Name: ________________________________ Date: ________________ Team: _____

Q.A. Lab Experiment # 8

Automatic Exposure Control (AEC) System Check

Purpose

To determine whether AEC system produces consistent exposure.

Learning Objectives

After completing this lab, you should be able to:

1. Use the laboratory equipment properly.
2. Set up the control console and ceiling tube mount correctly.
3. Function effectively in group work.
4. Perform the experiment independently.

Materials Needed

- Radiographic unit with AEC
- Dosimeter (ionization chamber)

Pre-Lab Discussion

Automatic Exposure Control Systems

The automatic exposure control (AEC) system has been used in radiography since the 1960s. It functions as a regulator for the exposure time and provides constant exposure to the image receptor regardless of the kilovolt (peak) or milliampere-second selected, or thickness of the part being imaged. This type of system involves some type of radiation detection device that measures the quantity of x-rays received by the patient or image receptor. When this exposure reaches a level corresponding to a predetermined value, the system causes the x-ray generator to terminate the exposure. This value is set by a service engineer on the basis of the image receptor system used in the department. A postreading milliampere-second indicator should be present on the control console and should display accurately the total milliampere-seconds delivered during the exposure. An AEC system has two main parts, the detector and the comparator.

Detectors

The detector, also known as the sensor, is a radiation detector that monitors the radiation exposure at or near the patient and produces a corresponding electric current proportional to the quantity of x-rays detected. Detectors are sometimes referred to as cells or chambers. Normally, three detectors are available for use by the radiographer, one in the midline and one on either side of the midline (Figure 1). Units also are available with one or as many as five detectors. The x-ray machine control console should have indicators present that reflect which detectors are active. Three different types of radiation detectors have been used in AEC systems: photodetectors, ion chambers, and solid-state detectors.

Photodetectors

The photodetector, or photocell, uses a scintillation crystal (usually sodium iodide) coupled with a photomultiplier tube. When radiation interacts with the crystal, light is created and it enters the photomultiplier tube. This light then releases electrons through the process of photoemission. The electrons multiply in number and form an electric current proportional to the original amount of radiation that struck the photocell. The photodetector was the original detector used as a sensor and was marketed under the name phototimer. This name is still used commonly to describe AEC systems, although the photodetector is seldom used in modern systems. These sensors are placed behind the image receptor to measure the exposure because they are not radiolucent. Care must be taken with these systems so that the lead in the back of the cassettes (normally present to control backscatter) is not excessive.

Ion Chambers

The ion chamber (discussed earlier in this chapter) consists of a gas-filled chamber. It is smaller than a photocell and can be made of a radiolucent material, which allows it to be placed between the grid and the front of the image receptor so that any type of cassette design can be used. An ion chamber is the most common type of sensor found in current AEC systems and is often marketed under the name ionomat.

Solid-State Detectors

The solid-state detector uses a small silicon or germanium crystal, which is more sensitive but also more expensive than photocells or ion chambers. The crystals are radiolucent and can be placed between the grid and image receptor. The solid-state detector is often marketed under the name autotimer.

Comparator

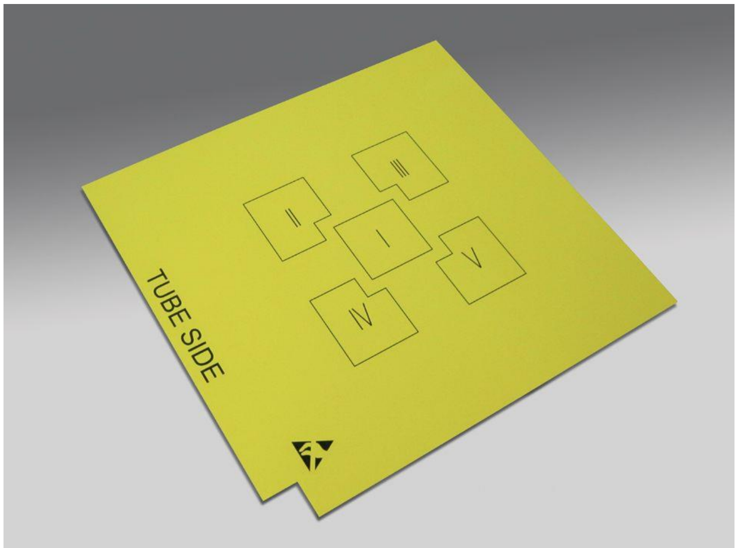
The comparator is an electronic circuit that receives the current signal sent by the sensor. An internal capacitor stores a voltage as long as this current is flowing. When the voltage in the capacitor becomes the same as a preset reference voltage, a switch is opened and it terminates the exposure. Changing the density selector switch changes this reference voltage and therefore the quantity of radiographs produced by the generator. Each step on the density selector should change the radiation exposure by 25% to 30%. The radiographer also must select the proper chamber, kilovolts (peak); verify the properly positioned patient and x-ray tube; and verify backup time/mAs in case of system failure.

Automatic Exposure Control Testing

It is becoming more common for radiographic examinations to be performed with AEC systems. It is estimated that more than 60% of all hospital radiology departments have radiographic equipment that uses an AEC system or anatomically programmed units (which contain a microprocessor circuit with preprogrammed technical factors). The advantage of AEC is that it delivers consistent image receptor exposure over a wide range of patient thickness and kilovolt (peak) settings. Proper system performance should therefore be monitored through quality control procedures at installation and then semiannually or whenever work is performed on the system. Items that should be monitored include the backup time/mAs or maximum exposuretime, and minimum exposure time. Results should be recorded as pass or fail on a documentation form.

Figure 1

AEC System



Consistency of Exposure With Varying Milliamperes

The AEC system should be able to adjust the exposure time and maintain image receptor exposure with any changes in milliamperes on the control panel. Any variation cannot exceed ±10%.

Instructions AEC Reproducibility:

- Obtain a homogenous phantom (Figure 2), which is uniform in thickness, made of acrylic plastic (Plexiglas or Lucite) that is at least 10 cm in thickness.
- Place a dosimeter on top of the table and below the phantom
- Center the central ray of the x-ray beam on the dosimeter using a SID of 40 in. Collimate the beam so that the x-ray field is just slightly larger than the dosimeter or remote probe.
- Make a series of five (the same) exposures of the dosimeter at 80 kVp and 100 cm (40"), 20 mAs, SID, and normal density setting. Clear the dosimeter (reset to zero) after each exposure. Record each reading on some type of documentation form.
- With the readings obtained, use the following equation to determine reproducibility variance:

$$\text{Reproducibility variance} = \frac{(\text{Exposure or air kerma}_{max} - \text{exposure or air kerma}_{min})}{(\text{Exposure or air kerma}_{max} + \text{exposure or air kerma}_{min})}$$

Corrective Action:
Any units that are found to exceed 0.1 (10%) variance in reproducibility will need to be corrected or repaired.

Instructions AEC Consistency of Exposure With Varying Milliamperes:

- Obtain a homogenous phantom (Figure 2), which is uniform in thickness, made of acrylic plastic (Plexiglas or Lucite) that is at least 10 cm in thickness.

- Place a dosimeter on top of the table below the phantom. The lead apron absorbs backscatter from the tabletop material, which reduces the accuracy of any readings obtained. If a lead apron is unavailable, substitute a sheet of lead vinyl.

- Center the central ray of the x-ray beam on the dosimeter using a SID of 40 in. Collimate the beam so that the x-ray field is just slightly larger than the dosimeter or remote probe.

- Make a series of three to five separate exposures of the dosimeter at 80 kVp and 100 cm (40”) SID, and normal density setting, with at least four different mA stations. Clear the dosimeter (reset to zero) after each exposure. Record each reading on some type of documentation form.

- With the readings obtained, use the following equation to determine reproducibility variance:

$$\text{Reproducibility variance} = \frac{(\text{Exposure or air kerma}_{max} - \text{exposure or air kerma}_{min})}{(\text{Exposure or air kerma}_{max} + \text{exposure or air kerma}_{min})}$$

Corrective Action:
Any units that are found to exceed 0.1 (10%) variance in reproducibility will need to be corrected or repaired.

Figure 2

Homogenous Phantom