



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



European Radiation Dosimetry Group

EURADOS →

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



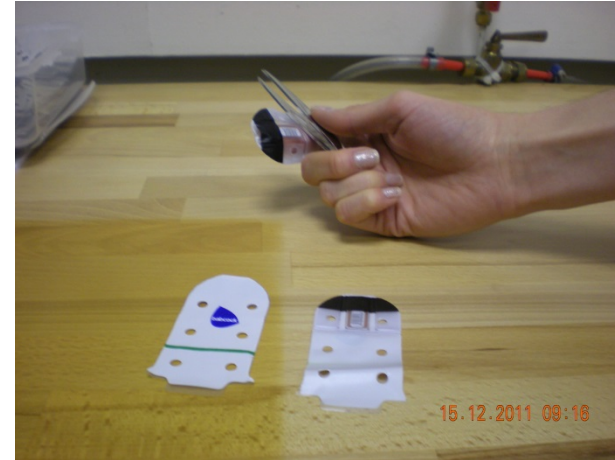
Thermo Fisher Scientific EPDs –
the approved dosimeter –
whole body, skin & eye/extremity



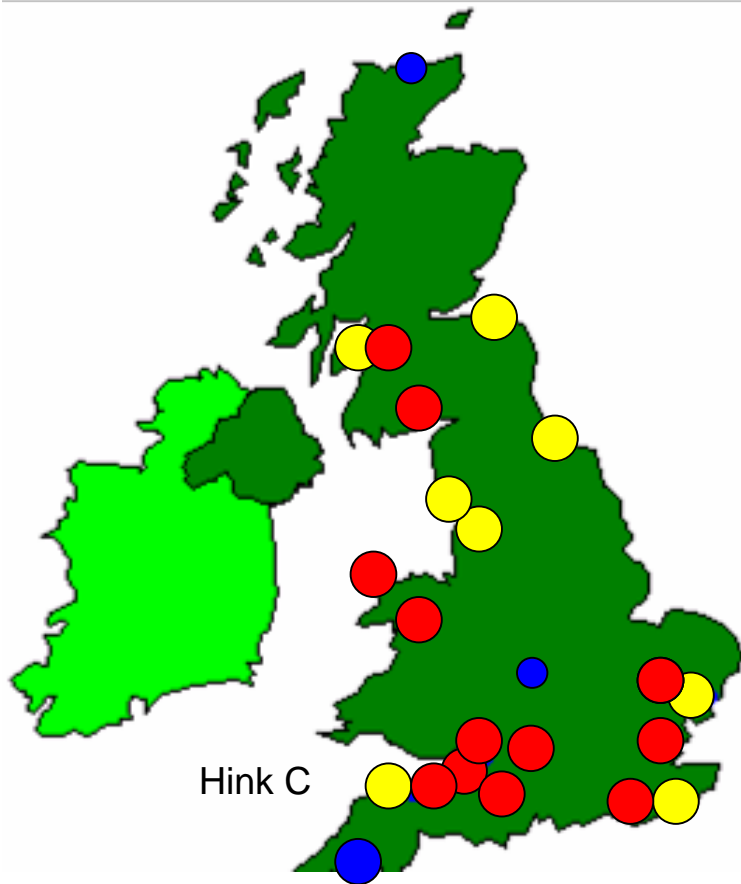
Extremity & eye TLDs –



35,000 issued / year – glove box, decommissioning pond work & vessel entry



Berkeley Approved Dosimetry Service



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 dosimeter or two?

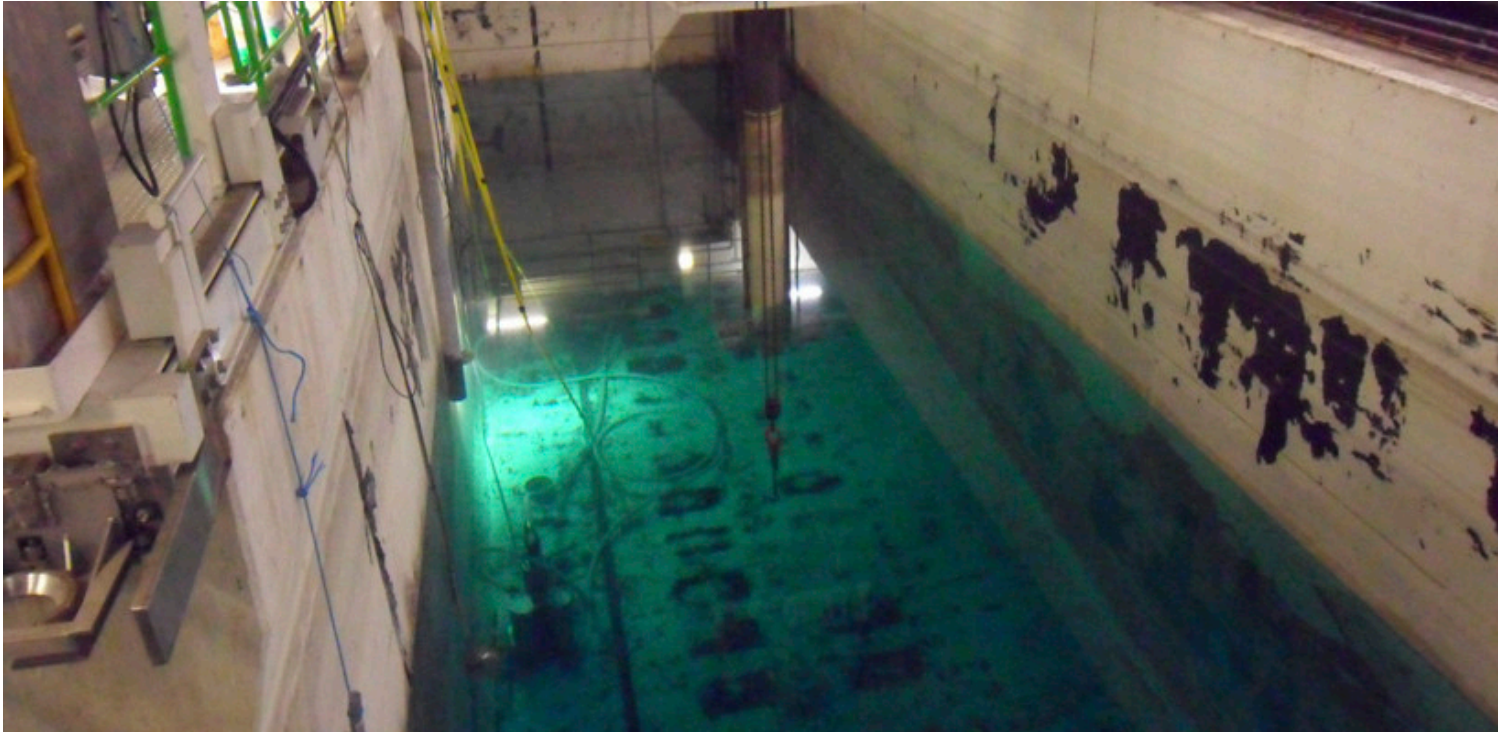


EPD Key Dates



1990	EPD Strategy Group convened
1997	EPD application to HSE
2000	Oldbury PS – 1 st site (in world) – EPD legal
2000-2006	CEGB sites change from film → EPD
2006-2009	4 Scottish sites join – Hunterston A & B, Chapelcross & Torness
2006 	Devonport joins Berkeley ADS network

Decommissioning Activities



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 dosimeter in fingerstall - 1985

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

Abstract

Extremity dosimeters are usually designed as skin dosimeters and as such should be capable of measuring dose equivalents to the radiosensitive cells of skin. Current designs of extremity dosimeter 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 dosimeter 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 dosimeter 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

Berkeley ADS $H_p(3)$ - front view showing PTFE filter



Berkeley ADS $H_p(3)$ - rear view showing bar code

For $H_p(3)$:

1.5 mm PTFE
~ 3.3 mm tissue

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

In lab conditions, $^{90}\text{Sr}/^{90}\text{Y}$ β^- 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?

Eye $H_p(3)$	The sum of the body skin $H_p(0.07)$ component of the EPD plus $H_p(3)$ from any eye dosimeter.
Extremity $H_p(0.07)$	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.

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

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

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 !

