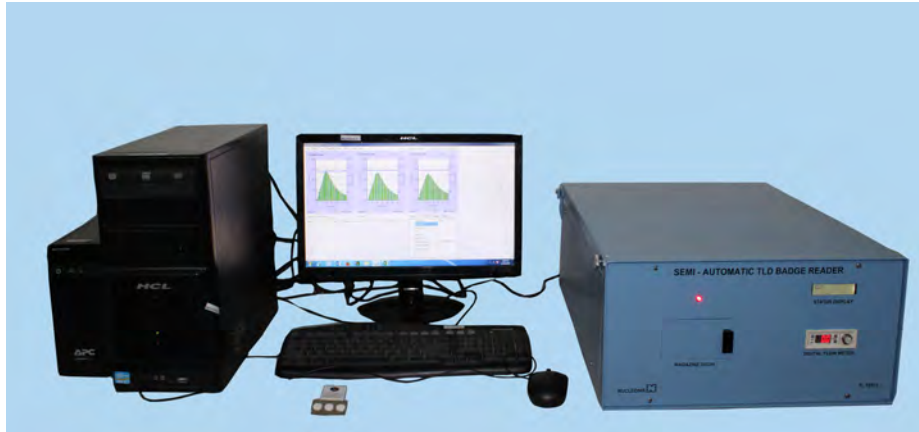


## SEMI-AUTOMATIC TLD BADGE READER

TYPE: TL1010S

## Technical Data



## Key Hardware Features :

- All DC motors are replaced by low power & low noise stepper motors for precise motion.
- Proven Nichrome Heater assembly, is used in the design.
- Temperature Stabilized LED Light source or Ni63 based **light source card** is used for PMT gain stability check as & when required.
- **Digital Flow rate** measurement instead of rotameter based design to ensure flow rate is within limits during entire readout cycle. This prevents readout when gas flow is beyond limits.
- Improved heat dissipation to prevent temperature rise within the PMT assembly resulting in better stability of readings.
- SMPS based power supplies for operating over wide voltage ranges.
- Mother board based design for easy maintenance of electronic sub-assemblies.
- Uses compact imported HV module for high stability and low ripple & drift.
- Automatic magazine home recognition & positioning.

**Semi Auto TLD Badge Reader TL1010S** is a personal monitoring system, designed to read the TLD card (TL dosimeters) worn by radiation workers.

This Badge Reader system is designed using state of art electronics, improvised electro-mechanical system, embedded code and software to load and read the TLD cards for TL glow curve / dose. System facilitates entry of ID number for the person and his dose record and glow curve can be stored in the system. TL dosimeter is heated by hot gas ( $N_2$ ) jet to  $285^\circ C$  using a Nichrome heater assembly & TL output is recorded using PMT where integral of the current output is proportional to the dose.

It is a Thermoluminescent dosimeter based personnel monitoring system. Thermoluminescent dosimeters make use of the property of certain materials which absorb energy when exposed to X, Gamma or Beta radiation. On heating, the absorbed energy is released in the form of visible light. A plot of light intensity emitted against temperature is known as a glow curve. For a given heating rate, the temperature at which the maximum light emission occurs, is called the glow-peak temperature and it is characteristic, of the individual TL material (also called phosphor).

The quantity of the visible light emitted (TL output) is found to be proportional to the energy absorbed by the TL material.

The TLD personnel monitoring system essentially consists of two major parts: TLD badge and the TLD badge reader.

The TLD Badge Reader comprises of a plastic cassette containing three Teflon TLD discs (13.3mm and 0.8mm thick) that are mechanically clipped on to circular holes (12.0mm) punched in an aluminium card (52 x 30 x 1mm).

The TLD Badge Reader is designed to measure X, Gamma and Beta radiation dose. The metal filter combination (1mm Al + 0.9mm Cu) is provided to reduce the photon energy dependence of the TL discs. The TL badge reader is calibrated such that the TL output of the disc under the metallic filter reads directly the gamma radiation dose.

## A. HARDWARE SPECIFICATIONS :

### Dosimeter :

Three-element BARC  $\text{CaSO}_4$  (Dy) PTFE disc dosimeter badge

**Light Measurement System:**  
Photo-multiplier tube (R6094 or its equivalent) bialkali Light measuring system (LMS). The I-F converter linearity is better than  $100\mu\text{A}$ .

### Dark current :

Dark current is  $1\mu\text{Sv}$  ( $\text{CaSO}_4$ ) equivalent with software-based sampling & subtraction.

### Heater Element :

Nichrome wire heater assembly.

### Heating Method :

Hot gas ( $\text{N}_2$ ) heating.

### Nitrogen flow rate measurement :

Digital flow rate meter

### Heating Cycle :

The temperature is raised to  $285^\circ\text{C}$  in 8-10 sec and clamped at  $285^\circ\text{C}$ .

### Dose Range :

Reader is capable of reading badges from  $50\mu\text{Sv}$  to  $2.0\text{Sv}$  automatically and the dose response is linear over the entire range.  $50\mu\text{Sv} - 10\text{Sv}$  (Gamma) and  $100\mu\text{Sv} - 10\text{Sv}$  (Beta).

**Dose Threshold :**  $<50\mu\text{Sv}$

**Readout time :** 100 sec. per badge

**Residual TL :** 8 to 12% of initial TL in the linear dose range specified.

**Light source:** Temperature stabilized LED light source or Ni63 based light source card is provided for PMT check & gain adjust.

**Flow Rate Measurement :**  
A digital flow measurement system is provided for flow rate measurement & failure check.

**Facilities Available:** Entry of personnel for badges editing of calibration factor etc. Storage of dose and glow curve data of badges in database. Stepper motor based drive assembly is provided for magazine & TLD card transport in a magazine. Digital linear actuators are used for TLD card raise & shutter control.

**Software :** Win 7 compatible software developed on .net platform for storage of readings in a database and display of glow curves, computations of dose & generation of dose reports.

### Temperature Monitoring :

Two Chromel Alumel thermocouples in hot gas stream, one called 'Heater Thermocouple' inside heater & the second called 'Air Thermocouple', in hot gas stream.

**Range Selection :** Auto-changeover

### Calibration :

Coarse adjustment by varying the EHT through a potentiometer in the EHT circuit; fine through software.

### Safeguards :

Heater/Gas flow failure: The heater and gas flow are checked for failure in every dosimeter readout cycle. In the event of failure of heater or gas flow the readout is terminated and a message indicating heater / gas flow failure is flashed on the PC monitor.

Mechanical Failure: Any mechanical failure during readout cycle is sensed by the programme and the cycle is terminated with an option for the user to restart the cycle. EHT & input circuit (I-F converter) are also sensed and reading cycle is terminated in case of failure.

### Nominal Power Supply :

Power supply : 230V, 50Hz :  $\pm 10\%$   
Power requirements: 500 VA (max including PC).

### PC Requirements:

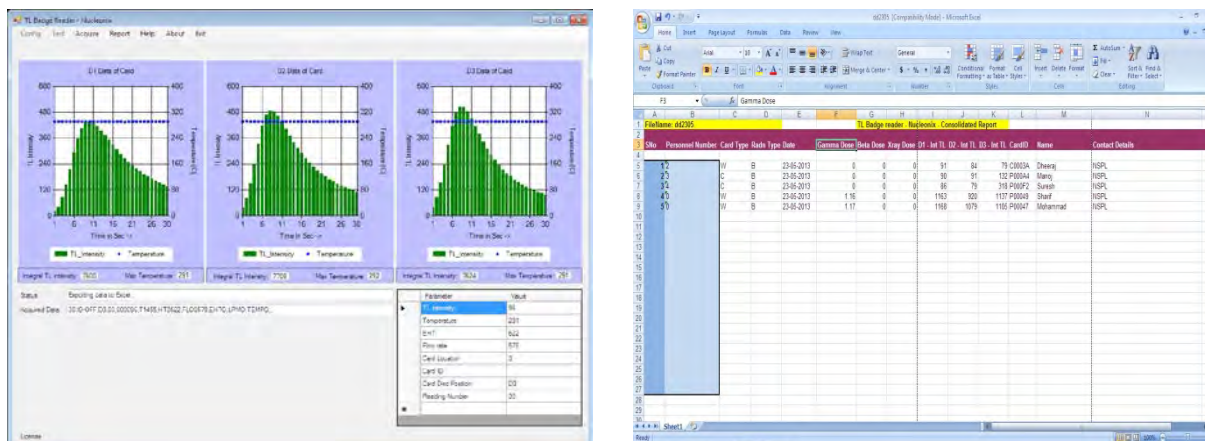
Suitable latest PC configuration with win 7 Operating system or as requested.

### Applications:

Personnel Monitoring of radiation workers in Nuclear power stations, Isotope laboratories, Industrial radiography installations, diagnostic & therapeutic radiology centres, etc.

## B. SOFTWARE FOR TL BADGE READER

The software for TL Badge reader serves as comprehensive 'TL Dose records management software'. It is user-friendly, reliable and feature rich. It has powerful fault diagnostics reporting capabilities.



### Key features of Software:

- Provides Commands for complete control & fault diagnostics of the Reader that includes checking of Light Source, Dark Current, Heater, Gas flow, EHT, Mechanical movements.
- Provides screen to enter Institution, Personnel and Card details prior to acquisition.
- Acquisition of up to 50 cards can be done in one go.
- During acquisition, parameters like EHT, Temperature, TLD number, Institution number, File name, Card position in magazine, card number, TL glow curve is displayed on screen.
- Acquisition can be paused & resumed without any loss of data.
- Fault checks are performed during acquisition and reported to user.
- Calibration factors for Reader and D1, D2, D3 positions can be set.
- Dose calculator is provided for calculation of Dose by manually entering Integral TL values for D1, D2, D3 positions.
- Glow curve data is stored in Text file and can be optionally exported to Excel.
- Glow curve data can be viewed at a later date individually for each card & printed.
- Dose values for each card, Personnel numbers are written to a batch file.
- Dose information can be optionally written to Nucleonix Dose Records management database and User wise Cumulative Dose reports can be generated.

### Suggested spares:

- Solenoid valve
- Heater assembly
- Heater coil
- Opto interrupter boards
- Digital rotameter
- EHT module (0-1200V @ 0.5A)

### Additional Accessories / Items Required for personnel monitoring TLD Lab

- Three element (BARC Developed)  $\text{CaSO}_4$  (Dy) PTFE disc dosimeter badges
- Magazine to hold 50 TLD cards
- Annealing oven
- Nitrogen cylinder / Generator with regulator
- Radioactive source exposure device for TLD cards calibration
- Light Source Card

**\* Note : Manufactured by NUCLEONIX SYSTEMS based on original Technology received from Bhabha Atomic Research Center, Mumbai, by incorporating improvements in design to achieve high reliability.**

## C. ACCESSORIES

### (i) HOT AIR ANNEALING OVEN

In Hot Air Annealing oven there is one path of circulating Hot Air in between the inner chamber and insulation. Forced Air Moved by the motorised blower is called Perfect System. It result minimum temperature variation at any point in working space. Temperature controlled by PID type Digital controller cum indicator with safety alarm from room temperature to 350/400<sup>o</sup> C with a sensitivity of +/- 1<sup>o</sup>C or better in Bare Oven. Working chamber is made of stainless steel and outside made of mild steel painted with good stoving enamel with adjustable trays. To work on 220 /230 volts A.C single phase supply.



**Working Chamber size** :14" x 14" x 14" (Approx) ; Litres :43

**No.of trays** : Two

**Heaters**: 80/200 Nichrome elements

**Working Temperature** : From ambient to 350<sup>o</sup> C / 400<sup>o</sup> C

**Temperature Accuracy**: +/- 1 degree , in bare oven

**Temperature Indication & Control**: Temperature controlled by PID type digital controller cum indicator with safety alarm

**Digital timer** : Digital timer of (0-99) Hrs can be set

**Air circulation System** : For maximum uniformity of temperature inside the working chamber, air circulating system is provided by means of a meter driven fan.

**Heaters** : Heaters are made out of best quality Nichrome Wire insulated with refractory runners and enclosed in stainless sheet and fitted to the sides of the Oven.

#### **Construction of Oven Body:**

**Interior** : Polished stainless steel 304/ Anodized Aluminum / SS.316 (GMP Model)

**Exterior** : Heavy gauge Mild steel / SS304 (GMP model)

**Chamber** : Double Walled

**Ventilation** :Air Ventilators are provided near the top of the sides for removing hot gases and fumes

**Insulation**:75mm thick Mineralwool  
**Shelves** : sturdy Elegant –fabricated precisely to give minimum resistances to air circulation.

**Finish** : Finished with attractive and durable powder coated in pleasant shade

**Door** : An insulated hinged side swinging type double walled door with asbestos gasket , ball catch lock and handle provided for easy and effortless closing & opening of door.

**Insulation**: High grade ceramic fibre blanket insulation is provided on all the six sides of the Oven  
**Power Rating**: 2.5 K.W.

**Input Supply** : Single phase AC, 230 Volts

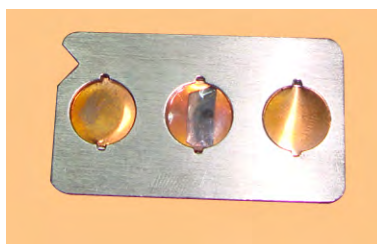
**(ii) TLD CARD**

Three  $\text{CaSO}_4$ : Dy Teflon TLD discs are mechanically clipped on an Aluminium plate. An asymmetric "V" cut is provided in the card to ensure its loading in the plastic cassette as well in heater drawer / magazine of TLD reader in only one orientation. Aluminium card should be uniformly Nickel plated or buffed, having plating thickness of about 10 micron.

**Characteristics of  $\text{CaSO}_4$  : Dy Teflon TLD disc**

Ratio of $\text{CaSO}_4$ : Dy and Teflon	:	1: 3
Effective Atomic Number (Z)	:	15.1
Density of the TLD Disc	:	2.52 g/cm <sup>3</sup>
Softening Point of Teflon	:	330° C
Main Glow Peak Temperature	:	230° C
Sensitivity of TLD Disc	:	About 30-40 times more than LiF TLD-100
Fading	:	2-3% in six months
Climactic Effect	:	Negligible
Effect of Sunlight	:	Negligible when covered by paper wrapper & polythene pouch and loaded in the badge
Useful Linear Dose Range	:	0.10 mSV to 20 SV (linearity within + 10%)
Reusability	:	20 cycles
Beta Response	:	60% of $^{60}\text{Co}$ gammas for Nat.U (effective energy 0.8Mev)
Thermal Neutron Response	:	$^{60}\text{Co}$ gamma ray equivalent to 2.4 mGy per 1010 n/cm <sup>2</sup>
Fast Neutron Response	:	Negligible

**LIGHT SOURCE CARD :** Ni-63 wrapped inside plastic scintillator, mounted in a dummy TLD card is used as the light source. This can be placed in a magazine to read PMT stability counts, whenever required over the day. This eliminates disadvantages encountered in the previous design, such as Ni-63 getting over heated along with plastic scintillator thereby causing damage to Ni-63 source.



### (iii) TLD CASSETTE

Three well-defined regions in the plastic cassette / holder corresponding to three TLD discs of the TLD card.

- Disc D1- sandwiched between a pair of filter combination of 1.0mm thick Cu (Copper filter nearer to the disc).
- Disc D2- sandwiched between a pair of 1.6mm thick (180mg/cm<sup>2</sup>) plastic filters and
- Disc D3- under a circular open window.

The asymmetric “V” cut of the card permits its loading in the plastic cassette in only one orientation and ensures proper positioning of three disc.

For identification purposes, photograph of the user could also be permanently fixed on the central transparent region of the badge.

There are two types of TLD badges/ cassettes in use namely,

1. Chest Badge for whole body monitoring and
2. Wrist Badge for extremity dosimetry

Though the dosimeter and design of both TLD badges are same, they have different attachment (clip/strap) for wearing purpose depending on their use.

### TLD CASSETTE DIMENSIONS

In this design of the TLD cassette, dimension of some of the filters was altered and crocodile clip was replaced by a smaller size clip. The cassette was made of ABS plastic (white) and filters were embedded into the plastic body.

