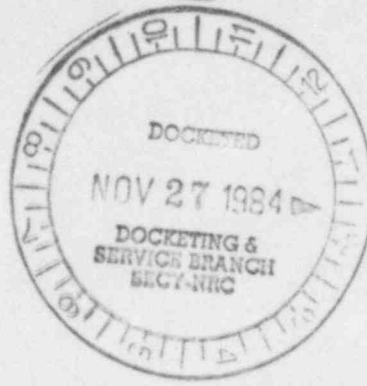


50-400-OL  
10/22/84

A-25

Applicants' Exhibit 25  
Joint Contention IV  
Docket No. 50-400 OL



Specifications of TL Badge and  
TL Badge Hanger  
(Thermoluminescent Dosimeters)

NUCLEAR REGULATORY COMMISSION

Docket No. 50-400-OL Official Exh. No. 25

In the matter of Asherson/Harris

Staff \_\_\_\_\_

Applicant K IDENTIFIED V

Intervenor \_\_\_\_\_ RECEIVED V

Cont'g Off'r \_\_\_\_\_ REJECTED \_\_\_\_\_

Contractor \_\_\_\_\_

Other \_\_\_\_\_ DATE 10-22-84

Reporter gsw Witness \_\_\_\_\_

8412170348 841022  
PDR ADOCK 05000400  
G PDR

SPECIFICATION OF  
TL BADGE  
MODEL SPECIFICATIONS

UD-801A  
UD-802A  
UD-803A  
UD-804A  
UD-806A  
UD-807A  
UD-808A  
UD-809A  
UD-811A  
UD-815A

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# MODEL SPECIFICATIONS

TL Badge : UD-802A group

Refer to the GENERAL SPECIFICATIONS for common specifications.

1. Model number : UD-802AQ , UD-802AR , UD-802AS
2. Use : Personnel monitoring
3. Applicable reader : UD-710A, UD-702E, UD-720A
4. Appearance : Fig. 1
5. Element and shield composition : Table 1
6. Measurable rays and range :  $\gamma$ -x rays (10keV ~ 10MeV) 1mrem ~ 1000rem  
(Rough energy evaluation is possible)  
B rays (0.5MeV ~ 4MeV) 10mrem ~ 1000rem  
( Measurable range is in the case where single kind of rays is measured. )
7. Recommended hanger : UD-875A, UD-885A
8. ID number : Specified serial numbers (7digits at maximum) are punched.
9. Label : The labels shown in Fig. 1 are stucked.
10. Weight : Less than                      grams.

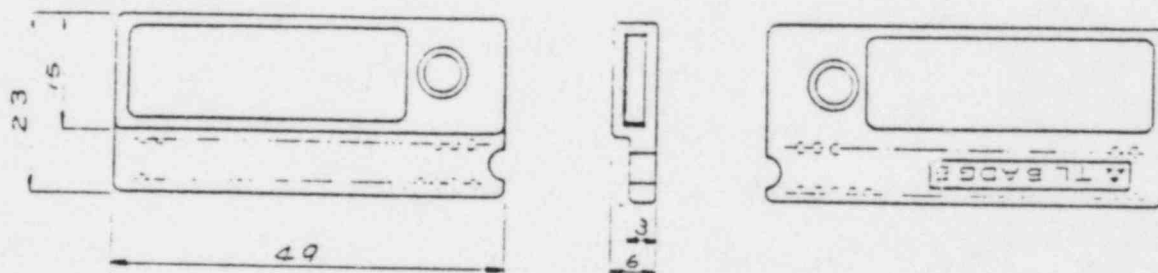


Fig. 1 Appearance of TL Badge: UD-802AQ  
(The figure also applies to UD-802AR and UD-802AS)

Table 1 Element and shield composition of TL Badge  
UD-802A group

Element	Phosphor	Shield
E1	$^n\text{Li}_2^{\text{n}}\text{B}_4\text{O}_7(\text{Cu})$	Plastics 14mg/cm <sup>2</sup>
E2	$^n\text{Li}_2^{\text{n}}\text{B}_4\text{O}_7(\text{Cu})$	Plastics 160mg/cm <sup>2</sup>
E3	$\text{CaSO}_4(\text{Tm})$	Plastics 160mg/cm <sup>2</sup>
E4	$\text{CaSO}_4(\text{Tm})$	Lead 0.7mm thick

\* The thickness of the hanger is not included. To obtain the total thickness when the badge is placed in the hanger, refer to the specifications of the hanger and add that thickness for each element.

SPEC NO. E-BDG/GS-1

SPECIFICATION OF  
TL BADGE

GENERAL SPECIFICATIONS

JANUARY 1983

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## INTRODUCTION

These specifications are common to all National/Panasonic TL Badges. As for detailed specifications, such as phosphorous materials and shield combinations, refer to the "Specifications for each TL Badge model."

For many measurements and dosage assessment applications, the National/Panasonic TL Badge must be used with a TL Badge Hanger.

As for the National/Panasonic TL Badge Hanger, refer to the "Specifications common to all TL Badge Hangers" and the "Specifications for each TL Badge Hanger model."

## 1. GENERAL

The TL Badge is a thermoluminescence dosimeter for measurement of integral dose of radiation.

Elements (up to four) are mounted on an element plate.

The element plate is put in the badge holder.

The element is made of a thin layer of thermoluminescence phosphor. A radiation shield is provided on the badge holder.

An identification number (up to seven digits) is provided on the badge and automatically read by a reader.

The badge is measured without the necessity of taking the element plate out from the badge holder. The element plate is locked to the badge holder to prevent deliberate removal of the plate.

## 2. APPEARANCE AND CONSTRUCTION

Figure 1 (a), (b), (c) shows the appearance of the TL Badge. Depending on the use, three types are available; one-window type, two-window type, and no-window type.

An extremity dosimeter shown in figure 1 (d) is also available. Forty-bit optical code holes can be made in the badge holder to provide the ID number, etc.

Figure 2 shows the sectional view and the dimensions of the TL Badge. (Though it shows the one-window type UD-802A, the figure also applies to other types.)

Figure 3 shows the enlarged sectional view of the element.



Virtually mono-layer of granular phosphor (average granule diameter is 90u) is formed on the thin resin substrate. The phosphor is covered with a protective, transparent film.

### 3. DETAILED COMMON SPECIFICATIONS

#### 3-1 Thermoluminescence phosphor

Depending on specific measurement, four kinds of phosphor are mounted on the plate in various combinations.

- ${}^n\text{Li} : {}^n\text{B}_2\text{O}_3 (\text{Cu})$  The phosphor is made of tissue-equivalent  $\text{Li}_2\text{B}_2\text{O}_5$  with Cu doped as an activator. Natural abundant material  ${}^n\text{Li}$  and  ${}^n\text{B}$  is used for Li and B. The phosphor is sensitive to x rays and  $\beta$  rays and somewhat sensitive to low-energy neutron.
- ${}^7\text{Li}, {}^{10}\text{B}_2\text{O}_3 (\text{Cu})$   ${}^n\text{Li}$  and  ${}^n\text{B}$  in  ${}^n\text{Li}, {}^n\text{B}_2\text{O}_3 (\text{Cu})$  mentioned above are replaced by enriched material  ${}^7\text{Li}$  and  ${}^{10}\text{B}$ . The phosphor has little sensitivity to neutron rays. The response to x rays and  $\beta$  rays is equivalent to  ${}^n\text{Li}, {}^n\text{B}_2\text{O}_3 (\text{Cu})$



$^6\text{Li}; ^{10}\text{B}_2\text{O}_3(\text{Cu})$   $^7\text{Li}$  and  $^{10}\text{B}$  in  $^7\text{Li}; ^{10}\text{B}_2\text{O}_3(\text{Cu})$  mentioned above are replaced by enriched material  $^6\text{Li}$  and  $^{10}\text{B}$ . The phosphor has high sensitivity to low-energy neutron rays. The response to  $\gamma$ .x rays and  $\beta$  rays is equivalent to  $^7\text{Li}; ^{10}\text{B}_2\text{O}_3(\text{Cu})$ .

$\text{CaSO}_4(\text{Tm})$  The phosphor is made of non-tissue-equivalent  $\text{CaSO}_4$  with Tm doped as an activator. Since the phosphor has high sensitivity it is used to evaluate low dose in combination with metal shield. Without metal shield, it shows over response to low-energy  $\gamma$ .x rays, and is used for energy evaluation of  $\gamma$ .x rays. The phosphor has little sensitivity to neutron rays.

### 3-3 Element Thickness

- a) Phosphor layer: Approx. 15 mg/cm<sup>2</sup>
- b) Substrate: Approx. 11 mg/cm<sup>2</sup>
- c) Transparent cover film: Less than 28mg/cm<sup>2</sup>

3-3 Measurement Range

- a)  $\text{Li}_2\text{B}_2\text{O}_7(\text{Cu})$  elements: 10 mrem to 1000 rem  
( $^{60}\text{Co}$ - $\gamma$  ray equivalent)
- b)  $\text{CaSO}_4(\text{Tm})$  element: 1 mrem to 200 rem  
( $^{60}\text{Co}$ - $\gamma$  ray equivalent)

3-4 Fading

- a)  $\text{Li}_2\text{B}_2\text{O}_7(\text{Cu})$  elements: Less than 10%/month,
- b)  $\text{CaSO}_4(\text{Tm})$  element: 3%/month,  
at the room temperature ( $25^\circ\text{C}$ )

3-5 Tribo-thermoluminescence

- a)  $\text{Li}_2\text{B}_2\text{O}_7(\text{Cu})$  elements: Lower than detection limit,
- b)  $\text{CaSO}_4(\text{Tm})$  element: Lower than detection limit.

3-6 Light Response (light sensitivity and light fading)

- a)  $\text{Li}_2\text{B}_2\text{O}_7(\text{Cu})$  elements: Lower than detection limit,
- b)  $\text{CaSO}_4(\text{Tm})$  element: Lower than detection limit,  
where mounted in the badge holder.

3-7 Sensitivity uniformity of element

There are three classes in the nominal uniformity of element; Class Q, Class R, and Class S. The class is indicated in the seventh digit of the model number.

(Example: UD-802AQ, UD-802AR, UD-802AS etc.)

Nominal uniformity indicated by the classes are as follows:

Class	Nominal uniformity		
Q	Percentage standard deviation	$\leq$	5.0%
R	Percentage standard deviation	$\leq$	7.5%
S	Maximum to minimum deviation	$\leq$	$\pm 30\%$

It is assumed that the uniformity is evaluated using the reader with rank correction function.

In evaluating uniformity, Class Q sometimes shows a percentage standard deviation of 5 to 6% and Class R does 7 to 8% depending on the exposing method and sampling method.

#### 7-8 Life Time

Repeated use: 300 times,  
 Total exposure: Lower than 10 rem  
 ( $^{60}\text{Co}$ - $\gamma$  ray equivalent)

#### 7-9 Working Conditions

Temperature:  $-10^{\circ}\text{C} \sim 40^{\circ}\text{C}$  (Fading increases above  $35^{\circ}\text{C}$ .)  
 Humidity: Less than 80% RH (without dripping)

For precautions before measurements, refer to the handling instructions.

7-10 Bit Format of Optical Code Hole on the TL Badge

The bit format of the optical code hole is shown in Fig. 4.

The 40 bits are used as follows;

- 28 bits : Number code (7 digits)
- 4 bits : Model code
- 6 bits : Element sensitivity correction code
- 2 bits : Parity code (Odd parity)

4. GUARANTEE

One year from date of delivery.

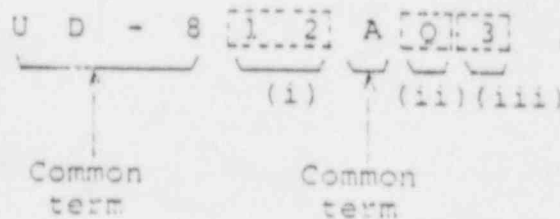
Replacement of new badge shall constitute a fulfillment of all obligations to the purchaser. The Panasonic will not be responsible for any damage resulting from improper use.

Please read the handling instructions carefully before use.

Appendix 1.

Model number format

The model number of TL Badges is constituted as follows;



- (i) . A code defining the composition of the element and shield.

01 to 15

- . Codes from 01 to 11 are assigned to standard specification badges and the composition is fixed.
- . Codes from 12 to 14 are assigned to special specification badges and the composition is determined by the purchaser. (Refer to (iii).)

( In this case, the reader parameter must be set according to the badge composition. The badge defining parameter for the UD-702E manual operation reader cannot be varied. )

- . Code 15 is assigned to the reader calibration badge.

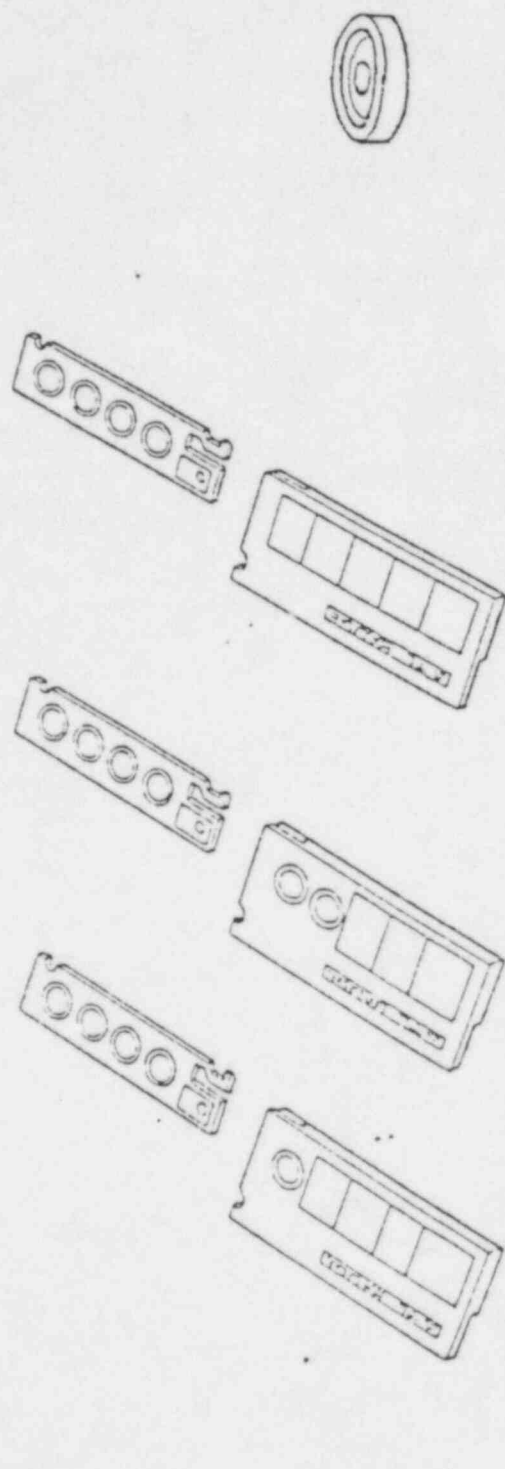
- (ii) A code defining the nominal uniformity class.

(Refer to 3-(7).)

- (iii) Special code

When a special specification code (between 12 and 14) is assigned to term (i), many TL Badges containing the same model number will result. To identify these badges, a serial number is assigned to the badges. For example, UD-812AQ has many variations: UD-812AQ1, UD-812AQ2, ... and incorrect readings will result when UD-812AQ1 is read by the reader given the badge defining parameters for UD-812AQ2.

( The special code may be assigned to the standard badges when necessary. )



(d) extremity dosimeter

(c) no-window type

(b) two-window type

(a) one-window type

Fig. 1 Appearance of TL Badge

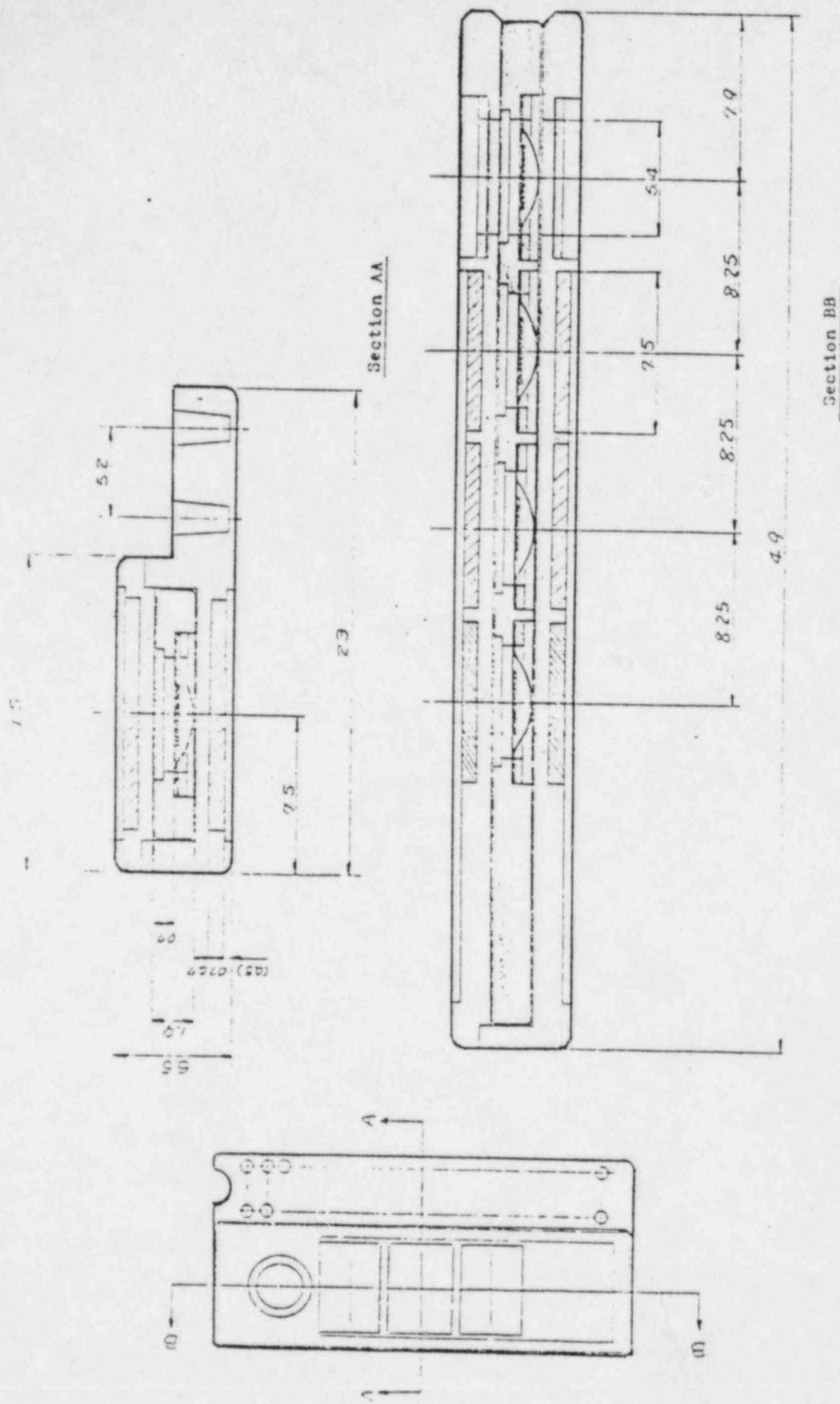


Fig. 2 Sectional view of the TL Badge  
( UD-802A as an example ).



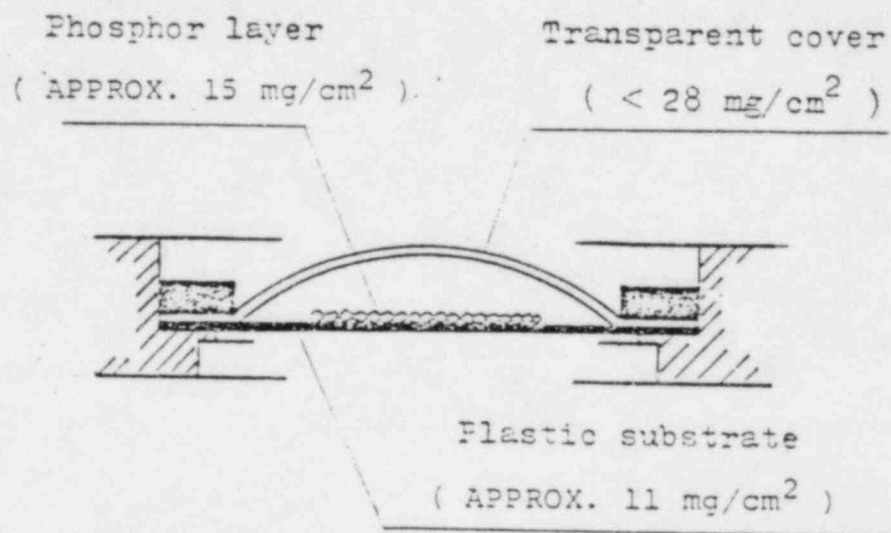


Fig. 3 Enlarged sectional view of the element.

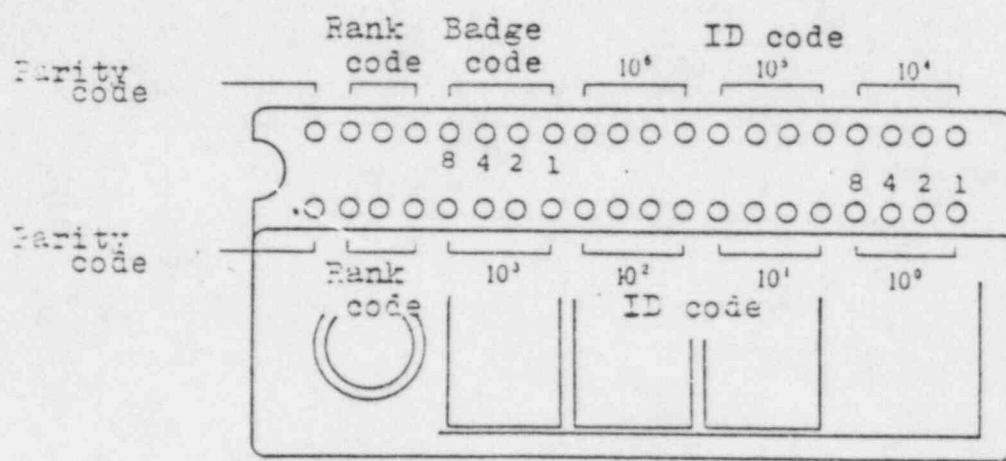


Fig. 4 Bit format of optical code hole.

SPECIFICATION OF  
TL BADGE HANGER  
MODEL SPECIFICATIONS

UD-854A  
UD-874A  
UD-875A  
UD-876A  
UD-885A  
UD-886A  
UD-887A

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# MODEL SPECIFICATIONS

TL Badge Hanger : UD-854A(H)

Refer to the GENERAL SPECIFICATIONS for common specifications.

1. Model number : UD-854A UD-854AH
2. Type : Open type for one badge
3. Applicable TL Badge : UD-801A, UD-815A  
(Examples)
4. Appearance : Fig. 1
5. Body material : ABS resin
6. Front wall thickness : For element 1 open  
for element 2 plastics 160 mg/cm<sup>2</sup>  
for element 3 plastics 160 mg/cm<sup>2</sup>  
for element 4 plastics 160 mg/cm<sup>2</sup>
7. Attaching device : An alminium clip  
(with a nylon strap :  
UD-854AH only)
8. Color : Clear with slight smokiness.
9. Weight : Less than grams.

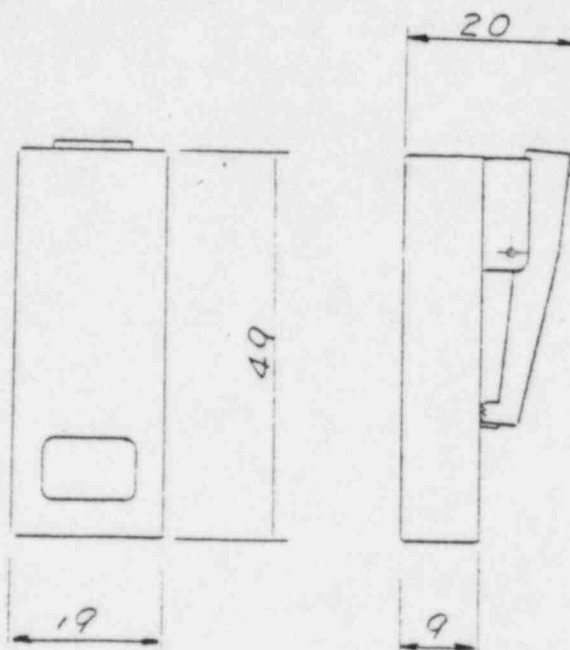
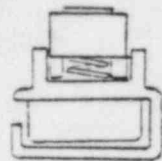


Fig. 1 Structure of hanger: UD-854A.

SPEC NO. E-HGR/GS-1

SPECIFICATION OF  
TL BADGE HANGER  
GENERAL SPECIFICATIONS

JANUARY 1983

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## INTRODUCTION

These specifications are common to all National/Panasonic TL Badge Hangers. As for detailed specifications regarding each hanger, refer to the "Specifications for each TL Badge Hanger model."

For many measurements and dosage assessment applications, the National/Panasonic TL Badge must be used with the TL Badge Hanger.

As for the National/Panasonic TL Badge, refer to the "Specifications common to all TL Badges" and "Specifications for each TL Badge model."

## 1. General

The TL Badge Hanger serves as both a wearing case and as an additive shield for the TL Badge. Except for special cases, TL Badges should be placed in the hanger before being used.

There are three kinds of hangers: an open hanger for single badges, a closed hanger for single badges, and a closed hanger for two badges.

## 2. Construction

The three above hangers are shown in Fig. 1.

A  $\gamma$ - $\beta$  TL Badge is encased in an open hanger, a closed hanger, and also in the right side of the closed hanger for two badges. The hangers are available in several thickness depending on the  $\gamma$ - $\beta$  TL Badges used.

The UD-809A neutron TL Badge is placed in the left side of the closed two-badge hanger.

The open hanger has a window for the  $\beta$  badge. The closed hanger's window is sealed with a  $3 \text{ mg/cm}^2$  thick plastic film, making its wall thickness slightly larger for the  $\beta$ -rays (skin dose) estimating element. The projection shown in Fig. 1 (b) and (c) provides a wall thickness of  $1000 \text{ mg/cm}^2$  for the deep dose estimating element.

Closed hangers are designed so that they cannot be easily opened without special jigs. There is a space for a label on each surface.

### 3. Shielding

#### 3-1 Shielding for $\gamma$ -B TL Badges

The front wall of the hanger is made of plastic. The thickness of each model is specified in the specifications for each model.

When a TL Badge is encased in a hanger, the total thickness for the  $\gamma$ .x and  $\beta$  rays is obtained by adding the hanger thickness to the badge shield thickness. Examples are shown in Appendix 1.

#### 3-2 The shield for a neutron badge

An additional cadmium-made shield for the UD-809A neutron badge can be formed on the left side of the closed two-badge hanger.

### 4. Guarantee

This guarantee is good for three months from the date of delivery. This guarantee does not cover problems caused by misuse, abuse, or negligence.

Panasonic will repair or replace, at no charge, your TL Badge Hanger if any problem develops during the guarantee period due to design or workmanship defects.

(Refer to "TL Badge Handling Instructions" for handling.)

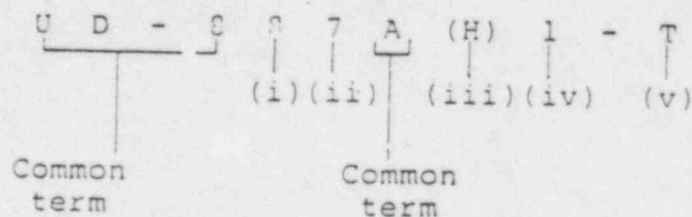
Appendix 1. An example of calculation of total wall thickness

Example : UD-808A TL Badge in UD-887A Hanger

Element	Phosphor	Shield thickness of UD-808A	Wall thickness of UD-887A	Total thickness	Remarks
E1	${}^7\text{Li}_2 {}^{11}\text{B}_4\text{O}_7(\text{Cu})$	Plastics 14 $\text{mg}/\text{cm}^2$	Plastics 3 $\text{mg}/\text{cm}^2$	Plastics 17 $\text{mg}/\text{cm}^2$	For $\beta$ -ray (skin dose) evaluation including $\beta$ -ray energy correction.
E2	${}^7\text{Li}_2 {}^{11}\text{B}_4\text{O}_7(\text{Cu})$	Plastics 66 $\text{mg}/\text{cm}^2$	Plastics 3 $\text{mg}/\text{cm}^2$	Plastics 63 $\text{mg}/\text{cm}^2$	
E3	$\text{CaSO}_4(\text{Tm})$	Plastics 160 $\text{mg}/\text{cm}^2$	Plastics 840 $\text{mg}/\text{cm}^2$	Plastics 1000 $\text{mg}/\text{cm}^2$	$\gamma$ -ray energy evaluation by comparing with E4.
E4	${}^7\text{Li}_2 {}^{11}\text{B}_4\text{O}_7(\text{Cu})$	Plastics 160 $\text{mg}/\text{cm}^2$	Plastics 840 $\text{mg}/\text{cm}^2$	Plastics 1000 $\text{mg}/\text{cm}^2$	Deep dose evaluation

## Appendix 2. Model number format

The model number of the TL Badge Hanger is constituted as follows;



### (i) Type code

5 ----- Open type

7 ----- One-badge closed type

8 ----- Two-badge closed type

### (ii) Front wall thickness code (Refer to the figure below.)

### (iii) Nylon strap code

H ----- Nylon strap provided

### (iv) Special code

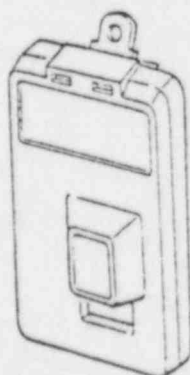
A serial number is assigned to the special specifications hangers.

### (v) Color code

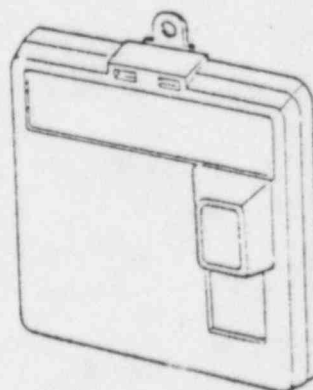
T ----- Transparent



(a) One-badge  
open type



(b) One-badge  
closed type



(c) Two-badge  
closed type

Fig. 1 Typical appearance of TL Badge hanger