



ANNUAL X-RAY INSPECTION REPORT 2011
RADIOLOGICAL HEALTH

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EXECUTIVE SUMMARY

A total of 116 x-ray facilities were inspected in 2011. Out of the 116 facilities 54 were in full compliance at the time of the inspection.

The main areas of concern are the darkroom, processing film, satisfactory lead aprons, personnel dosimetry records, and screen cleaning.

Annual dose rates to all operators of x-ray equipment of the facilities inspected were less than the maximum allowed limit of 5000 millirem. Annual dose rates to the public were less than the maximum allowed limit of 100 millirem.

The entrance skin exposure to the patient was within the appropriate limit for all facilities.

The dose to the patient and the dose to the operator is less for all x-ray facilities that use faster speed film. This can be observed most clearly for the dental facilities. As the speed of the film increases from "D" to "F" the average dose per exposure decreases from 0.43 to 0.26 millirem. It should also be noted that the use of digital x-ray again decreases the average dose per exposure from 0.26 millirem for "F" speed film to 0.14 millirem for direct digital x-rays. Doses from computed radiography (CR) are similar to doses from F speed film (0.22 and 0.26 millirem, respectively).

It is expected that as more digital x-rays are used we will see decreases in the total facility noncompliances because darkrooms, safelights, film, and processing are no longer needed. Forty one percent of dental, 21% of veterinary, 43% of medical, 7% of podiatric and 8% of chiropractic facilities are using digital x-ray.

OVERVIEW

To be conservative, exposures to the operator and public are measured at the configuration of highest exposure possible. Exposure to the public is performed by aiming the x-ray tube out of the exam room door from approximately the patient position for an x-ray exam and measuring the exposure at the doorway where the public passes by in the hall. Operator exposures are measured at the position the operator stands when making the exposure as indicated by the facility.

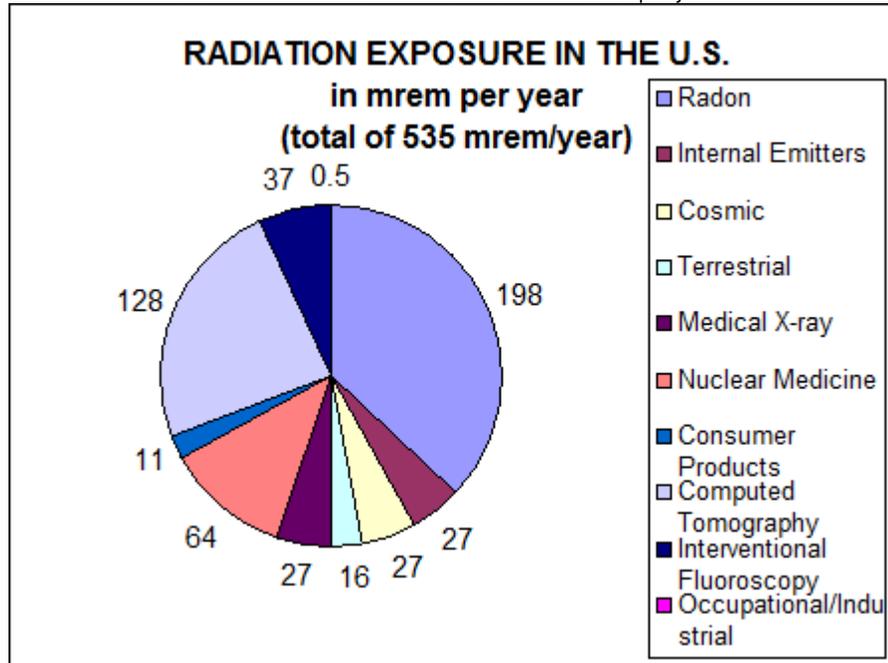
Operator and public exposures are measured in milliroentgen per hour using a Victoreen 471 ion chamber. The exposure per hour is converted to annual dose by converting hours to year and milliroentgen to rem using the number of x-rays the facility takes within a given period of time. 1 milliroentgen is equal 0.5 millirem (American National Standard Institute 6.1.1-1991) for whole body exposure from scattered radiation for the public and operators.

Patient exposures are measured in milliroentgen using an Unfors Xi. Patient exposures are converted from milliroentgen to millirem using the following factors based on the organ of greatest risk. Multiplication of the factor by the number of milliroentgen per exam results in the dose in millirem.

EXAM TYPE	FACTOR	ORGAN
Dental	0.0015	brain
PA Chest	0.1044	lung
AP Cervical Spine	0.0435	thyroid
AP Thoracic Spine	0.1044	lung
AP Lumbar Spine	0.1044	stomach/colon
AP Abdomen	0.1044	stomach/colon
AP Retrograde	0.1044	stomach/colon
Lateral Skull	0.0218	brain
Hand	0.0087	skin
Wrist	0.0087	skin
Arm	0.1044	bone marrow
Shoulder	0.1044	bone marrow
Leg	0.1044	bone marrow
Knee	0.1044	bone marrow
Ankle	0.0087	skin
DP Foot	0.0087	skin
Lateral Foot	0.0087	skin

Adapted from National Council on Radiation Protection and Measurements Report No. 116 tissue weighting factors and conversion factor from roentgen to rad of 0.87 rad/roentgen.

The average radiation dose from natural and man-made sources is 535 millirem per year.



Adapted from NCRP Report No. 160, 2009, Ionizing Radiation Exposure of the Population of the United States.

INSPECTION ITEMS

The following boxed sections indicate the individual items that are specifically looked at during an inspection for the following general groups: film/screen, processing, darkroom/safelight, personnel monitoring, patient shielding, collimation, timer, kVp and filtration, patient entrance skin exposure criteria, public exposure criteria, operator conditions, and physical condition (x-ray unit, shielding, etc.)

Some inspection items may pertain only to specific types of facilities. For example, repeat rate analyses pertain only to chiropractic facilities, whereas panoramic units pertain only to dental facilities. There are also inspection items that cover all facilities (e.g., registration of all x-ray units).

New facilities are not cited for non-compliant items. However, they are given a period of approximately one month to correct any non-compliant items found in the initial inspection.

Film/screen	Dental film is less than E speed X-ray film speed is less than 400 Film is not protected from scatter radiation Film is not stored properly Film is exposed to chemicals Out of date film is used Film and screen types not matched No screen installation date is on outside of cassette Screen and cassettes are not of the same type or age Screen cleaning interval is inadequate Screen cleaning solution and lint free wipes are not used per manufacturer instructions Cassette check is inadequate Cassettes are not permanently identified for their type of use Film viewbox is not available Film viewbox is not cleaned periodically Viewbox bulbs are not of the same intensity and color Luminance of viewboxes is not similar Viewbox bulbs are not replaced annually Technique factors are not recorded in the patient log book Technique charts are not available or up to date Left/right markers are not used on clinical radiographs Clinical radiographs are not properly identified
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<p>Processing</p>	<p>Thermometer is not available for manual processing Timer is not available for manual processing Floating cover is not present for manual processing Sight devevelopment is used No evidence of daily log is kept Developing technique recommended by the manufacturer is not used Developer and fixer temperature are not maintained in limits Processor cleaning interval is inadequate Processor is not operating properly Processor cleaning date is not recorded Clean-up film for processing all x-ray films (except intra-oral) are not run</p>
<p>Darkroom/Safelight</p>	<p>Safelight bulb is greater than 15 W Safelight is too close to the work area Light leaks are detected in the safelight housing Light leaks are detected in the safelight lens Safelight is improperly filtered Darkroom is not light tight Darkroom is not free of dust and dirt Daylight processor arm cuffs are not acceptable Daylight processor is not light tight Darkroom temperature/humidity are not acceptable There are other light sources present in the dark room</p>
<p>Personnel Monitoring</p>	<p>Personnel monitoring devices are required Control dosimeters are not properly used or stored Employee dosimeters are not properly used Employee dosimeters are not properly stored No evidence of employee review of records Personnel monitoring records are incomplete No radiation safety officer is designated for large practices Evidence of personnel holding film during exposure</p>
<p>Personnel/Patient Shielding</p>	<p>Satisfactory lead aprons are unavailable Satisfactory thyroid shields are unavailable Satisfactory gonadal shields are unavailable Lead aprons are improperly stored Lead aprons are not checked annually for tears and holes (radiographically or visually) Individuals holding patients are not protected Mobile equipment exposure switch cord is less than 6 feet long Non-essential individuals are in the x-ray room during exposure</p>

Collimation

X-ray beam is not restricted to the appropriate area
 X-ray beam is not restricted to the appropriate size
 Collimator light is not aligned with the x-ray field
 Collimation is not used in taking radiographs
 Collimator light is not bright enough under normal room lighting
 Collimator light problems (e.g. mirror broken, mirror obstructed)
 Inadequate collimation is used for clinical radiographs

Timer

Timer does not terminate exposure
 Timer activates at zero
 Timer is inaccurate
 Timer repeatability is unacceptable
 No deadman switch is available

kVp and Filtration

kVp is greater than 10% of set value
 kVp is non-repeatable
 Filtration in beam is less than required

Patient entrance skin exposure criteria

ESEC in milliroentgen for non-specialty radiographic examinations shall not be exceeded when technical factors for an average adult patient are utilized:

Examination	ESEC mR maximum	ESEC mR recommended	Body part thickness (cm)
PA Chest	30	15	23
AP Cervical Spine	250	175	13
AP Thoracic Spine	900	600	23
AP Lumbar Spine	1000	675	23
AP Abdomen	750	500	23
AP Retrograde Pyelogram	900	600	23
Lateral Skull	300	200	15
Dental (bitewing or periapical)	700	350	not applicable

OR

Examination	Dose mrem maximum	Dose mrem recommended	Body part thickness (cm)
PA Chest	3.13	1.57	23
AP Cervical Spine	10.88	7.61	13
AP Thoracic Spine	93.96	62.64	23
AP Lumbar Spine	104.4	70.47	23
AP Abdomen	78.3	52.2	23
AP Retrograde Pyelogram	93.96	62.64	23
Lateral Skull	6.54	4.36	15
Dental (bitewing or periapical)	1.05	0.53	not applicable

	<p>ESE for all x-ray units in facility are not within 20 percent of one another.</p> <p>Typical exposure value for the x-ray unit is not posted</p> <p>Exposure reproducibility is greater than 5%</p>
Public exposure	<p>Public exposure exceeded - 100 millirem per year</p> <p>Public is not protected from scatter radiation</p>
Operator conditions	<p>Operator exposure exceeded - 5000 millirem per year</p> <p>Operator cannot observe patient during exposure</p> <p>Operator cannot monitor kVp, mA, time, mAs during exposure</p> <p>Operator is not protected during exposure</p> <p>Satisfactory lead gloves are not available</p> <p>Mobile or stationary exposure switch cord is less than 6 feet long</p> <p>Exposure switch not located to prevent x-ray activation when operator is outside of of the control booth</p> <p>Operator holds film in patient's mouth</p>
Physical condition (x-ray unit, shielding, etc.)	<p>Console does not indicate tubes for multiple setup</p> <p>Panoramic or 3D unit does not reset before restarting</p> <p>Motion of panoramic or 3D unit is not smooth or is impeded</p> <p>X-ray tube head locks into position for panoramic, cephalometric and or 3D unit</p> <p>Table locks, tube crane locks, bucky-cassette locks are not functioning</p> <p>Filters for soft tissue imaging for cephalometric imaging are not available</p> <p>Focal spot is not indicated on the x-ray tube</p> <p>Source to image distance is less than 7 7/8 inches for intra-oral x-ray tubes</p> <p>Source to image distance is less than 40 inches for medical x-ray machines</p> <p>Unit is inaccurate/not calibrated in terms of examination distance</p> <p>Tube head is unstable</p> <p>Overhead crane does not move easily</p> <p>Exposure switch is not labeled</p> <p>Unit does not have visual indication of kVp, mA, time, or mAs</p> <p>Unit does not have audible/visual indication of exposure</p> <p>Angulation indicator on x-ray unit is not functioning</p> <p>Typical exposure for x-ray unit is not posted</p> <p>Structural shielding is inadequate</p> <p>Door interlock system is not functioning</p> <p>Condition of high voltage and other cables is inadequate</p> <p>X-ray head leaks oil</p> <p>Wires are exposed on tube head</p> <p>X-ray exposure button is missing or broken</p> <p>Wires are exposed on exposure switch</p> <p>Preventive maintenance records for x-ray machines and processor are not kept</p> <p>Bare sheet lead on walls/doors is not covered</p>

X-ray unit is not registered
Vermont State licenses are not displayed
No documentation of LMP (chiropractic)
Repeat rate analysis is not performed (chiropractic)

SUMMARY OF ALL INSPECTIONS

Total Number of Inspections Performed

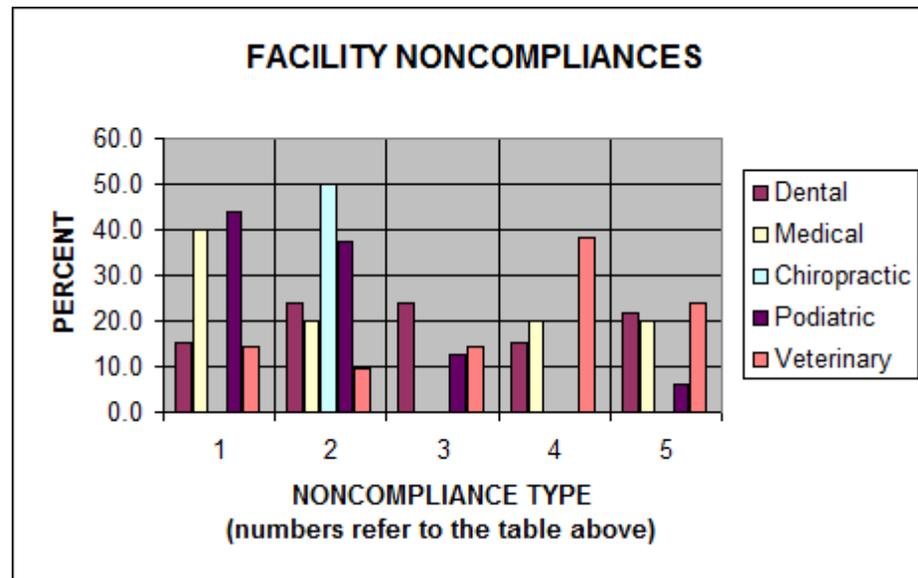
116

Total Number of Non-compliance Items

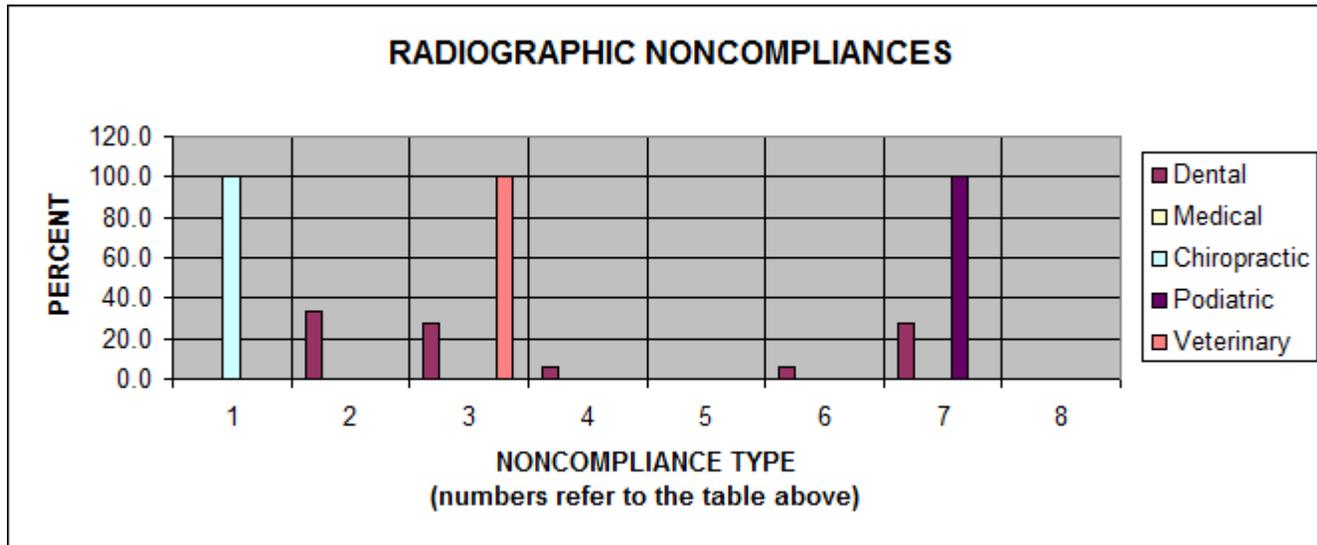
113

TOTAL NONCOMPLIANCES	113
Average number noncompliances per facility	0.97
Range of number of noncompliances/facility	0 - 7

TOTAL FACILITY NONCOMPLIANCES	90	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
1 Film/Screen	19	21.1
2 Processing	21	23.3
3 Darkroom/Safelight	16	17.8
4 Personnel Monitoring	16	17.8
5 Patient Shielding	17	18.9
6 License Not Displayed	0	0.0
7 Repeat Analysis Not Performed	1	1.1



TOTAL RADIOGRAPHIC NONCOMPLIANCES	23	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
1 Collimation	3	13.0
2 Timer	6	26.1
3 kVp & Filtration	6	26.1
4 Patient entrance skin exposure	1	4.3
5 Public exposure	0	0.0
6 Operator conditions	1	4.3
7 Physical condition (x-ray unit, shielding)	6	26.1
8 Unit not registered	0	0.0



Annual Dose to Occupational Worker		
Type of Facility	Average millirem per year	Range millirem per year
Dental	2	0.001 - 48
Medical	1.1	0.001 - 2.7
Chiropractic	0.006	0.002 - 0.01
Podiatric	0.04	0.001 - 0.22
Veterinary	6.4	0.5 - 72

Annual Dose to Public		
Type of Facility	Average millirem per year	Range millirem per year
Dental	6.3	0.022 - 74
Medical	7.3	0.01 - 36
Chiropractic	0.05	0.02 - 0.07
Podiatric	0.11	0.003 - 0.39
Veterinary	0.38	0.006 - 4.3

DENTAL INSPECTIONS

Total Number of Inspections Performed

73

Non-compliance Items

TOTAL NONCOMPLIANCES	64
Average number noncompliances per facility	0.88
Range of number of noncompliances	0-5

TOTAL FACILITY NONCOMPLIANCES	46	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	7	15.3
Processing	11	23.9
Darkroom/Safelight	11	23.9
Personnel Monitoring	7	15.2
Patient Shielding	10	21.7

TOTAL RADIOGRAPHIC NONCOMPLIANCES	18	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
Collimation	0	0.0
Timer	6	33.2
kVp & Filtration	5	27.8
Patient entrance skin exposure	1	5.6
Public exposure	0	0.0
Operator conditions	1	5.6
Physical condition (x-ray unit, shielding)	5	27.8
Unit not registered	0	0.0

Dose to Patients Per Exposure

Exam Type	Average millirem per exposure	Range millirem per exposure
Intra-oral D speed film	0.43	0.20 - 0.68
Intra-oral E speed film	0.24	na
Intra-oral F speed film	0.26	0.09 - 0.71
Intra-oral Portable digital	na	na
Intra-oral CR digital	0.22	0.05 - 0.57
Intra-oral DR digital	0.14	0.04 - 0.27
Panoramic film	0.82	0.08 - 1.67
Panoramic digital	0.66	0.04 - 1.30
Cephalometric	0.025	0.015 - 0.03
Cephalometric digital	na	na
Cephalometric scanner	na	na
iCAT	0.41	0.26 - 1.50

Annual Dose to Occupational Worker

Exam Type	Average millirem per year	Range millirem per year
Intra-oral D speed film	3.1	0.014 - 12.8
Intra-oral E speed film	8.4	na
Intra-oral F speed film	1.9	0.009 - 23.7
Intra-oral Portable digital	na	na
Intra-oral CR digital	3.1	0.016 - 18.5
Intra-oral DR digital	1.2	0.001 - 21.4
Panoramic film	2.8	0.043 - 48.1
Panoramic digital	2.6	0.058 - 21.5
Cephalometric	0.38	0.003 - 1.62
Cephalometric digital	na	na
Cephalometric scanner	na	na
iCAT	0.78	0.41 - 1.4

Annual Dose to Public

Exam Type	Average millirem per year	Range millirem per year
Intra-oral D speed film	12	0.24 - 93
Intra-oral E speed film	25	na
Intra-oral F speed film	5.2	0.022 - 35
Intra-oral Portable CR digital	na	na
Intra-oral CR digital	8.4	0.22 - 93
Intra-oral DR digital	3.9	0.022 - 20
Panoramic film	6.5	0.13 - 74
Panoramic digital	11	0.05 - 31
Cephalometric	0.41	0.006 - 0.92
Cephalometric digital	na	na
Cephalometric scanner	na	na
iCAT	11	0.72 - 31

MEDICAL INSPECTIONS

Total Number of Inspections Performed

12

Non-compliance Items

TOTAL NONCOMPLIANCES	5
Average number noncompliances per facility	0.42
Range of number of noncompliances	0-2

TOTAL FACILITY NONCOMPLIANCES	5	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	2	40
Processing	1	20
Darkroom/Safelight	0	0
Personnel Monitoring	1	20
Patient Shielding	1	20

TOTAL RADIOGRAPHIC NONCOMPLIANCES	0	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
Collimation	0	0
Timer	0	0
kVp & Filtration	0	0
Patient entrance skin exposure	0	0
Public exposure	0	0
Operator conditions	0	0
Physical condition (x-ray unit, shielding)	0	0
Unit not registered	0	0

Dose to Patients Per Exposure

Type of Exam	Average millirem per exposure	Range millirem per exposure
PA Chest	1.5	0.72 - 2.3
AP Cervical Spine	4.3	1.3 - 6.1
AP Thoracic Spine	na	na
AP Lumbar Spine	36	22 - 53
AP Abdomen	na	na
AP Retrograde	na	na
Lateral Skull	na	na
Type of Exam	Average millirem per exposure	Range millirem per exposure
Hand	0.09	0.053 - 0.16
Wrist	0.09	0.06 - 0.15
Arm	2.7	na
Shoulder	na	na
Leg	na	na
Knee	2.7	1.7 - 5.9
Ankle	na	na
DP Foot	na	na
Lateral Foot	na	na
Fluoroscopy		
Hand	na	na
Knee	na	na
Ankle	na	na
Foot	na	na
AP Lumbar	198	35 - 361
Fluoroscopy Spot Film	na	na
Sinus	11	na

Annual Dose to Occupational Worker

Average millirem per year	Range millirem per year
1.1	0.001 - 2.7

Annual Dose to Public

Average millirem per year	Range millirem per year
7.3	0.01 - 37

CHIROPRACTIC INSPECTIONS

Total Number of Inspections Performed

2

Non-compliance Items

TOTAL NONCOMPLIANCES	3
Average number noncompliances per facility	1.5
Range of number of noncompliances	0 - 3

TOTAL FACILITY NONCOMPLIANCES	2	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	0	0.0
Processing	1	50.0
Darkroom/Safelight	0	0.0
Personnel Monitoring	0	0.0
Patient Shielding	0	0.0
License Displayed	0	0.0
Repeat Analysis	1	50.0

TOTAL RADIOGRAPHIC NONCOMPLIANCES	1	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
Collimation	1	100.0
Timer	0	0.0
kVp & Filtration	0	0.0
Patient entrance skin exposure	0	0.0
Public exposure	0	0.0
Operator conditions	0	0.0
Physical condition (x-ray unit, shielding)	0	0.0
Unit not registered	0	0.0

Dose to Patients Per Exposure

Type of Exam	Average millirem per exposure	Range millirem per exposure
PA Chest	na	na
AP Cervical Spine	1.9	1.7 -2.2
AP Thoracic Spine	na	na
AP Lumbar Spine	38	25 - 51
AP Abdomen	na	na
AP Retrograde	na	na
Lateral Skull	na	na

Type of Exam	Average millirem per exposure	Range millirem per exposure
Hand	na	na
Wrist	na	na
Arm	na	na
Shoulder	na	na
Leg	na	na
Knee	na	na
Ankle	na	na
DP Foot	na	na
Lateral Foot	na	na

Annual Dose to Occupational Worker

Average millirem per year	Range millirem per year
0.006	0.002 - 0.01

Annual Dose to Public

Average millirem per year	Range millirem per year
0.05	0.02 - 0.07

PODIATRIC INSPECTIONS

Total Number of Inspections Performed

11

Non-compliance Items

TOTAL NONCOMPLIANCES	17
Average number noncompliances per facility	1.55
Range of number of noncompliances	0 - 7

TOTAL FACILITY NONCOMPLIANCES	16	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	7	43.8
Processing	6	37.5
Darkroom/Safelight	2	12.5
Personnel Monitoring	0	0.0
Patient Shielding	1	6.2

TOTAL RADIOGRAPHIC NONCOMPLIANCES	1	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
Collimation	0	0.0
Timer	0	0.0
kVp & Filtration	0	0.0
Patient entrance skin exposure	0	0.0
Public exposure	0	0.0
Operator conditions	0	0.0
Physical condition (x-ray unit, shielding)	1	100.0
Unit not registered	0	0.0

Dose to Patients Per Exposure

Type of Exam	Average millirem per exposure	Range millirem per exposure
DP Foot	0.15	0.05 - 0.23
Lateral Foot	0.18	0.09 - 0.26

Annual Dose to Occupational Worker

Average millirem per year	Range millirem per year
0.037	0.001 - 0.22

Annual Dose to Public

Average millirem per year	Range millirem per year
0.11	0.003 - 0.39

VETERINARIAN INSPECTIONS

Total Number of Inspections Performed

18

Non-compliance Items

TOTAL NONCOMPLIANCES	24
Average number noncompliances per facility	1.33
Range of number of noncompliances	0 - 4

TOTAL FACILITY NONCOMPLIANCES	21	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	3	14.3
Processing	2	9.5
Darkroom/Safelight	3	14.3
Personnel Monitoring	8	38.1
Patient Shielding	5	23.8

TOTAL RADIOGRAPHIC NONCOMPLIANCES	3	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
Collimation	2	0
Timer	0	0
kVp & Filtration	1	100
Patient entrance skin exposure	0	0
Public exposure	0	0
Operator conditions	0	0
Physical condition (x-ray unit, shielding)	0	0
Unit not registered	0	0

Exposure to Animals Per Exam

Type of Exam	Average milliroentgen per exposure	Range milliroentgen per exposure
Dog chest	39.2	7.4 - 109
Dog abdomen	40.5	6.5 - 117
Dog extremity	14.5	2.6 - 41
Dog dental	72	57 - 82
Cat-o-gram	18.7	2.3 - 49
Cat chest/abdomen	12.9	4.2 - 22
Cat extremity	9.4	1.3 - 34
Cat dental	35	7.9 - 51
Horse hoof	47.8	16 - 80
Horse navicular	40.2	25 - 56
Horse fetlock/pastern/ankle	14.0	12 - 16
Horse carpus/knee	25.2	16 - 35
Horse hock	14.4	7.6 - 21
Horse gaskin/forearm	na	na
Horse canon	8.1	0.1 - 16
Horse stifle/hip	110.0	37 - 243
Horse spine	0.7	na

Annual Dose to Occupational Worker

STATIONARY X-RAY Position of Operator	Average millirem per year	Range millirem per year
Operator exposure at edge of table	9	0.5 - 72
Operator exposure at opposite ends of table	6.9	0.5 - 68
Operator exposure 3 feet from x-ray unit	1.9	0.3 - 14
Operator exposure 6 feet from x-ray unit	0.72	0.02 - 7.2
Operator exposure behind shield, wall, or door	0.1	0.0004 - 0.67
Extremity exposure	25	1.3 - 208

PORTABLE X-RAY Position of Operator	Average millirem per year	Range millirem per year
Operator exposure holding unit	0.6	0.01 - 1.2
Operator exposure 3 feet from x-ray unit	0.06	0.002 - 0.12
Operator exposure 6 feet from x-ray unit	0.04	0.002 - 0.09
Operator exposure 9 feet from x-ray unit	0.0005	na
Operator exposure at end of exposure cord	0.03	0.0005 - 0.05
Operator exposure behind shield, wall, or door	na	na
Extremity exposure	0.08	0.07 - 0.09

DENTAL X-RAY Position of Operator	Average millirem per year	Range millirem per year
Operator exposure at edge of table	4.38	na
Operator exposure 6 feet from x-ray unit	0.005	0.0004 - 0.04
Operator exposure at end of exposure cord	na	na
Operator exposure behind shield, wall, or door	0.75	0.001 - 4.6
Extremity exposure	1.13	na

Annual Dose to Public

	Average millirem per year	Range millirem per year
Stationary X-Ray	0.53	0.006 - 4.3
Portable X-Ray	0.01	0.0003 - 0.02
Dental X-Ray	0.17	0.22 - 1.25

NOTE: na = not applicable