Wearing more than one dosemeter

How do we explain the differences for Hp(10) and gamma radiation?

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How many body dosemeters can you wear?

- **From an approved dosimetry service:**
- **Passive**
  - TLD, OSL, film
- **Active**
  - silicon diode based


- **Control dosemeters**
- **Silicon diode based**
- **GM based**
- **QFEs**

What level of agreement would wearers expect?

- **Typical examples from their own occupation**
- **Mechanical engineers – 0.1 mm in 100 mm = 0.1 %**
- **Electronics technicians - wide tolerance resistors = 5 %**
- **Pressure, temperature etc – 0.5^{0} C at room temperature = 0.2 %**
- **Steel fabricators– 3 mm in 3 m = 0.1 %**
- **Joiners – 4 mm on a door frame = 0.2 %**

- **What could they get from dosimetry?**
- **HSE RADS at <1 mSv, for normal incidence Cs-137, band A**
- **the magnitude of the bias for each of the groups of 5 dosemeters is less than 30%**
- **the relative standard deviation for each of the groups of 5 dosemeters is less than 15%**

If the gods were really against us?

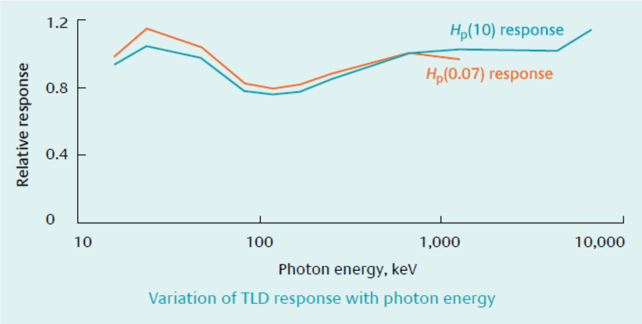
- Admittedly an extreme example
- At 0.6 mSv, two band A dosemeters could quite legitimately give 0.36 and 0.9 mSv for a true 0.6 mSv
- And that is for normal incidence Cs-137 gamma radiation
- Probably the simplest measurement we could make
- So we will never match the level of agreement most measurements achieve

Sources of operational differences between two dosemeters

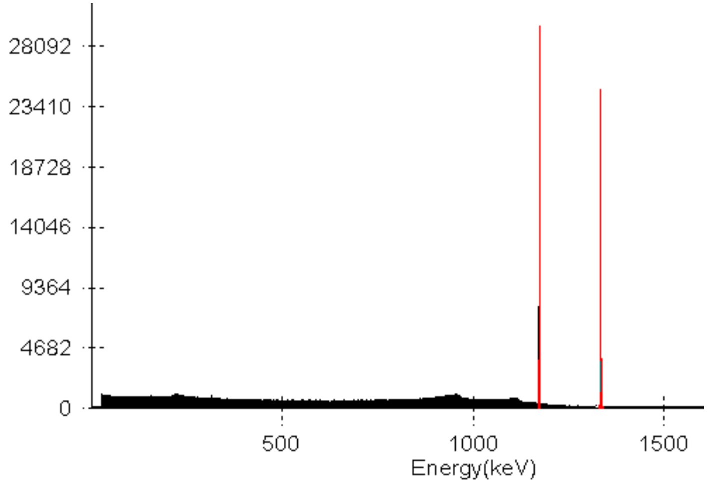
- **Were the dosemeters worn for the same period?**
  - Contractors may work on several sites during the wear period
- **Were they worn close together?**
  - Unless the exposure is unusually uniform, there will be differences
- **Are both dosemeters clipped to the body or can they move away from the body and rotate?**
  - Dosemeters on lanyards can
    - be closer to sources (more dose)
    - Be less well shielded by the body (more dose)
    - See less backscatter (less dose)
    - Rotate
- **Were they the right way round?**
  - I wondered why the numbers were upside down!

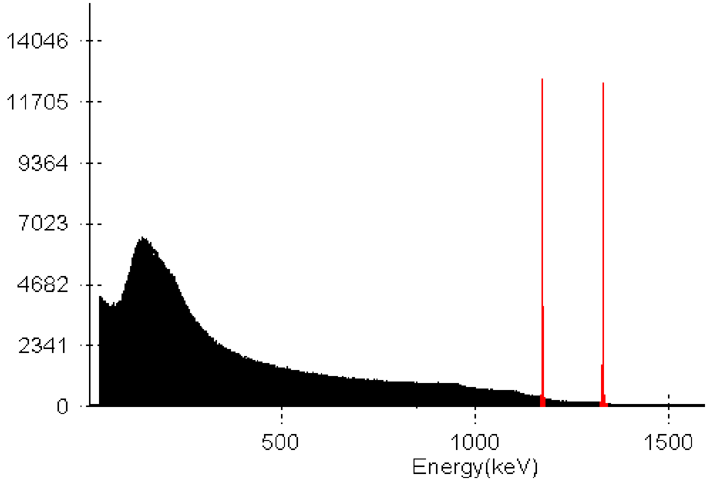
The radiation field

- Every dosemeter has a response which varies with energy and angle
- Typical energy response variation is about 20 % at normal incidence
- Very difficult to predict the radiation field at the position of the dosemeter even when the source is well understood
- Point Co-60 source in free air vs bulk Co-60 contaminated waste



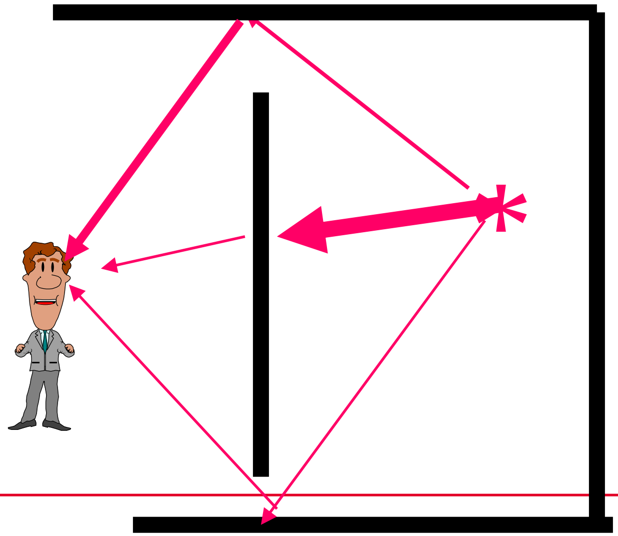
Variation of TLD response with photon energy





Or another way to look at it

- How do you choose the normalisation energy?
- Calibration energy - Cs-137 or Co-60
- Set to unity or to a factor chosen to
- Limit the maximum error (this way madness lies)
- Or minimise the average error (good for the majority, maybe bad for the individual)



Dealing with non tissue equivalent dosemeters

- Non tissue equivalent sensor + filters (+ energy threshold for electronics) + algorithm
- Reliable process provided the algorithm is linear
- i.e. the apparent doses under each element are multiplied by a fixed factor and then added
- Dangerous if it uses ratios between elements to estimate the “effective energy”
- Often it’s possible to think up a hugely different exposure mix which would give the same ratios but very different doses
- Such dosemeters can do well in tests but reality is much harder

Limit of reliable measurement

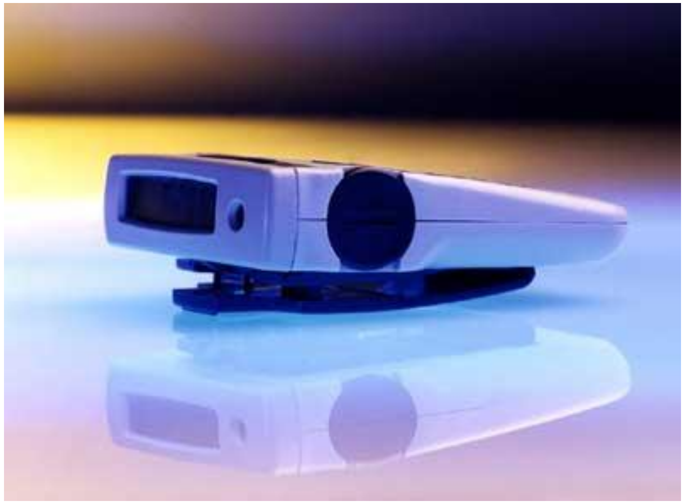
- **Electronic dosemeters – 1 µSv is statistically robust**
  - Thermo EPD = 120 counts for hard gamma
  - Tracerco GM based dosemeter = 3000 counts
- **GM based dosemeters have a high self-dose (glass in the detector) but easy to correct for**
- **Many passive dosemeters have a much higher threshold – 10s of µSv**
- **So potential large differences in reported doses at low dose rates**

Background correction

- Electronic dosemeters randomly issued and logging only each wear period – NO PROBLEM
- Electronic dosemeters issued to an individual and left on over days and weeks – who knows what the local conditions are
- Passive dosemeters stored in a defined position – use local reference value with the co-operation of the dosimetery service
- Passive dosemeters stored by the individual – who knows what the storage conditions are
- And potentially the worst case – left to the dosimetry service to pick a value
- May use a large value to avoid false positives
- Thus generating lots of false negatives

But it's not always that bad

- **Operational experience**
- **AGR boilers**
  - TLD produced an 8 % higher answer on average than a Thermo EPD
  - Credible, given that the EPD is calibrated for Cs-137 and the response drops slightly for Co-60
  - EPD answer actually closer to E
  - But still user concern
- **Submarine refits**
  - Similar performance, again dominated by Co-60



Investigations

- At low dose rates, simple hand-held sodium iodide spectrometers
- Interpretation of spectra takes skill
- Subtract the spectrum from a point source if the main components are Cs-137 or Co-60
- See what’s left.
- MCNP model?
- Directional information from a lead brick with a hole drilled in it and a small sodium iodide detector inside
- Spectral information from the dosemeters
- Time information from the electronic dosemeter

Summary and contentious suggestion

- **So why wear two?**
- **Electronic dosemeters are better Alara tools – alarms, dose with time, energy information, instant results, better low dose resolution, better radiological performance generally**
- **And if your life is simple – low doses, no credible opportunity for excursions – why do you need a dosemeter at all?**
- **Status symbol?**