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Title: Lens of Eye Dosimetry

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Lens of Eye Dosimetry

An analysis of LANL occupational dose measurements was made with respect to lens of eye dose (LOE), in particular, for plutonium workers. Table 1 shows the reported LOE as a ratio of the "deep" (photon only) and "deep+neutron" dose for routine monitored workers at LANL for the past ten years. The data compares the mean and range of these values for plutonium workers* and non-routine plutonium workers. All doses were reported based on measurements with the LANL Model 8823 TLD.

The following conclusions are made from the data presented in Table 1.
1. There is no significant difference in the ratio of LOE-to-deep+neutron dose for plutonium workers compared to the non-plutonium worker population at LANL.
2. On average, neutron dose to LANL plutonium workers is approximately the same as the photon (deep) dose. Neutron dose represents approximately 20% of the dose to non-plutonium workers at LANL.
3. On average, LOE is 10% > deep+neutron dose for plutonium workers; LOE is 2% > deep+neutron dose for non-plutonium workers. A 2 rem (20 mSV) annual LOE limit would accordingly be the limiting factor, and of significantly greater impact to LANL plutonium workers.

Table 1. Historical Lens of Eye Dose at LANL**

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Plutonium Workers										
Total # Measurements	9349	8959	8778	7909	5008	4514	4991	5349	4003	4782
Total # Positive Measurements	3305	3448	3134	2687	2371	2474	2468	2803	1521	1964
Non-Plutonium Workers										
Total # Measurements	52,119	50,725	47,622	42,742	30,416	27,632	27,385	25,865	19,247	21,089
Total # Positive Measurements	2613	2868	1804	1677	1961	2023	2061	1761	1935	1441

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Plutonium Worker, LOE/Deep										
Min	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max	16.89	8.46	7.82	7.90	9.70	11.29	8.22	12.07	8.00	8.25
Avg	2.36	2.45	2.40	2.23	2.75	2.40	2.18	2.41	2.39	2.44
StDev	1.39	1.31	1.30	1.22	1.64	1.34	1.14	1.24	1.15	1.15
Non-Plutonium Worker, LOE/Deep										
Min	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max	9.36	9.00	6.88	5.47	6.60	6.50	7.30	6.72	8.82	9.00
Avg	1.29	1.48	1.44	1.34	1.44	1.40	1.22	1.25	1.19	1.19
StDev	0.55	0.80	0.72	0.58	0.70	0.70	0.47	0.59	0.55	0.56

Plutonium Worker, LOE/Deep+Neutron										
Min	0	0	0	0	0	0	0	0	0	0
Max	4.00	4.00	3.50	3.33	2.80	4.57	3.00	3.25	2.80	3.20
Avg	1.07	1.09	1.01	0.98	1.03	1.09	1.17	1.17	1.18	1.20
StDev	0.64	0.65	0.63	0.65	0.52	0.51	0.46	0.45	0.46	0.44
Non-Plutonium Worker, LOE/Deep+Neutron										
Min	0	0	0	0	0	0	0	0	0	0
Max	9.36	7.87	4.15	3.50	4.26	5.50	5.33	5.92	5.36	6.82
Avg	1.08	1.06	0.91	0.86	0.89	0.97	1.11	1.13	1.09	1.12
StDev	0.67	0.69	0.64	0.65	0.60	0.57	0.49	0.46	0.32	0.40

*"Plutonium workers" is defined as all workers who are routinely issued dosimeters at the LANL plutonium facility.

**Min, max, avg, and stdev results based on analysis that only includes positive dose results.

Understanding your Whole-body Thermoluminescent Dosimeter Results

Your whole-body thermoluminescent dosimeter is designed to report dose equivalent quantities for various depths in soft tissue. These quantities are affected by the different types and energies of ionizing radiation that may be encountered in the work-place. The reference tissue depths for these quantities are given in the table below:

Tissue Depth	**What it Measures**	**Dose Equivalent Quantity**	**Annual Dose Equivalent Limit (10CFR835)**
Shallow	The dose to the skin from beta, x-ray, and gamma radiation	0.007 cm	50,000 mrem
Lens-of-the-Eye	The dose received at the sensitive depth within the eye from beta, photon and neutron radiations	0.30 cm	15,000 mrem
Deep	The deep organ dose from x-ray and gamma radiation	1.00 cm	
Neutron	The deep organ dose due to neutron radiation	1.00 cm	

The **effective dose equivalent**, which is the quantity most often referenced, is the sum of the **deep** plus **neutron** dose.

The **total effective dose equivalent (TEDE)** is the sum of the effective dose equivalent from external sources plus any committed effective dose equivalent received from the intake of radioactive materials into the body measured during the year. The annual limit is 5,000 mrem according to Federal Law 10CFR835. The laboratory and Department of Energy typically impose a further administrative limit for the purpose of ALARA of 2,000 mrem or less depending on the facility in which you work.