L15b Validation of external personal monitoring with TLDs /OSL Systems

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How to validate

- Scientific approach
- Systematic assessment of the influence of representative parameters of the result and uncertainty of a measurement method.
- The selection of assessed parameters shall be based on published scientific and technical literature.
- It may be supported by special investigations.

How to validate

- Comparative approach
  - Comparison with other, validated, methods.
  - Use of extended calibration routines with certified standard materials.
  - Participation in intercomparison exercises.
  - Simulation or modelling including expert judgement.

Validation planning

- Validation of external monitoring, using film batches, TLD, or similar devices can be done by:

  - Calibration of the readers and dosimeters by irradiating at a Secondary Standard Dosimetry Laboratory
  - Systematic investigations by using control dosimeters running with the field dosimeters whenever applicable
  - Laboratory intercomparison exercises
  - Performance Testing

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Validation planning

- Start with method selection
- Define acceptable performance criteria
- Plan irradiations to cover the performance criteria
- Do the irradiations
- Evaluate the dosimeters
- Assess the performance criteria
- Issue validation statement

Performance criteria

- The performance criteria are recommended by

- ISO/IEC61066
- “Thermo luminescence dosimetry systems for personal and environmental monitoring” and

- IAEA Safety Guide No RS-G-1.3. “Assessment of occupational exposure due to external sources of radiation”

Performance Requirements

- Batch homogeneity
- Reproducibility
- Linearity
- Detection threshold
- Self Irradiation
- Residual signal
- Energy response
- Isotropy

Further test, additionally to performance requirements:

Pre-irradiation fading

Post-irradiation fading

High dose linearity

Reader stability

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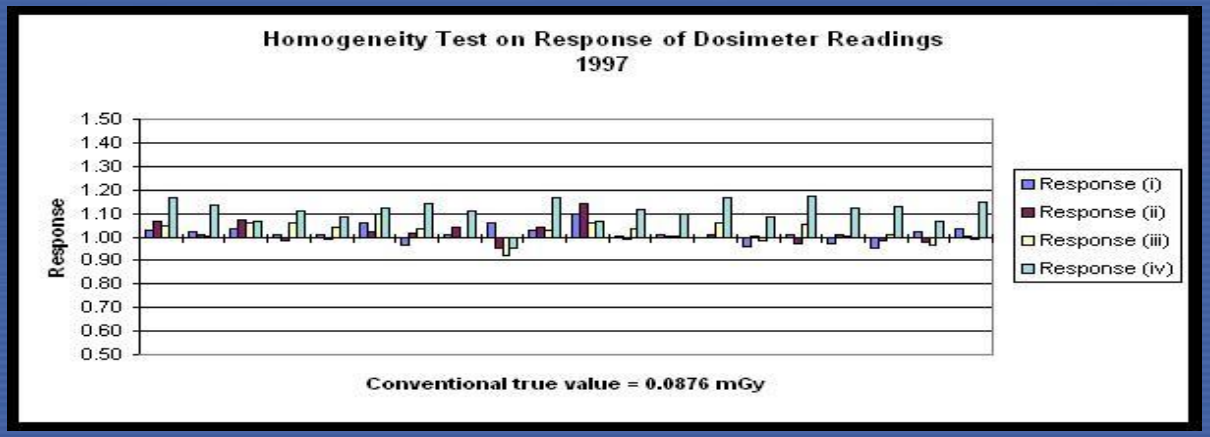
Batch homogeneity

- The evaluated value for any one dosimeter in a batch shall not differ from the evaluated value for any other dosimeter in the batch by more than 30% for a dose equal to 10 times the required detection threshold limit.



Batch homogeneity

- **Method:**
- TLD cards were cleaned with Methanol p.a. and left for drying for at least 2 hours
- The annealed cards were exposed to Sr-90 (irradiator integrated in 6600 TLD Reader) and read out.
- The value E was assessed for each dosimeter.
- E_{max} and E_{min} were determined.

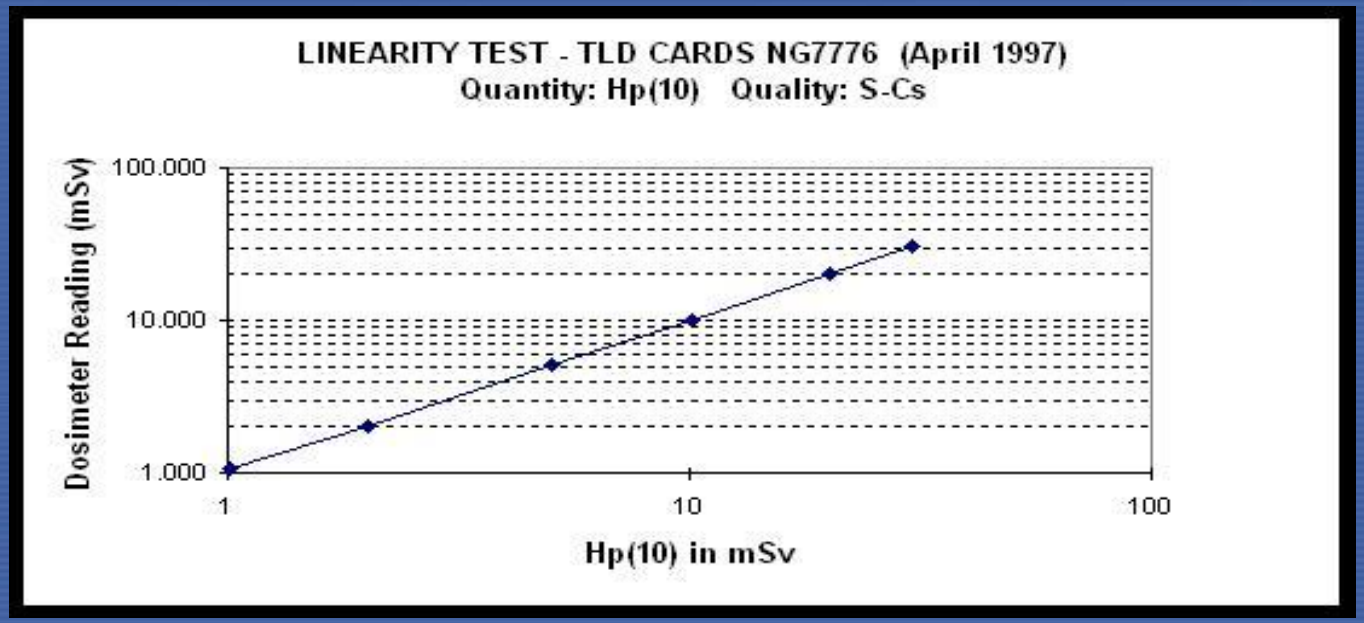
Reproducibility

- The coefficient of variation of the evaluated value shall not exceed 7.5% for each dosimeter separately and all *n* dosimeters collectively for a dose of 10 mSv.

- **Method**:
- Five dosimeters were prepared, irradiated to 10 mSv and read out. This procedure was repeated 10 times.

Linearity

- The response shall not vary by more than 10% over the range:
- 7 mg · cm^{-2}: 0.5 mSv – 1 Sv (50 mrem – 100 rem)
  100mg.cm^{-2}: 0.1 mSv – 1 Sv (10 mrem – 100 rem)



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Linearity

Method

- Prepare, irradiate and read out four groups of dosimeters.
- The dosimeters were annealed before irradiation
- The value E was determined for each group of irradiated dosimeters
- The mean of the evaluated value E was calculated for each group.
- The standard deviation for all groups of dosimeters was calculated.

Detection threshold

- The detection threshold shall not exceed:
- P_e (7 mg · cm^{-2}) 0.5 mSv
- P_e (1 000 mg · cm^{-2}) 0.1 mSv

Method

- 30 dosimeters were prepared and read out.
- The value E was determined for each unirradiated dosimeter
- The mean of the evaluated value E was calculated
- The standard deviation for all 30 dosimeters was calculated

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Self Irradiation

- After a storage period of 30 d, the zero point shall not exceed:

- P_e (7 mg · cm^{-2}) 0.5 mSv
- P_e (1 000 mg · cm^{-2}) 0.1 mSv

Self Irradiation

- Method

- Prepare 30-40 dosimeters and store them for 30 days under standard test conditions in a location where the background dose rate is known.
- Read out the dosimeters and determine the value E.
- Calculate E and s_E.
- Determine the conventional true value C_b (background irradiation)

Residual signal

- After irradiation with a conventional true value of 100 mSv, the required detection threshold shall not be exceeded and the response shall not change by more than 10% at a dose level of
  2 mSv

Residual signal

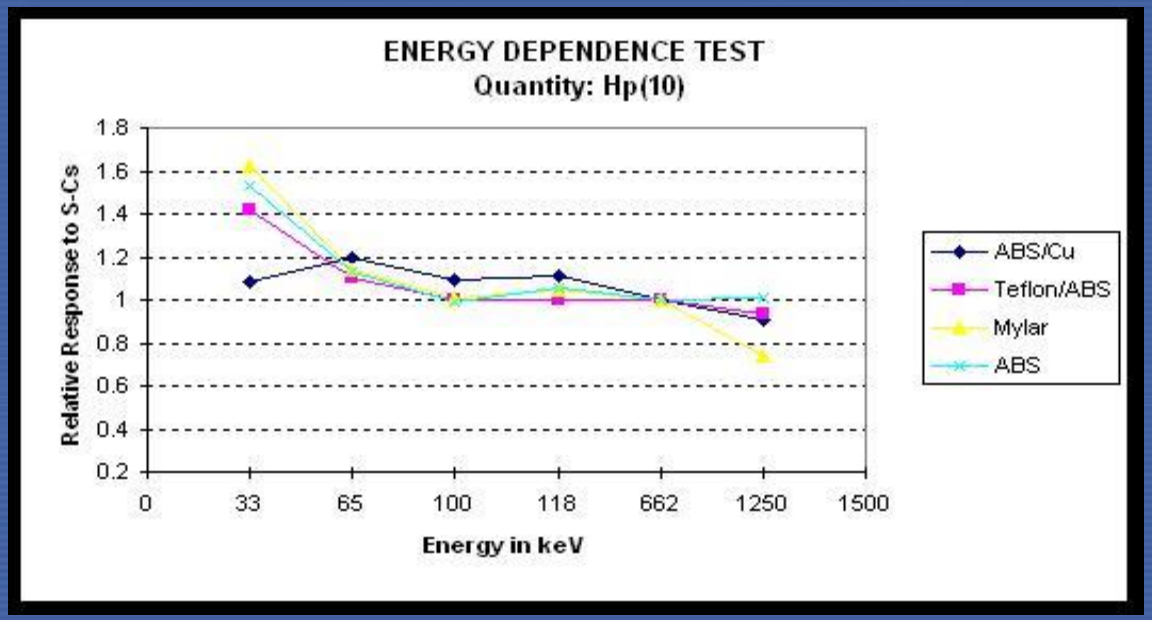
- **Method**
  - Four dosimeters were prepared, irradiated to 100 mSv and read out.
  - The same dosimeters were irradiated to 2 mSv and read out.
  - The value E was determined for each dosimeter.
  - The mean value E and the standard deviation were calculated

Energy response

- When irradiated with photons in the range:
  15 keV – 3.0 MeV, the evaluated value shall not differ from the conventional true value by more than 30%.
- When irradiated with beta rays in the range (E_{max}) 0.5 MeV to 3.0 MeV, the response shall not vary by more than 30%.

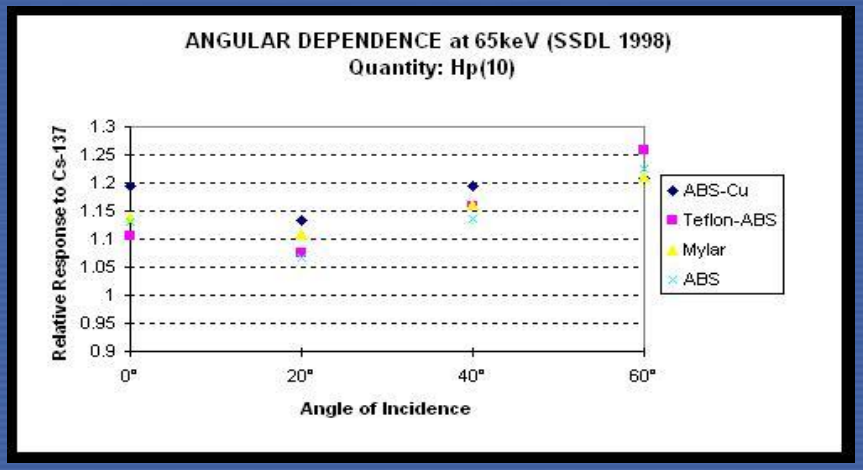
Energy response

- Method
- Several dosimeters irradiated at the IAEA SSDL with the following radiation qualities:
  N-40, N-80, N-120, N-150, S-Cs, S-Co



Isotropy (Directional dependence)

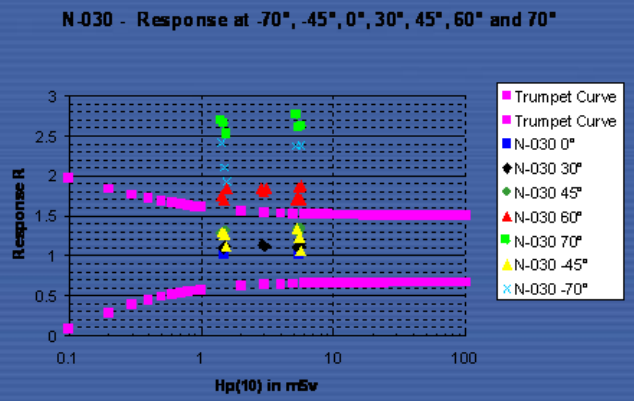
- When irradiated in two perpendicular planes with photons of (60 ± 5) keV, the mean value of the responses at an angle of incidence of 20º, 40º and 60º from normal shall not differ from the corresponding response for normal incidence by more than 15%

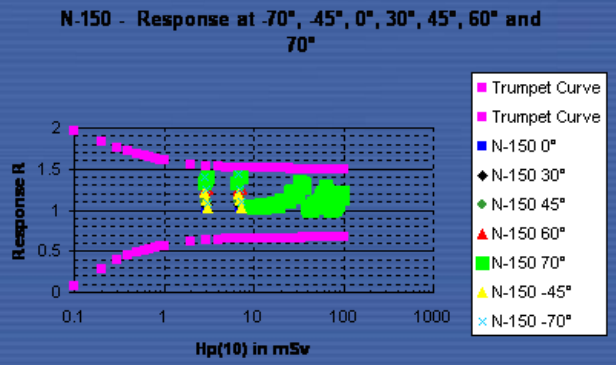


Isotropy (Directional dependence)

- **Method**:
- Radiation quality N-15 to N-300, S-Cs, S-Co
- Dose range of 1-5 mSv and 5-10 mSv and
- Angles of incidence:

  -30°,-45, -60°,-70°, 0°, 30°, 45°, 60°, 70°



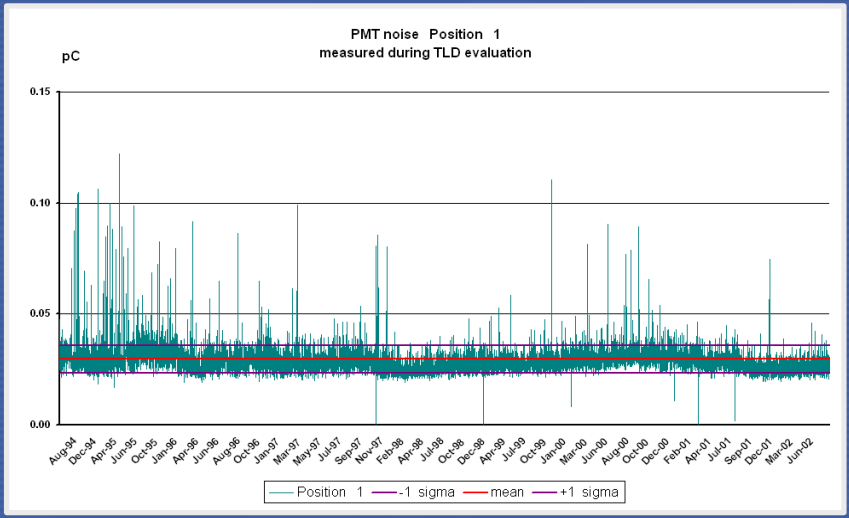


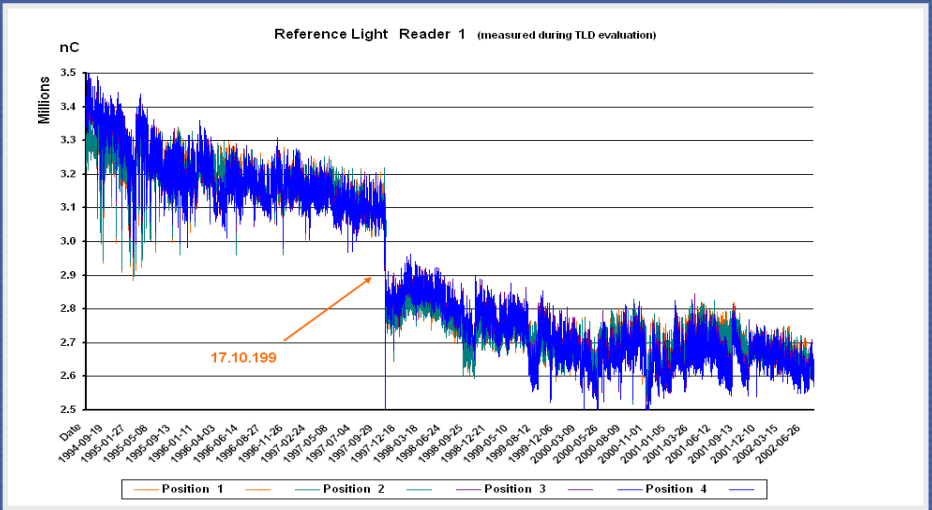
Reader stability

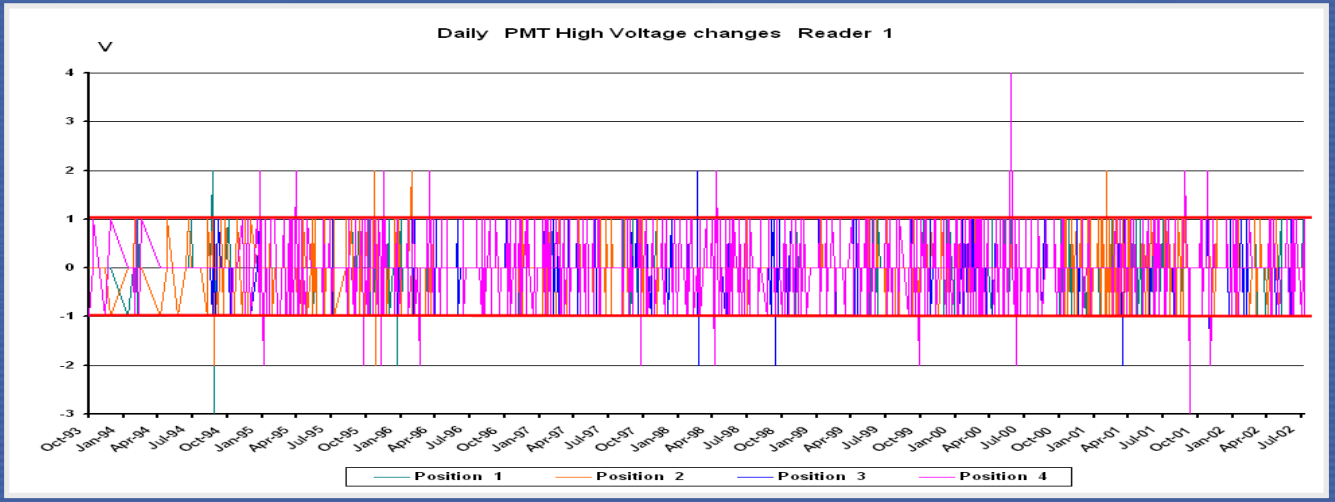
- The evaluated values of dosimeters read out 24 h apart and 168 h apart shall not differ from each other by more than 5% and 10% respectively.

- Test Method:
- The reader stability is checked by quality control of the PMT noise, the reference light and the RCF behavior over the time.

Reader stability







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Resume

- In this lecture we have discussed on how to:

➢ Perform validation of external personal monitoring with TLDs /OSL Systems using published scientific and technical literature based parameters