I Determining X-Ray Beam's HVL:

We begun the experiment by shooting an x-ray beam with an energy of $81kVp$ and at Source to Image Distance (SID) of 121.05 cm, then we added thin layers of Aluminum until the beam's dose was reduced by half, the results are:

Al Thickness (mm)	**Output Dose** (μGy)
0	242.1
1	189.9
2	152.7
4	108.2

Table 1: Output Dose with various thicknesses of Al layers.

We will be using the following two equations to determine the HVL:

$$HVL = \frac{\ln 2}{\mu} \tag{1}$$

$$I = I_o e^{-\mu x} \tag{2}$$

Eq.2 can be used to get an expression describing μ as a function of activities and distances as follows:

$$\frac{I_1}{I_2} = e^{\mu(x_2 - x_1)}$$

$$\mu = \left(\frac{1}{x_2 - x_1}\right) \ln\left(\frac{I_1}{I_2}\right)$$

$$\bar{\mu} = \sum_{\substack{ij \\ i \neq j}}^{N} \left(\frac{1}{x_j - x_i}\right) \ln\left(\frac{I_i}{I_j}\right) \Big/ N$$

Thus, we can use the dose at different distances, obtain a value of μ, average it across different distances, and then obtain HVL from it

$$\bar{\mu} = 0.209\ mm^{-1}$$

$$HVL = \frac{\ln 2}{0.209} = 3.32\ mm$$

II Experiments:

II.I Lead Thickness in Lead Apron:

Using this equation of activity, we will be able to determine the thickness of the attenuator x, which is in this case a lead apron:

$$A = A_o e^{-\mu x} \implies x = \frac{1}{\mu} \ln\left(\frac{A_o}{A}\right)$$

The beam was set to shoot at maximum voltage of 100 kVp, thus, for lead we have $\mu = 59.7cm^{-1}$. Without the apron we detected an activity of 420.3 mR and after installing it we obtained an activity of 20.68 mR, so:

$$\begin{aligned} x &= \frac{1}{59.7 * 10^2} \ln\left(\frac{420.3 * 10^{-3}}{20.68 * 10^{-3}}\right) \\ &= 0.000504489\ m = 0.5\ mm \end{aligned}$$

II.II Radiation Protection: Distance Vs. Shielding

II.II.1 Data

In this experiment, we will be investigating which aspect of shielding has better effect in reducing the dose of the radiation. The experiment was done under these specifications: 85 kVp, 100 mAs, 40 $in\ SID$

After following the instructions on the manual, we obtained the following table:

Exposure #	**Exposure (mR)**	**% of Exposure #1**	**Exp. Pb Apron (mR)**	**% of Exposure #1**
1- Directly in the X-Ray beam	629.1	100%	629.1	100%
2- Just outside the beam	27.62	4.39%	1.527	0.243%
3- One meter away from the beam	996.2*10^{-3}	0.158%	1*10^{-3}	0.000158%
4- Directly in the beam with lead apron	18.52	2.94%	18.52	2.94%

Table 2: Obtained experimental data.

II.II.2 Analysis

Now we will analyze the above results to answer the following questions:

2.a) The exposure conditions with the *least* amount of dose received was **One meter away** from the beam **With lead apron**.

2.b) The exposure conditions with the *most* amount of dose received was **Just outside** the beam **Without lead apron**.

3) The most effective radiation protection principle was ***Distance***.

4) Two important guidlines for the technologist:

a. Always **wear the lead apron** when you are required in the area of exposure.

b. **Stay away** from the beam field of view, *while* being shielded.

II.II.3 Conclusion

In conclusion, we found out that ***distancing*** the technologist from the beam is more effective than wearing a lead apron. It is vital to note that the best protection against radiation is by using both of these principles while also minimizing the time of exposure.

III Portable Vs. Fixed X-Ray

Fixed X-Ray tube has wider amount of accelerating voltages, it also capable of delivering high doses and for longer times. From a technical point of view, fixed x-ray has a rotating anode, allowing it to distribute the heat which can lead to the ability of taking high doses with longer times.

On the other hand, portable X-Ray tube allows for high mobility which can reflect and the patient's wellfare. Also, it has less amount of accelerating voltages, and is limited when it comes to high doses or obese patients. From a technical point of view, portable x-ray has a stationary anode, which limits its capabilities to take high doses for a long time.