



**Global Dosimetry**  
Solutions

Back to Basics  
TLD - Dosimeter  
Response/Sensitivity/LLD

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Kip Bennett  
Portland, ME  
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# Panasonic Element Correction Factors (ECFs)

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- Three distinct methods for ECF generation
  1. Compare to a Reference Set (normal)
  2. Compare to a known dose
  3. Compare to an average within the group

- $$\text{ECF (i,j)} = \frac{\text{E(i,j)}}{\text{EM (i)}}$$

Where:

ECF(i,j) = ECF for element i of dosimeter j

E(i,j) = response of element i of dosimeter j

EM (i) = mean response of all element i for all reference dosimeters



# Panasonic Element Correction Factors (ECFs)

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- Basic ECF procedure
  - Obtain TLDs for ECF generation
  - Intersperse reference TLDs in the tray (slot 1 and 25)
  - Anneal the ECF test group
  - Irradiate the ECF test group
  - Read the ECF test group after a specified time period (~24 hours)
  - Perform 2 more times
  - Run and analyze the ECF reports
  - Remove failed TLDs
  - Reperform about every 2 years



# Panasonic Element Correction Factors (ECFs)

## Report Analysis

- Reference Badges should have low %CV

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802 Reference Badge Results (mRem)

      Id          E1          E2          E3          E4
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0016749      312.081      300.349      290.196      309.465
0047635      342.217      322.529      281.909      292.479
0131709      309.413      279.635      285.429      307.336
0137716      340.077      327.448      292.446      291.886
0099387      327.742      301.423      288.911      302.812
0121077      315.431      312.243      280.000      296.500
5017435      307.933      322.388      273.052      294.621
0102535      320.477      294.803      284.282      300.096
0133743      323.061      318.846      279.880      301.217
0101492      337.205      323.588      285.398      301.201
-----
Average      323.564      310.325      284.150      299.761
Std.         12.809       15.640       5.724       5.937
Percent Cv   3.959        5.040        2.014       1.981
Low Reference 307.933      279.635      273.052      291.886
Hi Reference 342.217      327.448      292.446      309.465
Ref Range    34.284       47.813       19.394      17.579

Total type 802 reference badges 10
Summary of computed RCFs:
E1 RCF: 1.000
E2 RCF: 1.000
E3 RCF: 1.000
E4 RCF: 1.000
RCF'S defaulted to 1.0 (do not use reference badges flag set).

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# Panasonic Element Correction Factors (ECFs)

- ECF report can be used to eliminate those with high %CV between the 3 ECF test runs

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S02 ECF Results

Id	Tra	Sl	Nl	New Average ECF	Percent Cv	Ave	%CV	Gold	Silv	%D1	%D2	%D3	%D4	%DFX	
10120919	001	021		310.587 0.611 0.973 1.0321	1.4 6.1 2.3 4.1			X	X	0.01	0.04	0.01	0.01		
10114124	001	051		310.775 0.816 0.996 1.0311	4.4 3.7 2.5 2.6			XXX	XXX	0.01	0.02	0.01	0.00		
10091872	001	061		310.858 0.823 0.955 0.9231	5.6 2.5 2.6 3.2			XX	XXX	0.00	0.01	0.01	0.00		
10130106	001	081		310.669 0.811 0.943 0.9721	8.0 5.2 1.6 1.9			XX	XX	0.06	0.04	0.02	0.01		
10098374	001	101		310.571 0.607 0.926 1.0141	7.6 7.5 2.9 1.4			XX	XX	0.01	0.04	0.00	0.01		
10020862	001	111		310.733 0.744 0.838 0.6931	5.0 3.7 1.4 1.3			X	XXX	0.03	0.02	0.00	0.00		
10033214	001	131		311.158 0.887 0.985 0.9471	1.7 4.3 2.1 3.0			X	XX	XXX	0.02	0.02	0.01	0.02	
10116868	001	141		310.788 0.755 0.952 0.9641	6.8 10.6 4.0 5.7		*			0.01	0.05	0.02	0.01		
10138406	001	151		311.138 1.051 1.078 1.0561	3.4 2.5 1.6 2.6			XXXX	XXX	0.02	0.00	0.01	0.01		
10134895	001	171		310.894 1.011 0.843 0.8321	2.1 1.9 9.3 6.1		*	XX	XX	0.02	0.03	0.05	0.04		
10062140	001	191		311.325 1.231 0.984 1.0061	7.4 9.0 0.7 1.5			XX	XX	0.04	0.06	0.00	0.01		
10128410	001	231		310.816 0.859 0.854 0.8641	1.7 4.3 8.0 7.0		*	X	XX	0.00	0.01	0.03	0.04		
10087954	001	261		310.821 0.891 1.288 1.2871	6.5 5.7 2.7 1.7				XX	0.04	0.03	0.02	0.02		
10139959	001	281		310.828 0.915 1.021 1.0221	9.7 3.8 2.9 4.4			XX	XX	0.03	0.02	0.00	0.03		
10108239	001	291		310.686 0.794 1.021 1.0091	2.3 8.0 1.8 0.9			XX	XX	0.04	0.01	0.01	0.00		
10087908	001	301		310.833 0.802 1.077 1.1211	4.0 9.8 1.5 1.8			XX	X	XX	0.03	0.06	0.02	0.00	
10122690	001	311		310.845 0.846 1.103 1.1261	7.4 7.0 3.5 4.8				X	0.03	0.02	0.01	0.02		
10097235	001	321		311.103 1.113 1.023 1.0341	5.8 3.6 2.3 3.4			XX	XXX	0.04	0.00	0.01	0.01		
10122322	001	331		310.819 0.804 1.087 1.0591	5.0 6.9 3.0 1.4			X	X	XX	0.03	0.03	0.02	0.00	
10129755	001	411		310.942 0.963 0.953 0.8971	1.5 9.2 2.8 4.9			X	X	X	0.00	0.05	0.02	0.02	
10123551	001	421		310.784 0.840 1.143 1.0271	4.1 7.8 1.9 1.8			XX	X	XX	0.02	0.04	0.00	0.01	
10135870	001	431		310.944 0.956 0.865 0.9171	10.0 3.0 2.6 3.5		*	XX	XX	0.05	0.01	0.01	0.02		
10133720	001	451		311.014 0.950 0.975 0.9291	3.7 5.4 2.3 2.0			X	XX	X	XX	0.04	0.05	0.02	0.02
10123189	001	481		310.721 0.774 1.082 1.0721	12.3 11.7 2.8 2.3		**	XX	XX	0.06	0.06	0.01	0.00		
10127688	001	491		310.915 0.808 0.973 0.9841	6.4 12.9 0.6 2.3		*	XX	XX	0.03	0.05	0.01	0.03		
10093844	001	501		310.813 0.819 1.059 0.9631	8.7 10.4 0.4 3.6		*	X	X	0.05	0.05	0.00	0.00		
10087602	002	021		310.901 0.889 1.287 1.2761	6.8 6.1 4.4 5.5					0.03	0.00	0.03	0.02		
10098503	002	031		310.779 0.913 0.962 0.8821	6.8 3.5 1.4 1.2			XXX	XXX	0.02	0.00	0.01	0.00		
10076353	002	041		310.929 0.999 0.838 0.8821	2.3 7.2 4.0 3.0			X	X	X	0.06	0.04	0.03	0.02	
10116604	002	051		310.918 0.888 0.985 0.9901	4.5 3.8 3.1 1.7			X	X	XXX	0.03	0.04	0.02	0.01	
10068993	002	061		311.088 1.020 1.018 1.0391	14.6 11.3 1.9 1.4		**	XX	XX	0.08	0.07	0.01	0.00	**	
10076391	002	071		310.968 0.828 0.811 0.8651	13.0 8.7 1.5 0.6		*	XX	XX	0.03	0.05	0.02	0.00		
10117941	002	081		310.626 0.658 0.953 0.9461	9.4 5.1 3.0 0.6			X	XX	0.05	0.03	0.02	0.02		
10092949	002	111		310.867 0.786 1.254 1.2331	3.6 1.9 5.3 6.3			X	XX	0.03	0.00	0.03	0.02		
10130701	002	131		310.971 1.112 0.889 0.9551	8.0 7.0 1.1 2.4			XX	XX	0.03	0.03	0.01	0.02		
10138739	002	141		310.813 0.868 0.968 0.9521	4.4 4.6 1.7 1.9			XX	XXX	0.02	0.01	0.01	0.00		
10086856	002	151		310.768 0.940 1.246 1.2071	15.4 8.6 5.7 3.8		*			0.07	0.04	0.03	0.02		
10116325	002	161		310.848 0.745 0.956 0.9191	7.2 10.9 1.1 2.5		*	XX	XX	0.06	0.04	0.01	0.01		
10103003	002	171		310.558 0.616 0.996 0.9581	7.5 3.7 1.1 2.7			XX	XX	0.02	0.03	0.00	0.01		
10066469	002	181		311.008 1.004 0.945 0.9361	8.4 5.2 3.9 4.7					0.05	0.03	0.02	0.03		

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# Harshaw Element Correction Coefficient (ECC)

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- **Once again 3 methods**
  1. Compare to a reference set
  2. Compare to a known dose (normal with WinRems)
  3. Compare to an average of the group (usually done for Calibration Cards)
- $ECC = \frac{\text{Average Element Response of Calibration Set (or known dose)}}{\text{Response of Individual TLD Element}}$



# Harshaw Element Correction Coefficient (ECC)

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- Basic Procedure
  - Obtain ECC Test TLDs (and reference)
  - Anneal the ECC Group
  - Irradiate the ECC Group
  - Wait a specified time period
  - Read the ECC Group
  - Run ECC report



# CR39 Sensitivity

- CR39 Batch**

**Correction Factors**

- Manufacturing techniques prevent the plastic from being exactly the same from batch to batch.
- Have not found significant difference within batches.
- Holder will also create differences in response
- $BCF = \frac{\text{Delivered Dose}}{\text{Reported Dose}}$

**CR39 Acceptance Data**

Batch B	S	B +S
BV 0.156	0.031	0.187
BW 0.322	0.031	0.353
BX 0.158	0.034	0.191
BY 0.138	0.049	0.188
BZ 0.195	0.047	0.242

**BCF Development DATA**

Batch	BCF
BV	0.843
BW	0.729
BX	0.835
BY	0.853
BZ	0.795



# Lower Limit of Detection (LLD)

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- Many equations and methodologies to calculate the LLD of TLD dosimeters.
- Determines the lowest reportable dose that the TLD can report with confidence.
- NVLAP equation:

$$\text{LLD} = \frac{2[1.8s + fh]}{(1-f)}$$

$$f = [1.8S/(1+b)^2]$$

Where:

S = standard deviation of the control dosimeters

s = standard deviation of the performance quotient of test TLDs

b = average of the performance quotient of test TLDs

h = average of the control readings



# Lower Limit of Detection (LLD)

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- DOELAP method

$$LLD = \frac{2[t_p S_o + [1.75 * S/(1+B)]^2 H_o']}{1 - [1.75 * S/(1+B)]^2}$$

Where:

$t_p$  = t dist for n-1 degrees of freedom and a p value of 0.95

$S_o$  = Standard deviation of the background

$H_o$  = Average of the background readings

$S$  = Standard deviation of the performance quotient of test TLDs

$B$  = Average of the performance quotient of test TLDs

