (in world) – EPD legal</td>
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<tr>
<td>2000-2006</td>
<td>CEGB sites change from film → EPD</td>
</tr>
<tr>
<td>2006-2009</td>
<td>4 Scottish sites join – Hunterston A &amp; B, Chapelcross &amp; Torness</td>
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<tr>
<td>2006</td>
<td>Devonport joins Berkeley ADS network</td>
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The ponds stored used fuel elements after they were removed from reactors, before being sent for reprocessing at Sellafield. Ponds can be decommissioned when all the used fuel has been removed from a site.
Boil in the bag suits
Vinten extremity dosemeter in fingerstall - 1985

J.C. Dutt, E. Greenslade, and T.O. Marshall

Abstract

Extremity dosemeters are usually designed as skin dosemeters and as such should be capable of measuring dose equivalents to the radiosensitive cells of skin. Current designs of extremity dosemeter used in the NRPB extremity monitoring service employ thermoluminescent LiF as the detector in powder form contained in polyethylene sachets or finger stalls. These designs are too thick (30 mg.cm\(^{-2}\)) for the measurement of skin dose. However, Vinten Instruments have developed a new extremity dosemeter with an effective thickness of approximately 12 mg.cm\(^{-2}\) capable of making adequate measurements of beta rays with energy spectra with maximum energies above 0.2 MeV and mean energies greater than 0.06 MeV. Its dosimetric performance has been assessed at NRPB and found to be very satisfactory and trials have been carried out successfully with eleven customers over a six month period. As a result a decision has been taken to introduce the dosemeter into service towards the end of 1985.

Radiation Protection Dosimetry
1997 version 2 – the Thermo EXTRAD

LiF:Mg,Cu,P  7mg cm\(^{-2}\)

Filtration: either
Black PVC 10mg cm\(^{-2}\) (stronger) or
Aluminised polyester 3.2mg cm\(^{-2}\)
(better low energy response)

customer survey before introduction – which choice?: not one response!
January 2014: eye TLD filtration increased - usually worn attached to inside of visor

For $H_p(3)$:

1.5 mm PTFE
~ 3.3 mm tissue

Pond decommissioning - main source $^{90}$Sr/$^{90}$Y (546 keV – 2284 keV)

In lab conditions, $^{90}$Sr/$^{90}$Y $\beta^-$ effectively stopped by visor (2.6mm polycarbonate) + 1.5mm PTFE but the true work place field is much more complicated...
Dose summation & recording – over estimation?

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Eye $H_p(3)$</td>
<td>The sum of the body skin $H_p(0.07)$ component of the EPD plus $H_p(3)$ from any eye dosimeter.</td>
</tr>
<tr>
<td>Extremity $H_p(0.07)$</td>
<td>The sum of the body skin $H_p(0.07)$ component of the EPD plus any $H_p(0.07)$ from any TLD worn on that extremity.</td>
</tr>
</tbody>
</table>

Dose always attributed to eye & extremity even if extremity dosimeter not worn. Practice started in the 1970's to ensure that eye & extremity dose was never under estimated for any period.
Highest individual doses at a decommissioning site
- each row represents the “critical individual worker (eye)” for the year - mSv

<table>
<thead>
<tr>
<th>Year</th>
<th>Whole body - EPD</th>
<th>Skin – EPD</th>
<th>Right arm EPD + TLD</th>
<th>Left arm EPD + TLD</th>
<th>Eye lens EPD + TLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>6.2</td>
<td>11.8</td>
<td>41.3</td>
<td>35.6</td>
<td>28.7</td>
</tr>
<tr>
<td>2011</td>
<td>3.2</td>
<td>7.4</td>
<td>27.3</td>
<td>27.5</td>
<td>14.1</td>
</tr>
<tr>
<td>2012</td>
<td>5.5</td>
<td>17.9</td>
<td>66.6</td>
<td>57.8</td>
<td>33.1</td>
</tr>
<tr>
<td>2013</td>
<td>6.0</td>
<td>27.0</td>
<td>38.9</td>
<td>41.6</td>
<td>37.3</td>
</tr>
<tr>
<td>2014*</td>
<td>9.8</td>
<td>39.7</td>
<td>80.3</td>
<td>76.7</td>
<td>50.3</td>
</tr>
<tr>
<td>2015</td>
<td>6.8</td>
<td>12.7</td>
<td>48.2</td>
<td>51.8</td>
<td>20.9</td>
</tr>
</tbody>
</table>

2014* new eye filtration introduced (but not universally...)}
Conclusions

1) Operational health physics teams not really interested in finer points of dosimetry – they have other things on their minds

2) 20 mSv has been the effective operational limit for the eye lens at UK nuclear power stations since start of 2015 - job done?

3) Increasing filter thickness to 3.3 mm tissue is now helping to reduce *recorded* operational eye dose
THE END!