MODEL L-430; L-431 & L-434
HVL FILTERS

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Introduction

The purpose of the Ludlum HVL filters is to help the medical physicist or service engineer confirm the necessary filtration required to remove the damaging low-energy radiation from the primary beam of the various X-ray tubes used in diagnostic radiology.

The HVL Filter sets come in three types:

The Model L-430 is the standard high-purity aluminum for HVL determinations of mid-range generators (80-140 kVp). The set includes 11 filters (10 x 10 cm); five of them with 1.0 mm thickness, two of them with 0.5 mm thickness and four of them with 0.1 mm thickness. It is made with type-1100 aluminum. Weight: 0.06 kg (15 lb).

The Model L-431 copper set is for HVL determinations of high-range X-ray generators (140-400 kVp). The set includes 10 filters (10 x 10 cm): four of them with 1.0 mm thickness, two of them with 0.5 mm thickness, and four of them with 0.1 mm thickness. Weight: .56 kg (1.25 lb).

The Model L-434 is the ultra-high purity aluminum typically required for HVL determination of mammography. Because type 1100 aluminum is only 99.0% pure, it has some impurities that can give an HVL value that is 7.5% lower than those measured with pure aluminum. When doing HVL measurements on a mammography unit, it is recommended that the highest purity aluminum be used. This set of six attenuators satisfies this recommendation, because they are 99.9% pure (type 1145 aluminum).

Overview

HVL can be defined as the layer of aluminum needed to attenuate the dose detector signal to 50% of its original value. The primary purpose is to ensure that the total filtration in the tube assembly is maintained at an appropriate level to minimize the patient skin dose.

HVL testing also helps to confirm kVp values and provides an indication of what the X-ray spectrum looks like. A spectrum with a low maximum energy but high filtration could have the same HVL value as a spectrum with a higher maximum energy and a lower filtration.

Measuring on a so-called simulator may pose a problem. The collimator is usually equipped with radiation attenuating wires and markings, which will disturb the dose detector. Use the light field to verify the detector is outside these markings.

Note: This applies for ion chambers as well.

An overall accuracy of ±25% in the conversion from HVL to total filtration can be expected. This error can be reduced substantially if the waveform and the correct interpolation procedures are noted.

Most protocols and regulations state a total filtration of 3.0 mm Al at 80 kVp. Dedicated chest stand should have an added Cu-filtration of 0.1 mm. This equals approximately 6 mm Al.

Warning: The mammographic HVL filters are very thin and easily bent. Be very careful when handling these. Do not touch them with your fingers directly.

General Procedure

Prior to any HVL measurements, the following should be checked:

1. The total filtration or HVL should be stated on the X-ray equipment to be measured. Note particularly if there is any added copper filter present. This will affect the kVp measurements. (If there is a copper filter, it should be located upstream to the aluminum filter. The copper generates secondary, characteristic X-rays, which will only add to the skin dose.)

2. The X-ray equipment should be easily removable or have changeable filters. Make sure they are correctly positioned and properly marked. The chosen filter should be noted in the measurements.

3. The light field/radiation field coincidence must be within acceptance limits (usually within 1% of focus film distance). [The Model L-661-662 will help to confirm this.]

4. Ensure the kVp is within acceptance limits (usually within 5% for radiographic units and within 1kV for mammographic units). This is particularly important when measuring mammographic kVp.

5. The reproducibility of the generator should be checked (kVp and output).

6. The field must be collimated to an area just slightly larger than the detector. Ensure that the filter covers the entire field. This may prove difficult at large focus to tabletop distances. The stand must then perhaps be built up to satisfy

the condition of positioning the filter halfway between the focus and detector.

7. Ensure the X-ray control is set to manual mode and set the appropriate kV, using a fixed mA. No exposure control should be enabled. Proceed with further exposures, adding filters until the value drops well below half the initial value. The generator settings must not be changed during the measurement procedure.

General Procedure-Under-table Tubes

1. Raise the image intensifier to the maximum height.

2. Collimate the beam. The field should be smaller than the aluminum filters that will be placed in the filter holder. The detector should then be placed facing the tube side (upside down from the user's view).

3. Switch the X-ray control to manual mode and set the appropriate kVp, using a fixed mA. No exposure control should be enabled. On fluoroscopy dedicated equipment only (i.e. C-arms), measure the dose rate at a fixed mA. Wait until the dose rate value stabilizes.

4. Proceed with further exposures, adding filters until the value drops well below half the initial value. The generator settings must not be changed during the measurement procedure.