CHAPTER 17

RADIOLOGY

INTRODUCTION

Radiology technologists (X-Ray Technician) are Hospital Corpsmen (HM) performing diagnostic imaging. Technologists may specialize in a number of areas with the ultimate goal to provide quality radiographic images of patients for interpretation by a Radiologist.

Based on the American Society of Radiologic Technologists website, "Radiologic technologists often specialize in a particular diagnostic imaging area."13

- General "Diagnostic" Radiographers "use radiation (x-rays) to produce black-and-white images of anatomy. The images are captured on film, computer or videotape. X-ray may be used to detect bone fractures, find foreign objects in the body, and demonstrate the relationship between bone and soft tissue. The most common type of x-ray exam is chest radiograph."13

- Computed Tomography (CT) Technologists "use a rotating x-ray unit to obtain "slices" of anatomy at different levels within the body. A computer then stacks and assembles the individual slices, creating a diagnostic image. With CT technology, physicians can view the inside of organs - a feat not possible with general radiography."13

- Magnetic Resonance (MR) Technologists "are specially trained to operate MR equipment. During a Magnetic Resonance Imaging (MRI) scan, atoms in the patient's body are exposed to a strong magnetic field. The technologist applies a radiofrequency pulse to the field, which knocks the atoms out of alignment. When the technologist turns the pulse off, the atoms return to their original position. In the process, they give off signals that are measured by a computer and processed to create detailed images of the patient's anatomy."13

- Cardiovascular-Interventional Technologists "use sophisticated imaging techniques such as biplane fluoroscopy to help guide catheters, vena cava filters, stents or other tools through the body. Using these techniques, disease can be treated without open surgery."13

- Nuclear Medicine Technologists "administer trace amounts of radiopharmaceuticals to a patient to obtain functional information about organs, tissues, and bone. The technologist then uses a special camera to detect gamma rays emitted by the radiopharmaceuticals and create an image of the body part under study. The information is recorded on a computer screen or on film."13

- Sonographers "use sound waves to obtain images of organs and tissues in the body. During an ultrasound examination, the sonographer places a transducer in contact with the patient's body. It emits high-frequency sound waves that pass through the body, sending back "echoes" as they bounce off organs and tissues. Special computer equipment converts those echoes into visual data."13

- Mammographers "produce diagnostic images of breast tissue using special x-ray equipment. Under a federal law known as the Mammography Quality Standards Act, mammographers must meet stringent educational and experience criteria in order to perform mammographic procedures."13

- Oral radiography is the art of recording images of a patient's oral structures on film by using X-rays. As the X-ray films are processed, the resulting radiographs provide the Dental Officer with a valuable diagnostic aid. In the case of death, radiographs can be used to aid in identification.
HISTORY OF X-RAY

LEARNING OBJECTIVE:

*Explain the history of x-ray.*

The rays were discovered in 1895 by a scientist, Wilhelm Conrad Roentgen. While experimenting with a device called a Crooke's tube, which generated cathode rays, he noted that a photographic plate completely wrapped in black paper and lying near the tube was fogged when developed.

He knew that the cathode rays could travel only short distances outside the cathode tube and realized he was observing a new, unknown ray, which he called an X-ray because the symbol "X" is used for the unknown in mathematics.

The first dental radiograph was taken during the same year by Dr. Otto Wallkoff. Within 10 years of the first discovery of x-ray, radiographs were being used for diagnosis of medical and dental conditions, for X-ray therapy, and for scientific studies. Although technology over the years has made tremendous improvements in X-ray equipment, the basic concepts are the same.

X-radiation can be harmful and HMs must observe safety precautions when using an X-ray machine or working areas using them. The major portion of this chapter is devoted to the operation of x-ray equipment, the process for taking radiographs, and safety precautions for x-radiation.

MEDICAL X-RAY EQUIPMENT

There are a number of medical imaging equipment pieces HMs might see. This chapter outlines the most common that are utilized. Figures 17-1 and 17-2 are medical and dental X-ray machines.

*Figure 17-1.—Medical X-Ray Machine*

*Photograph provided by HM2 Pablo A. Mercado of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD.*

*Figure 17-2.—Dental X-Ray Machine*

*Photograph provided by HM2 Pablo A. Mercado of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD.*
Film Viewers

The film viewer is a metal case with a back-lit screen. The viewer is used to mount and examine radiographs. Figure 17-3 shows a wall mount film viewer. Never light the film viewer in the darkroom when working with unwrapped or unprocessed film. Keep the viewer screen clean at all times (Fig. 17-3).

Figure 17-3.—Wall Mount Film Viewer

Photograph provided by HM2 Pablo A. Mercado of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD.

FUNDAMENTALS

LEARNING OBJECTIVES:

Identify the aspects of radiation safety.

Identify the aspects of patient protection.

MEDICAL X-RAY

Like visible light rays, X-rays are electromagnetic rays that traveling in a wave motion. The measurement of this wave motion is called a wavelength. The difference between X-rays and other electromagnetic rays is their wavelength. The wavelength for X-rays is extremely short in comparison to electromagnetic rays which are longer. The shorter wavelength enables them to penetrate matter that usually absorbs or reflects light. X-rays and other electromagnetic rays have actions that are considerably different.

Some of the characteristics and properties of X-rays are:

- They travel in straight lines at the speed of light
- They affect photographic film by producing a hidden image made visible by processing
- They cause certain substances to fluoresce (glow)
- They cause irritation of living cells. In large amounts can cause necrosis (death) of the cells, a fact that necessitates caution in using X-rays

X-rays are produced in the x-ray tube head when a metal (tungsten) target is bombarded by a stream of electrons. The X-rays are sent from the x-ray machine the cone head, through the patient, and then reach the x-ray cassette (holds the film) to produce an image on the film.

The density of the X-ray image is controlled by four factors: kilo-voltage (kVp), exposure time, milli-amperage (mA), and target-film distance (TFD). All of these factors are interrelated and may be varied by the operator.

RADIATION SAFETY

Radiation safety and radiation protection are everyone’s responsibility. Proper warning signs are required in areas utilizing radiation.

Several groups and national committees were created to monitor the use of ionizing radiation after many occupational workers were killed or developed a medical condition due to excessive radiation exposure. One of these national groups is the Nuclear Regulatory Commission (NRC). During the early years of radiation use, there were no monitoring or governing bodies which resulted in improper use of radiation such as x-rays of shoes for foot size and heads for hats sizes.
Radiation protection is sub-divided into occupational radiation protection (protection of workers); medical radiation protection (protection of patients); and public radiation protection (protection of individual members of the public population). The types of exposure, as well as government regulations and legal exposure limits are different for each of these groups, so they must be considered separately.

There are several factors that affect the amount of exposure (dose) a patient receives from the source. Radiation exposure is managed by a combination of these factors:

- **Time**: Reducing the time of an exposure reduces the effective dose proportionally. An example of reducing radiation doses by reducing the time of exposures can be accomplished through operator training to reduce the amount of repeated x-rays. The MAS (milliampere per second) controls the exposure time to the patient.

- **Distance**: Increasing distance (x-ray source to patient) reduces dose due to the “Inverse Square” law. Another distance example includes having non-essential personnel standing further away from the radiation exposure area.

- **Shielding**: Adding shielding will reduce radiation dose to the patient. The radiation getting through decreases with the thickness of the shield. The walls of X-ray rooms are lead lined providing an element of shielding to people outside the room. The X-ray machine operator is shielded when standing behind a leaded glass window and can wear a lead apron. Almost any material can act as a shield from X-rays if used in sufficient amounts. Lead aprons and vests are the best methods of shielding.

A good rule is the acronym, **ALARA**, "As Low As Reasonably Achievable." The aim is to minimize the risk of radioactive exposure or other hazards. The rule of **ALARA** is based on the principle that any amount of radiation exposure, no matter how small, can increase the chance of negative biological effects such as cancer.

It is based on the principle that the probability of the occurrence of negative effects of radiation exposure increases with the total lifetime dose. X-ray and other practices involving the use of radiation bring great benefit to the patient population and limiting radiation exposure will reduce negative effects when utilized safely.

Attention to shielding and the rule of **ALARA** protects the patient and workers. There are four major ways to reduce radiation exposure to patient and workers:

- **Shielding**: Use proper barriers to block or reduce ionizing radiation
- **Time**: Spend less time in radiation fields
- **Distance**: Increase distance between radioactive sources and workers or population. As a good rule during radiation exposures, the radiation worker should be a minimum distance of 6 feet from the source
- **Amount**: Limit the number of x-ray exposure taken to the lowest number possible

The facility will have Standard Operating Procedures (SOP) for the operation of radiographic (X-ray) units and equipment. The HM will be required to read these procedures before operating equipment in the Radiology Department.

**RADIATION PROTECTION STANDARDS**

**Patient Protection**

Safety precautions will be observed by all persons working in or near an area where X-rays are generated. A number of precautions are taken to prevent the patient from being overexposed to radiation.

When taking radiographs, the HM should always have patients wear lead aprons and thyroid collars to shield reproductive organs and thyroid glands. The only exception is when obtaining a panorex radiograph as the thyroid collar blocks part of the X-ray beam.
Before taking radiographs on a female, always ask whether or not she is pregnant or if pregnancy is questionable. If there is belief of a pregnancy, consult a provider.

Other radiation safety measures include X-ray machines that have built-in safeguards that filter out harmful radiation and restrict the central X-ray to the smallest possible area.

**Occupational Worker Protection**

When working near a source of radiation, personnel assigned to the Radiology department will be issued an environmental dosimetry radiation film badge (Fig. 17-4). Film badges are used to monitor scatter (stray) radiation that occurs in the Radiology department. The badges are placed in the X-ray room behind the technician’s protective lead-lined barrier or at least 6 feet from the tube head and never in the direct line of radiation during exposure.

The film badges contain X-ray sensitive film in a light-tight packet. They are collected by radiation health technician every 6 to 7 weeks. After collection, the film is sent to the radiation detection laboratory for processing and evaluation. In an ideal environment, zero REM [Radiological Equivalent Man or mammal] exposure is expected for all workers. On occasion there might be an exposure (i.e., greater than 0.010 REM) and will be referred to the Radiation Health Office for investigation.

Radioactive material shall not be used in such a manner to cause any non-radiation worker to exceed a total effective dose equivalent of 500 mRem (5 mSv) per year considering occupancy factors and source usage. When taking radiographs on a patient, observe the following precautions to avoid unnecessary exposure to radiation:

- **NEVER** stand in the path of the central X-ray beam during exposure
- **NEVER** hold the X-ray film packet in the patient's mouth during a dental exposure
- **NEVER** hold the tube head or the tube head cylinder of the X-ray machine during exposure
- **ALWAYS** stand behind a lead-lined window during an exposure

**X-Ray Film Log**

Another aspect of radiation safety is accounting for all radiographs that are taken. An X-ray film log is maintained in all X-ray rooms and will contain the following information: Patient's name, rank, SSN, unit assigned, reason for x-ray retake (if applicable), number of exposures taken, and the settings (if possible).

**NOTE:**

When stating the reason for an x-ray retake, be specific on the nature of the retake.

For example: cone-cut, elongated, foreshortened, dark image, etc.

**Radiation Levels**

The NRC has established total whole body doses for radiation workers which is found in Title 10, Part 20, of the Code of Federal Regulations (10 CFR Part 20), "Standards for Protection Against Radiation." It sets the annual total effective dose limit at 5,000 mRem (5 Rem) for the entire body.
The Navy has trained Radiation Health professionals to monitor medical and non-medical radiation doses. Refer to the local Radiation Health department or the P-5055, Radiation Health Protection Manual, for further guidance.

**Bio Effects**

Prolonged exposure to radiation may result in loss of hair, redness and inflammation of the skin, blood count changes, cell atrophy (wasting away), ulcers, sterility, genetic damage, cancer, leukemia, and death. Adherence to radiation safety will reduce the possibility of these conditions.

**Precious Metals Recovery Program**

The precious metals recovery program is designated to save Department of Defense (DOD) money by recycling precious metals and using those funds to offset the cost of supplies for DOD activities. Both lead and silver are precious metals found in all x-ray departments. Lead is found in x-ray tube packets, floor coverings, wall shielding, patient shields, and x-ray packets. Silver is found in used fixer solutions and medical/dental films. Precious metals will be saved and turned into the Supply Department following the guidelines in BUMEDINST 4016.3, Precious Metals Recovery Program.

**Infection Control**

Both radiographic equipment and film can become contaminated resulting in the transmission of infectious agents. To protect workers and the patient, HMs will ensure that infection control standards are used in the radiology area. Information and procedures on the Infection Control Program can be found in BUMEDINST 6220.9 Series, Nosocomial Infection Control Program and BUMEDINST 6600.10 series, Dental Infection Control Program.

**Handwashing**

Follow proper hand washing procedures when treating radiology patients. Refer to Chapter 9 of this manual for handwashing technique.

**Darkroom**

The darkroom might be a location that is overlooked as an area being contaminated. Disinfect all surfaces that the HM comes in contact with on a daily basis which includes doorknobs, light switches, and other surfaces. Good infection control measures include disinfecting all area that HMs and patients touch.

**Oral Film Positioning Devices**

Film positioning devices should be disposable (single use) or steam sterilized between patients. The treatment facility should have an adequate supply of film positioning devices for the daily patient load. If supplies are short, the HM may disinfect film positioning devices between patients by immersion in an EPA-registered chemical disinfection such as a 2 percent glutaraldehyde solution. Rinse thoroughly after disinfection. Follow manufacturer's instructions for high-level disinfection. Wear gloves when placing intra-oral films and handling contaminated film packets.

**Panoramic Unit Bite-Blocks**

Use a disposable panoramic unit bite block cover for each patient. When disposable covers are not available, disinfect bite blocks in the same manner as a film holding device.

**Intraoral Film Packets**

Intraoral film packets become contaminated when placed in a patient's mouth during exposure. The following section explains procedures to handle and process contaminated intraoral film packets from the X-ray room to the dark room to avoid cross contamination.
PATIENT PREPARATION PROCEDURES

LEARNING OBJECTIVE:
Identify steps for preparing a patient for an x-ray.

To prepare a patient for an X-ray procedure, employ the following techniques:

1. Ensure a provider’s order for the examination.
   a. Only a Medical Officer, Dental Officer, Nurse Practitioner, Physician Assistant (PA) and Independent Duty Corpsmen (IDC) can order a radiographic examination.
   b. The order may be in the Composite Health Computer System (CHCS) or a written order on a SF-519, RADIOLOGIC CONSULTATION REQUEST/REPORT.

   **NOTE:**
   If working in an operational environment or area not within close proximity of a Radiologist, seek the ordering provider’s impression of findings prior to forwarding the films to the Radiologist.

2. If the patient is a woman, ask if she is pregnant.
3. If she is or the HM suspects that she might be, consult the ordering physician.
4. Ask the patient to remove eyeglasses, jewelry (affected area), or any other object in the area of examination.
5. Drape the patient with a lead apron ensuring the reproductive organs are covered, unless area of examination will preclude covering.
6. Position the affected anatomy securely against the film screen. Positioning the patient varies according to the type of radiographic examination and the film placement technique to be used.
7. Give appropriate instructions (breathing, remain still, etc.) to the patient.
8. Set KVp and Mas based on current facility charts.
9. Make the exposure.

After the X-ray procedure is completed, return the lead apron and/or thyroid collar back to the storage device(s) to avoid damage.
MEDICAL X-RAY PROCEDURES

LEARNING OBJECTIVES:

Identify the proper patient positioning techniques.

Identify the proper film size for an x-ray exam.

Identify structures shown in an x-ray.

POSITIONING OF THE HAND

Posterior anterior (PA) Projection (Fig. 17-5)

1. Film Size 8 X 10 or 10 X 12
2. Source to image distance (SID)- 40 inches (x-ray tube 40 inches from film)
3. Part position
   a. Rest the patient’s forearm on the table:
   b. Place the hand with the palm down
   c. Slightly spread the fingers
4. Central ray
   a. Perpendicular to the film
   b. Direct the central ray to the third metacarpophalangeal (MCP) joint
   c. Adjust the long axis of the cassette parallel with the long axis of the hand and forearm
5. Structures shown
   a. PA projection of the:
      i. Carpals
      ii. Metacarpals
      iii. Phalanges
      iv. Thumb will be oblique to 45°
      v. Interarticulations of the hand
      vi. Distal radius and ulna
6. Indications
   a. Discomfort due to mechanism of injury

Figure 17-5.—Posterior Anterior (PA) Projection of the Hand

Photograph provided by JMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
Oblique Projection (Fig. 17-6)

1. Film size 8 X 10 or 10 X 12
2. SID - 40 inches
3. Part Position
   a. Rest the patient’s forearm on the table with the hand pronated and the palm resting on the cassette. If possible use an angled sponge as it will allow the fingers to remain straight and provide increased visualization of the joint spaces.
   b. Adjust the obliquity of the hand so that the MCP joints form an angle of approximately 45 degrees with the cassette
   c. Fingers are flexed with fingertips resting on the cassette
4. Central ray
   a. Perpendicular to the film
   b. Direct central ray to the third metacarpophalangeal joint
   c. Adjust the midline to be parallel with the long axis of the hand and forearm
5. Structure shown:
   a. PA oblique projection of the bones and soft tissues of the hand
6. Indication
   a. Determine possibility of fracture

Figure 17-6.—Oblique Projection of the Hand

Photograph provided by HMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.

17-9
Lateral Projection (Fig. 17-7)

1. Film size 8 X 10 or 10 X 12
2. SID - 40 inches
3. Part position
   a. Extend the patient’s digits and adjust the first digit at a right angle to the palm
   b. Place the palm surface perpendicular to the cassette
   c. Evenly fan the fingers apart
4. Central ray
   a. Perpendicular to the film
   b. Direct the central ray through the second metacarpophalangeal joint
   c. Adjust the midline to be parallel with the long axis of the hand and forearm
5. Structures shown
   a. Lateral projection of the structures of the hand
   b. An extended lateral hand will demonstrate the second through fifth digits superimposed

**NOTE:**
X-rays of the wrist use the same positions as hand x-rays. Finger extension is not required.

6. Indication
   a. Phalangeal fracture
POSITIONING OF THE CHEST
Posterior anterior (PA) projection

(Fig. 17-8)

1. Film size - 14 x 17
2. SID - 72 inches
3. Part position
   a. Patient is in the upright position
   b. The upper border of the film is positioned approximately 1 ½ inches above the relaxed shoulders
   c. The median sagittal plane of the body is centered to the midline of the grid device
   d. Body weight is evenly distributed over both feet
   e. The head is adjusted so that the median sagittal plane of the skull is vertical and the chin is resting over the edge of the grid device
   f. Place the back of the hands on the hips
   g. Adjust the shoulders to lie in the same transverse plane
   h. If a woman's breasts are large enough to superimpose over the lower part of the lung field, have the patient pull them upward and laterally
4. 'Central ray (Cross-hairs)
   a. Perpendicular to the film
   b. Directed to the level of T-7 (Inferior Scapula Angle)
5. Respirations
   a. Exposure is made following full inhalation on the second breath
   b. For certain conditions, an additional exposure is taken following exhalation
6. Indications
   a. Routine physical
   b. Chronic cough
   c. Respiratory disease
   d. Asbestos
   e. Fractured ribs
   f. Pain with respirations

Figure 17-8.—Posterior Anterior (PA) Projection of the Chest

Photograph provided by HMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
Lateral Projection\textsuperscript{15} (Fig. 17-9)

1. Film size - 14 x 17
2. SID - 72 inches
3. Part position
   a. Patient is in the upright position
   b. Place the appropriate shoulder (Left Lateral preferred) against the grid device
   c. The median sagittal plane of the body is parallel to the cassette with the adjacent shoulder in contact with the grid device
   d. The upper border of the film is 1 to 2 inches above the shoulders
   e. Center the thorax to the grid device
   f. Extend the arms over the head
4. Central ray
   a. Perpendicular to the film
   b. Directed to the level of T7
5. Respiations
   a. Exposure is made following full inspiration on the second breath
6. Structures shown
   a. Lateral projection of the heart and aorta
   b. Pulmonary lesions of the side closest to the film
   c. Interlobular fissures
   d. The lobes are differentiated
7. Indications
   a. Routine physical
   b. Chronic cough
   c. Respiratory disease
   d. Asbestos
   e. Fractured ribs
   f. Pain with respirations

Figure 17-9.—Lateral Projection of the Chest

Photograph provided by HMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
POSITIONING OF THE ABDOMEN

KUB (Kidneys, Ureter, Bladder) AP projection
(Supine/standing position)
(Fig. 17-10)

1. Film size - 14 X 17 lengthwise
2. SID – 40 inches
3. Part Position
   a. Patient is supine or standing
   b. The median sagittal plane is perpendicular and centered to the grid device
   c. Adjust the shoulders to lie in the same transverse plane and place arms where they will not cast shadows on the film
4. Central ray (cross-hairs)
   a. Perpendicular to the cassette
   b. Centered to the level of the iliac crest for supine
   c. 2” above iliac crest for standing position.
5. Respiration
   a. Suspended at the end of exhalation
6. Structures shown:
   a. Bilaterally Kidney
   b. Ureter
   c. Bladder

NOTE:
For standing, must include inferior aspect of lungs (Costophrenic angles).

7. Indications
   a. Quadrant pain
   b. Abnormal bowel movement
   c. Bladder trauma
   d. Abdominal trauma
   e. Impaled object
   f. Lower spine (defects, trauma related, impaled, injuries.)
SPINE/PELVIS

Positioning of the Cervical Spine

AP axial projection (Fig. 17-11)

1. Film size - 8 x 10 or 10x 12
2. SID - 40 inches
3. Part position
   a. Patient is supine or upright
   b. Adjust the shoulders to lie in the same transverse plane
   c. Center the median sagittal plane of the patient's body to the midline of the grid device
   d. Extend the chin so that a line from the upper occlusal plane to the mastoid tips is perpendicular to the grid device
   e. Center the cassette at C4 (1/2” above Adam's apple)
4. Central ray
   a. Angled 15 - 20 degrees cephalic (towards head)
   b. Directed to C4 (1/2” above Adam's apple)
5. Respirations
   a. Suspended
6. Structures shown
   a. C3 to T1 in entirety
7. Indications
   a. Tracheal deviation
   b. Foreign body
   c. Trauma

Figure 17-11.—AP Axial Projection of the Cervical Spine

Photograph provided by HMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
Lateral projection (Fig. 17-12)

1. Film size - 8 x 10 or 10 x 12
2. SID - 72 inches
3. Part position
   a. Patient is upright and in the true lateral position
   b. Adjust cassette so that it is centered at C4 (1/2" above Adam's Apple)
   c. Center the coronal plane that passed through the mastoid tips to the midline of the film
   d. Place adjacent shoulder in contact with the grid device
   e. Adjust the shoulders to lie in the same transverse plane, depress them as much as possible and immobilize them by using sandbags of equal weight distributed in both hands
   f. Elevate the chin slightly to prevent superimposition of the mandibular rami over the cervical spine
   g. Ensure the long axis of the cervical spine is parallel to the film
4. Central ray
   a. Horizontal
   b. Perpendicular to the film
   c. Directed to the level of C4
5. Respiration
   a. Suspended at the end of full exhalation
6. Structures shown
   a. Lateral view of the c-spine vertebrae from C1-T1
7. Indications
   a. Musculoskeletal injuries

Figure 17-12.—Lateral Projection of the Cervical Spine

Photograph provided by Biol James Smith of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
Positioning of the Thoracic Spine
AP projection (Fig. 17-13)

1. Film size: 14 x 17
2. SID – 40 inches
3. Part position
   a. Patient is in the supine or upright position
   b. Center the median sagittal plane of the body to the midline of the grid
   c. Place arms along the sides of the body
   d. If the patient is supine, flex the hips and knees to place back in contact with the table
   e. If the patient is erect, distribute body weight equally between both feet
   f. Center film at the level of the T-7 approximately three to four inches below the manubrial notch (Normally this will place the upper edge of the cassette 1 1/2 to 2 inches above the shoulder)
4. Central ray
   a. Directed perpendicularly to T7
   b. Utilize the anode heel effect by positioning the cathode end of the tube towards the feet
5. Respiration
   a. Breathing technique
      i. Slow, shallow breaths
   b. Non-breathing technique
      i. Suspend following full exhalation
6. Structures shown
   a. AP projection of the thoracic bodies, interpediculate spaces and surrounding structures
7. Indications
   a. Chronic pain
   b. Trauma
   c. Cervical spine
   d. Musculoskeletal injuries/abnormalities

Figure 17-13.—AP Projection of the Thoracic Spine

Photograph provided by HMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
Lateral projection (Fig. 17-14)

1. Film size: 14 X 17
2. SID – 40 inches
3. Part position
   a. Patient is in a true lateral position, either recumbent or upright
   b. Place a firm pillow under the patient’s head
   c. Flex the hips and knees to a comfortable position
   d. Center the median coronal plane of the body to the midline of the grid at the level of T7
   e. Adjust the arms at right angles to the long axis of the body
   f. Use a radiolucent support under the lower thoracic region to place the vertebral column horizontal with the film
4. Central ray
   a. Directed perpendicularly to the median coronal plane at the level of T7
   b. Utilize an angulation of 10 degrees for women and 15 degrees for men, due to the differing shoulder widths, if necessary
5. Respiration
   a. Long exposure
      i. Quiet breathing
   b. Short Exposure
      i. Suspend respirations at the end of exhalation
6. Structures shown
   a. A lateral image of the thoracic bodies, their interspaces, the intervertebral foramina and the lower spinous processes
   b. The upper three or four segments are usually not demonstrated in this position
7. Indications
   a. Chronic pain
   b. Trauma
   c. Cervical Spine
   d. Musculoskeletal injuries/abnormalities
Positioning of the Lumbar Spine

AP Projection (Fig. 17-15)

1. Film size: 11 x 14
2. SID - 40 inches
3. Part position
   a. Patient may be either supine or upright
   b. Center the median sagittal plane to the midline of the grid
   c. Adjust the shoulders to lie in the same transverse plane
   d. Flex the knees to help flatten the natural lordotic curve of the spine
   e. Flex the patient’s elbows and place the hands on the upper chest
   f. Center the film at the level of L-3
4. Central ray
   a. Perpendicular to the film
   b. Directed to the level of L-3
5. Respiration
   a. Suspended on expiration
6. Structures shown
   a. Lumbar bodies
   b. Intervertebral disk space
   c. Interpediculate spaces
   d. Laminae
   e. Spinous and transverse processes
7. Indications
   a. Chronic pain
   b. Trauma
   c. Cervical Spine
   d. Musculoskeletal injuries/abnormalities

Figure 17-15.—AP Projection of the Lumbar Spine

Photograph provided by HM1 James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
Lateral Projection (Fig. 17-16)

1. Film size: 11 X 14 lengthwise
2. SID – 40 inches
3. Part position
   a. Use the same body position (recumbent or upright) as used for the AP
   b. Place patient on the indicated side and flex the hips and knees for stability and comfort
   c. Align the median coronal plane of the body to the midline of the grid
   d. Place the arms at right angles to the body
   e. If needed, place a support under the lower thorax to position the long axis of the spine in a horizontal plane
   f. Place a sheet of leaded rubber on the table behind the patient
4. Central ray
   a. Perpendicular to the film
   b. Directed to the level of L3
5. Respirations
   a. Suspended on exhalation
6. Structures shown
   a. Lumbar bodies and their interspaces
   b. Spinous processes
   c. Lumbosacral junction
   d. The first four lumbar intervertebral foramina
7. Indications
   a. Chronic pain
   b. Trauma
   c. Cervical spine
   d. Musculoskeletal injuries/abnormalities

Figure 17-16.—Lateral Projection of the Lumbar Spine

Photograph provided by HMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
Positioning of the Pelvis
AP Projection (Fig. 17-17)

1. Film size 14 x 17 crosswise
2. SID – 40 inches
3. Position of patient
   a. Place the patient on the table in the supine position
4. Position of part
   a. Center the mid-sagittal plane of the body to the mid-line of the grid
   b. Adjust the patient in a true supine position
   c. Have the patient rest their hands across their chest
   d. Unless contraindicated, medially rotate the feet and lower limbs about 15-20 degrees to place the femoral neck parallel with the plane of the cassette
   e. The heels should be 8-10 inches apart
   f. Immobilize the legs with a sandbag across the ankles, if needed
   g. Position upper border of the film 1 ½ inches above the iliac crest
5. Respirations
   a. Suspend respiration prior to exposure
6. Central ray
   a. Perpendicular to the midpoint of the cassette
7. Shield reproductive organs
8. Structures shown
   a. AP projection of
      i. The pelvis
      ii. Femoral head
      iii. Femoral neck
      iv. Trochanters
      v. Proximal 1/3 or 1/4 of the shaft of the femur
9. Indications
   a. Pelvic fracture
   b. Genitourinary system complications
   c. Discoloration
   d. Deformity
   e. Hip pain

Figure 17-17.—AP Projection of the Pelvis

Photograph provided by HM1 James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
POSITIONING OF THE FOOT
AP Projection (Fig. 17-18)

1. Film size 8 x 10 or 10 x 12
2. SID - 40 inches
3. Position of patient
   a. Place the patient on seated or supine position on the table
   b. Flex the knee of the affected side
   c. Rest the sole of the foot firmly on the radiographic table
4. Position of part
   a. Position the cassette under the patient’s foot
   b. Center the cassette to the base of the third metatarsal
   c. Adjust cassette so that its long axis is parallel with the long axis of the foot
   d. Ensure that no rotation of the foot occurs
5. Central ray
   a. 10 degrees towards the heel
   b. Direct central ray to the base of the third metatarsal
6. Shield reproductive organs
7. Structure shown:
   a. AP projection (Dorsoplantar) of the:
      i. Tarsal bones anterior to the talus
      ii. Metatarsals
      iii. Phalanges
8. Indications
   a. Chronic pain
   b. Trauma
   c. Abnormalities

Figure 17-18.—AP Projection of the Foot

Photograph provided by HMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
Oblique Projection (Fig. 17-19)

1. Film size 8 x 10 or 10 x 12
2. SID – 40 inches
3. Position of patient
   a. Place the patient on a seated or supine position
   b. Flex the knee of the affected side
   c. Rest plantar surface of the foot firmly on the radiographic table
4. Position of part
   a. Place the cassette under the patient’s foot
   b. Place film parallel to the foot and with its long axis
   c. Center film to the midline of the foot at the level of the base of the third metatarsal
   d. Rotate the foot medially until the plantar surface forms an angle of 30 degrees to the plane of the cassette
5. Central ray
   a. Perpendicular to the film
   b. Direct central ray to the base of third metatarsal
6. Shield reproductive organs
7. Structures shown
   a. Interspaces between the following:
      i. The Cuboid and the Calcaneus
      ii. The Cuboid and the fourth and fifth Metatarsals
      iii. The Cuboid and the lateral Cuneiform
      iv. The Talus and the Navicular bone
      v. The Cuboid is shown in profile
   b. The Sinus Tarsi is also well demonstrated
8. Indications
   a. Chronic pain
   b. Trauma
   c. Abnormalities

Figure 17-19.—Oblique Projection of the Foot

Photograph provided by HMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
1. Film size 8 x 10 or 10 x 12
2. SID – 40 inches
3. Position of patient
   a. Have the patient lie on the radiographic table and turn toward the affected side
   b. Place the opposite leg behind the patient
4. Position of part
   a. Elevate the patient’s knee enough to place the patella perpendicular to the horizontal plane
   b. Adjust a sandbag support under the knee
   c. Center the cassette to the mid-area of the foot
   d. Adjust the cassette so that its long axis is parallel to the long axis of the foot
   e. Dorisflex the foot to form a 90-degree angle with the lower leg
5. Central ray
   a. Perpendicular to the film
   b. Direct central ray to the base of the third metatarsal
6. Shield reproductive organs
7. Structures shown
   a. The entire foot in profile
   b. The ankle joint
   c. The distal ends of the tibia and fibula
8. Indications
   a. Chronic pain
   b. Trauma
   c. Abnormalities
Positioning of the Ankle
AP Projection (Fig. 17-21)

1. Film size 8 x 10 or 10 x 12
2. SID – 40 inches
3. Position of patient
   a. Place the patient in the supine or seated position with the affected limb fully extended
4. Part position
   a. Adjust the ankle joint in the anatomic position to obtain a true AP projection
   b. Flex the ankle and foot enough to place the long axis of the foot in the vertical position
   c. The leg should have no rotation
5. Central ray
   a. Perpendicular to the ankle joint at a point midway between the Malleoli
6. Shield reproductive organs
7. Structures shown
   a. Ankle joint
   b. Distal ends of the Tibia and Fibula
   c. Proximal portion of the talus
8. Indications
   a. Chronic pain
   b. Trauma
   c. Abnormalities

Figure 17-21.—AP Projection of the Ankle

Photograph provided by HM1 James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.

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Oblique Projection (Medial Rotation)
(Fig. 17-22)

1. Film size 8 x 10 or 10 x 12
2. SID – 40 inches
3. Position of patient
   a. Place the patient in the supine or seated position with the affected limb fully extended
4. Part position
   a. Center the cassette to the ankle joint midway between the Malleoli
   b. Adjust the cassette so that its long axis is parallel with the long axis of the leg
   c. Dorisflex the foot enough to place the ankle at nearly right-angle flexion
   d. Grasp the lower femur with one hand and the foot with the other. Internally rotate the entire leg and foot together until the 45-degree position is achieved
5. Central ray
   a. Perpendicular to the ankle joint
   b. Entering midway between the Malleoli
6. Shield reproductive organs
7. Structures shown
   a. Distal ends of the Tibia and Fibula
   b. Parts of Tibia and Fibula are often superimposed over the talus
   c. Tibiofibular articulation should be demonstrated
8. Indications
   a. Chronic pain
   b. Trauma
   c. Abnormalities

Figure 17-22.—Oblique Projection of the Ankle

Photograph provided by HM1 James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.
Lateral Projection (Fig. 17-23)

1. Film size 8 x 10 or 10 x 12
2. SID – 40 inches
3. Position of patient
   a. Have the supine patient turn toward the affected side until the ankle is lateral
4. Part position
   a. Place the long axis of the cassette parallel with the long axis of the patient’s leg and center it to the ankle joint
   b. Have the patient turn anteriorly or posteriorly as required to place the patella perpendicular to the horizontal plane
   c. Place a support under the knees if necessary
   d. Dorisflex the foot, and adjust it in the lateral position
5. Central ray
   a. Perpendicular to the ankle joint, entering the medial Malleolus
6. Shield reproductive organs
7. Structures shown
   a. Lower third of the Tibia and Fibula
   b. Ankle joint\Tarsal Bones
8. Indications
   a. Calcaneous fracture
   b. Abnormalities
   c. Twisted ankles

Figure 17-23.—Lateral Projection of the Ankle

Photograph provided by HMI James Q. Royal of the Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD by the Radiology Department of National Naval Medical Center, Bethesda, MD.