Radiographic Testing Classroom Training Book second edition

Errata – 3rd Printing 01/20

The following text correction pertains to the second edition of the *Radiographic Testing Classroom Training Book*. Subsequent printings of this publication will incorporate the correction into the printed text.

The attached corrected page applies to the third printing. In order to verify the print run of your book, refer to the copyright page. Ebooks are updated as corrections are found.

Page	**Correction**
13	Under “Division Using Logarithms,” in the sentence “Using logarithmic tables, we find that log 100 = 2 and log 4 = 0.06020 so that:” the incorrect value for log 4 is stated. The correct value is “log 4 = 0.6020”
33	In Table 3, the incorrect value for the half-value layer for X-ray tube potential of 50 kVp is shown as 0.5 mm for lead. The correct value is 0.05 mm.

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There is one more step involved: finding the antilog. The antilog is, in effect, the reverse of the log, or the number resulting from the application of an exponent to a particular base. In this example, the antilog of 2.3010 in base 10 equals 200. This can also be calculated as:

$10^{2.3010} = 200$

Division Using Logarithms

Would you agree that 100/4 = 25? Here is how to obtain this same result through use of logarithms:

$\log (100/4) = \log 100 - \log 4$

Thus, division in log is actually subtraction. As a rule:

$\log (m/n) = \log m - \log n$

Using logarithmic tables, we find that log 100 = 2 and log 4 = 0.6020 so that:

$2 - 0.6020 = 1.398$

Since this value is expressed as a logarithm, we have to release the log and bring the result to a natural number by taking the antilog. In this case, the antilog of 1.398 = 25. Therefore, we have proved that 100/4 = 25 through use of logarithms.

Logarithms of Square Roots

If the same number is multiplied two times, it is the square of that number, so that $5 \times 5 = 5^2$. Three times a number is the cube of that number, and *n* times is the number to the power of *n*. Thus:

$25^2 = 25 \times 25 = 625$

Now, performing the opposite, if the square of 25 is 625, the square root of 625 is 25, normally written as:

$\sqrt{625}$

or

$625^{1/2}$

If we take the log of the square root of 625, it will appear as follows:

$\log 625^{1/2} = 1/2 \log 625 = (1/2)\cdot 2.8 = 1.4$

The antilog of 1.4 = 25.

Table 3: Approximate X-ray half-value layers.

Shielding material	Half-value layer for X-ray tube potential of:							
	50 kVp	70 kVp	100 kVp	125 kVp	150 kVp	200 kVp	250 kVp	300 kVp
Lead (mm)	0.05	0.15	0.24	0.27	0.29	0.48	0.9	1.4
Concrete (in.)	0.168	0.33	0.59	0.79	0.88	1	1.11	1.23

Table 4: Approximate gamma ray half- and tenth-value layers.

Shielding material in. (cm)	Radioisotope source					
	Co-60		Ir-192		Cs-137	
	1/10	1/2	1/10	1/2	1/10	1/2
Lead	1.62 (4.1)	0.49 (1.2)	0.64 (1.6)	0.19 (0.5)	0.84 (2.1)	0.25 (0.6)
Steel	2.9 (7.4)	0.87 (2.2)	2 (2.5)	0.61 (1.5)	2.25 (5.7)	0.68 (1.7)
Concrete	8.6 (21.8)	2.6 (6.6)	6.2 (15.6)	1.9 (4.8)	7.1 (18)	2.1 (5.3)
Aluminum	8.6 (21.8)	2.6 (6.6)	6.2 (15.7)	1.9 (4.8)	7.1 (18)	2.1 (5.3)

Example 5

A 200 kVp X-ray machine must be located so that the primary radiation is directed toward an adjacent occupied room. Without shielding, the dose rate in the adjacent room is 500× the acceptable safe limit. How thick of a concrete wall is required to reduce the dose rate in the adjacent room to a safe value?

Step 1: Because 1 HVL reduces dose rate by a factor of 1/2; 2 HVLs by 1/2 × 1/2 or 1/4, 3 HVLs by 1/2 × 1/2 × 1/2 or 1/8, and so on, then 9 HVLs will reduce the dose rate by a factor of 1/512 to an acceptable safe limit.

Step 2: From Table 3, the concrete HVL for 200 kVp radiation is 1 in. (2.54 cm). Thus, 9 in. (22.9 cm) of concrete shielding is required to reduce the dose rate to an acceptable safe value.

Example 6

The dose rate for a technician 20 ft (6.1 m) from a 35 Ci (1295 GBq) Ir-192 source is 516.25 mR/h (5162.5 µSv/h). If the technician must remain at the same location, how much lead shielding is required to reduce the dose rate to 3 mR/h (30 µSv/h)?

Step 1: The desired dose rate is 3 mR/h; therefore, the original dose rate of 516.25 must be reduced 516.25/3 or 172 times.

Step 2: Seven half-value layers reduce the dose rate by a factor of 1/27 or 128 times, but 8 HVLs reduce it by a factor of 1/28 or 256 times. Thus, 7 HVLs will not provide the required shielding, but 8 HVLs will.

Step 3: From Table 4, the lead half-value layer for Ir-192 radiation is 0.19 in. (4.8 mm) Therefore, 8 × 0.19 or 1.52 in. (36.6 mm) of lead shielding is required to reduce the dose rate to an acceptable safe value.