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HUMAN ERROR REDUCTION TECHNIQUES ENCOMPASSED IN PERSONAL MONITORING SERVICES AT TLD LAB, KUDANKULAM NUCLEAR POWER PROJECT

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SUMMARY

Personnel monitoring services in a nuclear power plant plays an imperative role in Radiation Safety. Adequacy of radiation safety to radiation worker could be ensured by accuracy in assessment of individual dose. Rigorous administrative controls and engineered controls are implemented in Personal Monitoring Services at TLD laboratory, Kudankulam Nuclear Power Project, which facilitates effective reduction in human error in estimation of individual dose and assuring the accuracy.

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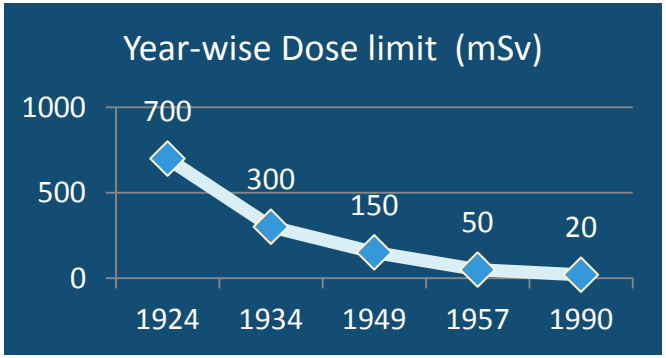
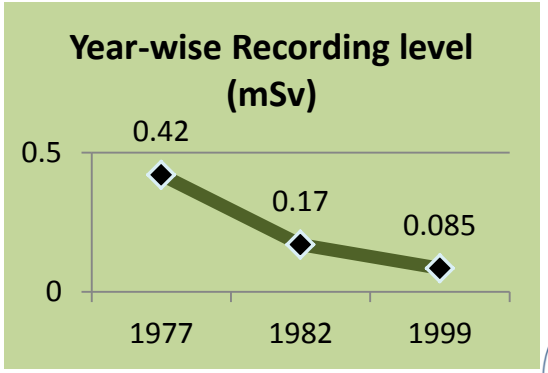
INTRODUCTION

- About 1500 radiation workers involved in Operation and Maintenance activities at KKNPP
- Personal Monitoring Services enables control of individual exposure within the dose limits stipulated by Atomic Energy Regulatory Board (**AERB**) for occupational workers and supports the measures to be taken for further reduction of doses to as low as reasonably achievable (ALARA).
- Reduced limits have obviously increased the demands on the requirement of individual monitoring in terms of accuracy, performance and recording level.
- Human errors were reduced to a greater extent by implementing various measures through engineering controls and administrative controls.





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ERRORS CONTRIBUTING TO OVERALL UNCERTAINTY

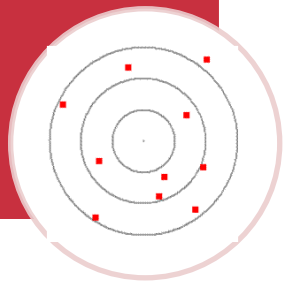
Overall uncertainty of a dosimetric system is determined from the combined effects of the two types of errors namely

- **Can be reduced by increasing the number of measurements. Random error is always present in a measurement. It is caused by inherently unpredictable fluctuations in the readings**

Typical sources of Random error :

- In-homogeneity of detector sensitivity
- Variability of detector readings due to limited sensitivity and background
- Variability of detector readings at zero dose.

Random error

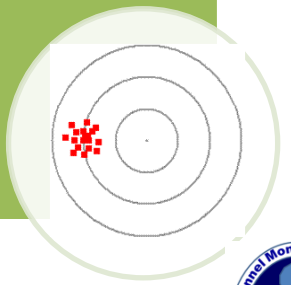


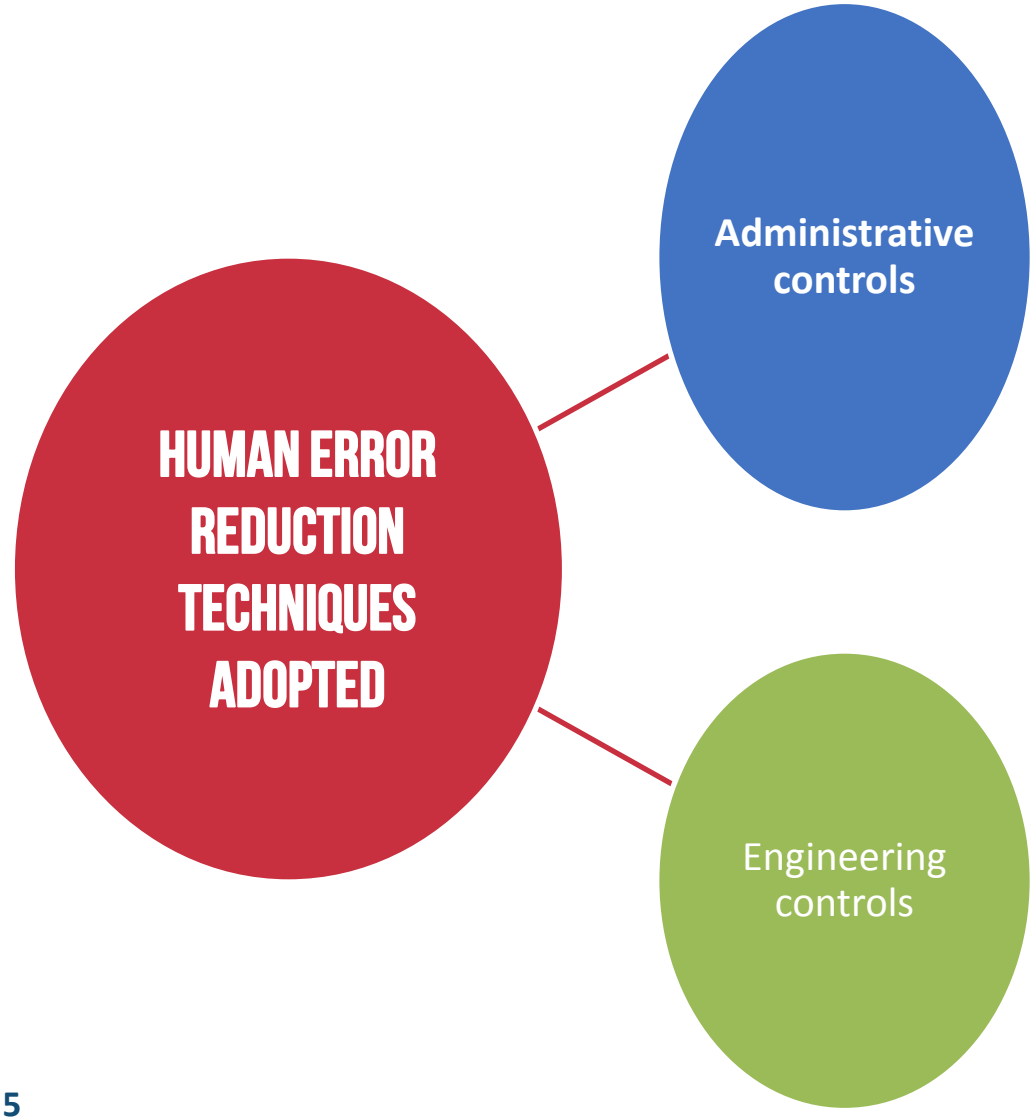
Systematic error is predictable and typically constant or proportional to the true value

Typical sources of Systematic error:

- Energy dependence, Directional dependence
- Non-linearity of the response
- Fading, Effects due to exposure to light, mechanical shock
- Effects due to exposure to types of ionizing radiation that are not intended to be measured by the dosimeter
- Calibration errors, Variation in local natural background

Systematic error





- Multiple Exposures For Reader Calibration
- Software for dose estimation
- Software for updating TLD card status and history
- Usage Of Checklist Cum Datasheet
- Peer Review Of Data
- Colour Codification Of TLD Wrapper/Cassette

- Multichannel Nitrogen Gas distribution System
- Auto-Irradiator System

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Old system

Calibration Table

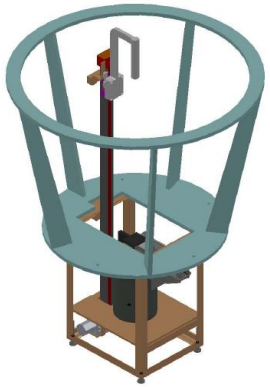
- Difficulties in positioning of source at the central designated point
- Error in exposure time due to positioning or removing the source after completion of exposure time.
- The source getting disengaged from the tong and falling down on floor or table.
- Non-uniform exposure of TLD cards due to transportation of source from pit to table and back.

New system

Auto Irradiator

The features of Auto-irradiator system are:

1. Accuracy in dose delivery.
2. Reproducible geometry
3. Reduction of operator dose.



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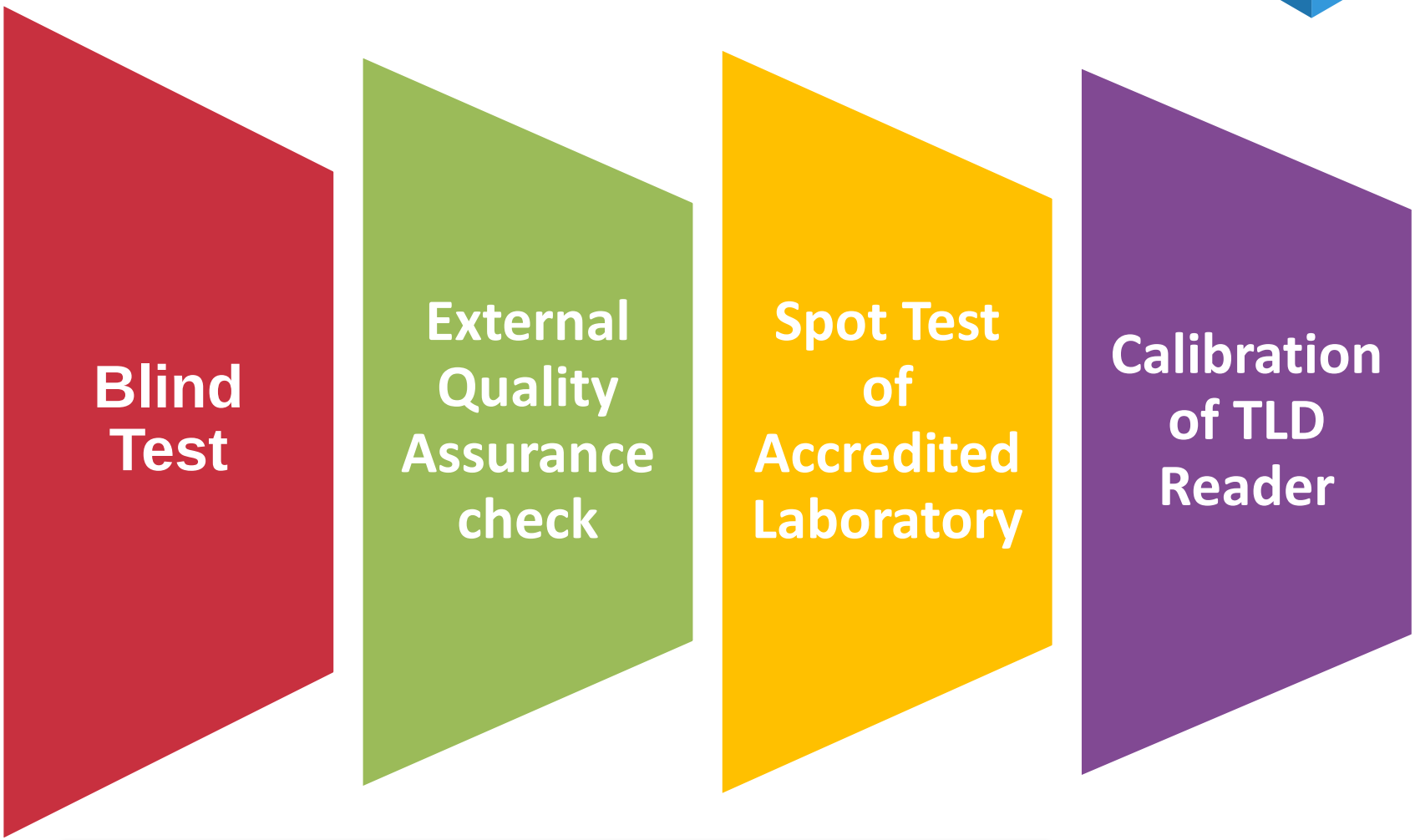
ASSESSMENT



- ANSI 2009 Criteria:
- Trumpet curve analysis:

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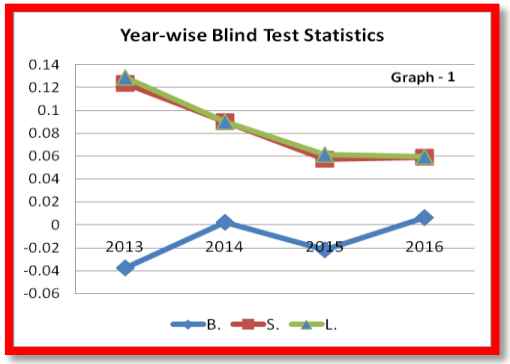
OUTCOME

Blind Test

External Quality Assurance check

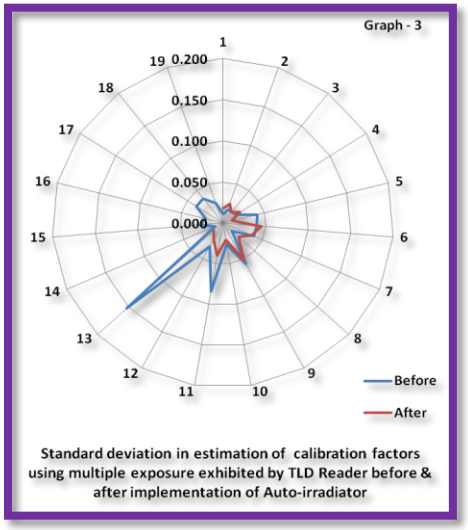
Spot Test of Accredited Laboratory

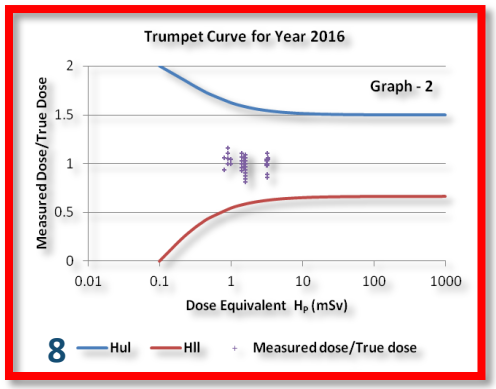
Calibration of TLD Reader



Year-wise Performance parameters			
Cycle (Year)	B	S	L
38 (2012)	-0.03	0.12	0.15
39 (2013)	0.00	0.13	0.13
40 (2014)	0.13	0.20	0.24
41 (2015) *	0.04	0.09	0.10

Year-wise Performance parameters			
Year	B	S	L
2013	-0.03	0.06	0.09
2015 *	0.04	0.06	0.07





*** After implementation of the Auto irradiator**

B & S are the Bias & Standard deviation of the Performance Quotient;
L is the Tolerance level

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CONCLUSION

The implementation of suitable corrective measures through administrative and engineered controls has helped effectively reduce the identified human error possibilities.

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thank
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HINTS

- Personnel Monitoring Service in India was first started by Radiological Monitoring Laboratory in 1955 for DAE at TIFR.
- The dose limit at that time was 15 R/yr.
- Dose limit was reduced to 5 Rem/yr in Year 1957
- In 1974 a new monitoring device, TLD, was introduced with manual reader. Both the dosimeter and the reader were developed indigenously by DRP
- First semi automatic TLD Badge Reader introduced (1998)
- Dose limit gradually reduced to 20mSv/yr (1998 – 2000)
- Film badge was completely phased out (2003).
- Minimum reporting level for gamma brought down to 0.1mSv from 0.2mSv2005.
- In the meantime, TLD labs were established in every NPP and other organizations within DAE to cater to the increasing PMS requirements.

Year	DL (mSv)
1902	30000.0
1924	700.0
1934	300.0
1949	150.0
1957	50.0
1990	20.0

Year	Recording level (mSv)
1977 ICRP26	0.42
1982 ICRP 35	0.17
1999 ICRP 75	0.085

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ICRP recommendations 35 indicate acceptable levels of uncertainty
at two dose levels:
(a) In the region near the relevant dose limit, a factor of 1.5 in either direction is considered acceptable;
(b) In the region of the recording level, an acceptable uncertainty of ±100% is implied.
ICRP publication [24] recommends that a factor of two in either direction is an acceptable uncertainty for doses of about one-fifth of the relevant dose limit. On this basis, the allowable accuracy interval can be smoothed as a function of dose level [25].

The upper limit RUL is given by:

$$R_{UL} = 1.5 \times \left(1 + \frac{H_0}{2H_0 + H_1}\right)$$

The lower limit RLL is given by:

$$R_{LL} = \begin{cases} 0 & \text{for } H_1 < H_0 \\ \frac{1}{1.5}\left(1 + \frac{2H_0}{H_0 + H_1}\right) & \text{for } H_1 \geq H_0 \end{cases}$$

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