

**ANNUAL X-RAY INSPECTION REPORT 2007
VERMONT DEPARTMENT OF HEALTH
RADIOLOGICAL HEALTH**

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EXECUTIVE SUMMARY

A total of 188 x-ray facilities were inspected in 2007. Out of the 188 facilities 56 were in full compliance at the time of the inspection.

The two main areas of concern found during the inspections involved the light tightness of the darkroom and problems with the safelight. In addition, film processing procedures, storage and condition of lead aprons/gloves/gonadal shields, and personnel monitoring procedures were of concern. With respect to facility noncompliances, radiographic noncompliances were not as numerous. However, it should be noted that the older dental units (e.g. Yoshida Kaycor and Tokyo Emix Lumix) are failing the kilovoltage test and need to be replaced once the kilovoltage falls below 50 kVp. Another common problem for the operator is not being able to observe the patient during the exposure.

The average return time of the "Certification of Noncompliance Items Abatement Status" form was 28 calendar days. The range of return times varied from 1 to 279 calendar days.

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 except for one facility.

The entrance skin exposure to the patient was within the appropriate limit except for one facility. This facility closed in early 2008.

The dose to the patient and the dose to the operator are decreased 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 0.26 to 0.16 millirem. It should also be noted that the use of digital x-ray again decreases the average dose per exposure from 0.16 millirem for "F" speed film to 0.11 millirem for direct digital x-rays.

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. Thirty seven percent of dental and 8% of veterinary facilities are using digital x-ray.

Within the next year we expect to put this and future reports and "X-Ray Facility Tips" on our website at www.healthvermont.gov under Radiological Health. The X-Ray Facility Tips will include the following topics: darkroom fog, shielding, lead aprons and thyroid collars, personnel dosimeters (badges), darkroom conditions, and inspection results.

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.

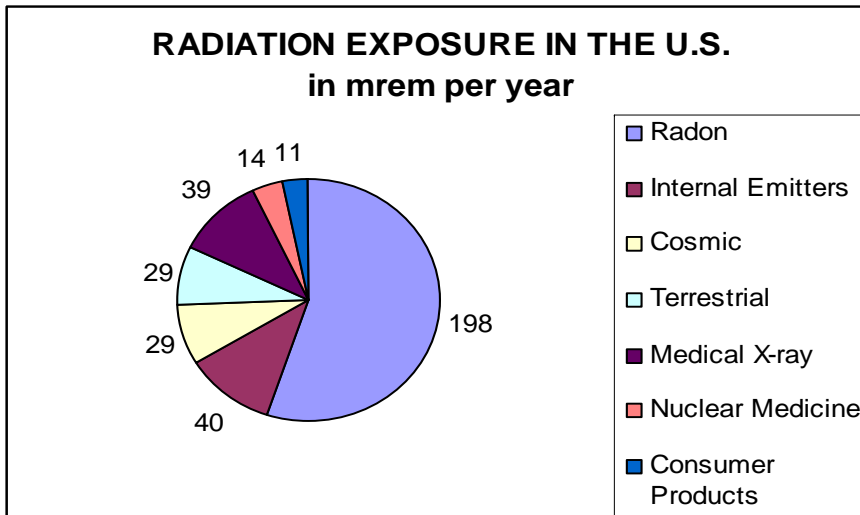
Operator and public exposures are measured in milliroentgen per hour using a Victoreen 471 ion chamber. The exposure per hour is converted to annual dose by converting hours to year and milliroentgen to rem using the number of x-rays the facility takes within a given period of time. 1 milliroentgen is 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 360 millirem per year.



Adapted from Handbook of Health Physics and Radiological Health, 3rd edition, 1998

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 Panoramic and cephalometric 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 is not manufacturer recommended Cassette check is inadequate Film viewbox is not available Film viewbox is not cleaned periodically Viewbox bulbs are not of the same type Viewbox bulbs are not replaced annually Technique factors are not recorded in the patient log book Left/right markers are not used on clinical radiographs Clinical radiographs are not properly identified
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Processing	<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 Clean-up film for panoramic and cephalometric films are not run</p>
Darkroom/Safelight	<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 Darkroom or daylight processor fog test results are unacceptable Daylight processor is not light tight</p>
Personnel Monitoring	<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>
Patient Shielding	<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 Individuals holding patients are not protected Non-essential individuals are in the x-ray room during exposure</p>
Collimation	<p>X-ray beam is not restricted to the appropriate area X-ray beam is not restricted to the appropriate size 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</p>

Timer	<p>Timer does not terminate exposure Timer activates at zero Timer is inaccurate Timer repeatability is unacceptable No deadman switch is available</p>																																																																								
kVp and Filtration	<p>kVp is greater than 10% of set value kVp is non-repeatable Filtration in beam is less than required</p>																																																																								
Patient entrance skin exposure criteria	<p>ESEC in milliroentgen for non-specialty radiographic examinations shall not be exceeded when technical factors for an average adult patient are utilized:</p> <table border="1"> <thead> <tr> <th>Examination</th> <th>ESEC mR maximum</th> <th>ESEC mR recommended</th> <th>Body part thickness (cm)</th> </tr> </thead> <tbody> <tr> <td>PA Chest</td> <td>30</td> <td>15</td> <td>23</td> </tr> <tr> <td>AP Cervical Spine</td> <td>250</td> <td>175</td> <td>13</td> </tr> <tr> <td>AP Thoracic Spine</td> <td>900</td> <td>600</td> <td>23</td> </tr> <tr> <td>AP Lumbar Spine</td> <td>1000</td> <td>675</td> <td>23</td> </tr> <tr> <td>AP Abdomen</td> <td>750</td> <td>500</td> <td>23</td> </tr> <tr> <td>AP Retrograde Pyelogram</td> <td>900</td> <td>600</td> <td>23</td> </tr> <tr> <td>Lateral Skull</td> <td>300</td> <td>200</td> <td>15</td> </tr> <tr> <td>Dental (bitewing or periapical)</td> <td>700</td> <td>350</td> <td>not applicable</td> </tr> </tbody> </table> <p style="text-align: center;">OR</p> <table border="1"> <thead> <tr> <th>Examination</th> <th>Dose mrem maximum</th> <th>Dose mrem recommended</th> <th>Body part thickness (cm)</th> </tr> </thead> <tbody> <tr> <td>PA Chest</td> <td>3.13</td> <td>1.57</td> <td>23</td> </tr> <tr> <td>AP Cervical Spine</td> <td>10.88</td> <td>7.61</td> <td>13</td> </tr> <tr> <td>AP Thoracic Spine</td> <td>93.96</td> <td>62.64</td> <td>23</td> </tr> <tr> <td>AP Lumbar Spine</td> <td>104.4</td> <td>70.47</td> <td>23</td> </tr> <tr> <td>AP Abdomen</td> <td>78.3</td> <td>52.2</td> <td>23</td> </tr> <tr> <td>AP Retrograde Pyelogram</td> <td>93.96</td> <td>62.64</td> <td>23</td> </tr> <tr> <td>Lateral Skull</td> <td>6.54</td> <td>4.36</td> <td>15</td> </tr> <tr> <td>Dental (bitewing or periapical)</td> <td>1.05</td> <td>0.53</td> <td>not applicable</td> </tr> </tbody> </table> <p>ESE for all x-ray units in facility are not within 20 percent of one another. Exposure reproducibility is greater than 5%</p>	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	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
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Public exposure	<p>Public exposure exceeded - 100 millirem per year Public is not protected from scatter radiation</p>																																																																								

Operator conditions	<p>Operator exposure exceeded - 5000 millirem per year Operator cannot observe patient during exposure Operator cannot monitor kVp, mA, time, mAs during exposure Operator is not protected during exposure Satisfactory lead gloves are not available Mobile or stationary exposure switch cord is less than 6 feet long Operator holds film in patient's mouth</p>
Physical condition (x-ray unit, shielding, etc)	<p>Console does not indicate tubes for multiple setup Panoramic unit does not reset before restarting Motion of panoramic unit is not smooth or is impeded X-ray tube head locks into position for panoramic and/or cephalometric unit Filters for soft tissue imaging for cephalometric imaging are not available Focal spot is not indicated on the x-ray tube Source to image distance is less than 7 7/8 inches Tube head is unstable Typical exposure for x-ray unit is not posted Structural shielding is inadequate Condition of high voltage and other cables is inadequate X-ray head leaks oil Wires are exposed on tube head X-ray exposure button is missing or broken Wires are exposed on exposure switch Preventive maintenance records for x-ray machines and processor are not kept Bare sheet lead on walls/doors is not covered</p>
X-ray unit is not registered	
Vermont State licenses are not displayed	
Repeat rate analysis is not performed	

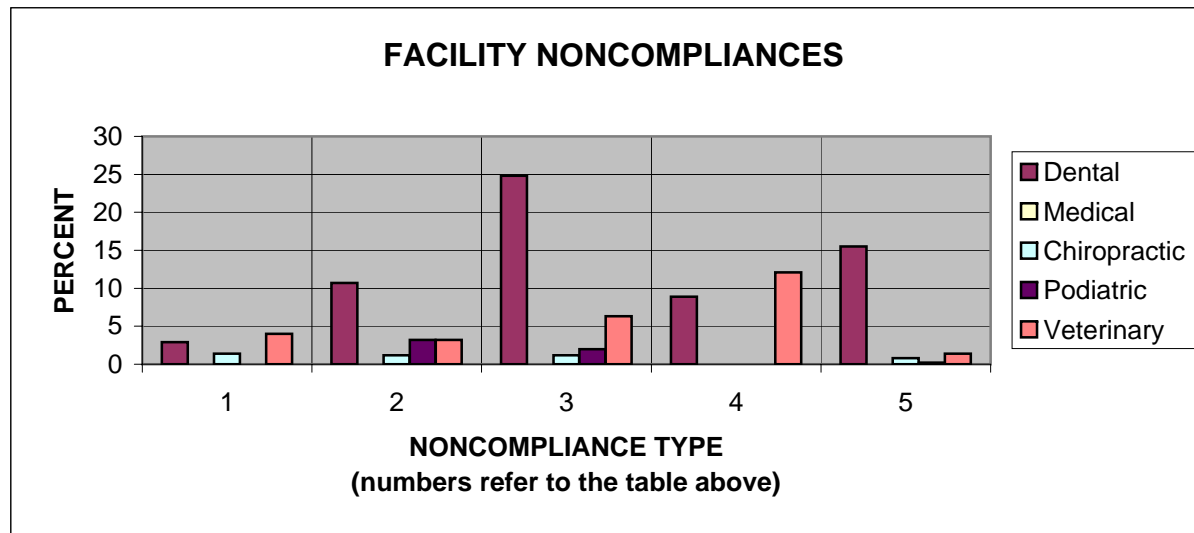
SUMMARY OF ALL INSPECTIONS

Total Number of Inspections Performed 188

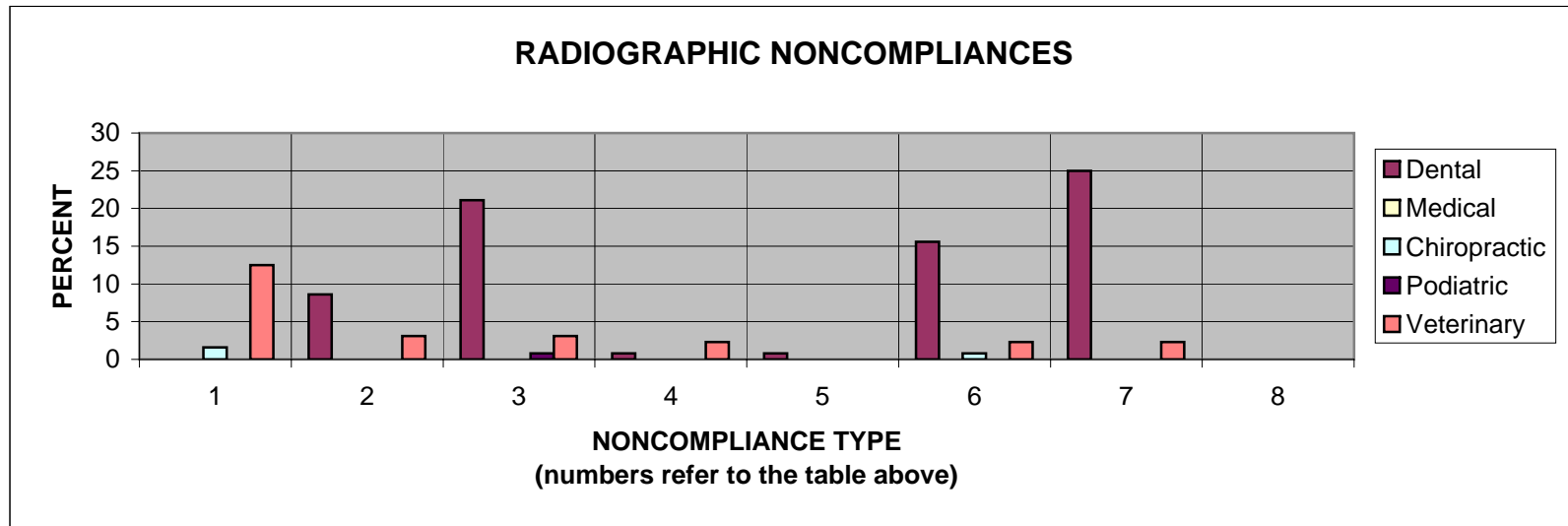
Total Number of Non-compliance Items

TOTAL NONCOMPLIANCES	476
Average number noncompliances per facility	2.5
Range of number of noncompliances/facility	0 - 11

TOTAL FACILITY NONCOMPLIANCES	347	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
1 Film/Screen	29	8.4
2 Processing	63	18.2
3 Darkroom/Safelight	119	34.3
4 Personnel Monitoring	73	21.0
5 Patient Shielding	63	18.2



TOTAL RADIOGRAPHIC NONCOMPLIANCES	128	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
1 Collimation	18	14
2 Timer	15	11.7
3 kVp & Filtration	32	25
4 Patient entrance skin exposure	4	3.1
5 Public exposure	1	0.1
6 Operator conditions	24	18.8
7 Physical condition (x-ray unit, shielding)	35	27.3
8 Unit not registered	0	0



Annual Dose to Occupational Worker		
Type of Facility	Average millirem per year	Range millirem per year
Dental	2.71	0.0006 - 50
Medical	0.2	0.11 - 0.30
Chiropractic	0.021	0.001 - 0.055
Podiatric	0.067	0.0019 - 0.34
Veterinary	8.7	0.0001 - 250

Annual Dose to Public		
Type of Facility	Average millirem per year	Range millirem per year
Dental	7.87	0.005 - 141
Medical	0.22	na
Chiropractic	0.048	0.001 - 0.095
Podiatric	0.77	0.003 - 2.81
Veterinary	0.31	0.0008 - 3.5

DENTAL INSPECTIONS

Total Number of Inspections Performed

116

Non-compliance Items

TOTAL NONCOMPLIANCES	310
Average number noncompliances per facility	2.7
Range of number of noncompliances	0 - 11

TOTAL FACILITY NONCOMPLIANCES	218	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	10	2.9
Processing	37	10.7
Darkroom/Safelight	86	24.8
Personnel Monitoring	31	8.9
Patient Shielding	54	15.5

TOTAL RADIOGRAPHIC NONCOMPLIANCES	92	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
Collimation	0	0
Timer	11	8.6
kVp & Filtration	27	21.1
Patient entrance skin exposure	1	0.8
Public exposure	1	0.8
Operator conditions	20	15.6
Physical condition (x-ray unit, shielding)	32	25
Unit not registered	0	0

Dose to Patients Per Exposure

Exam Type	Average millirem per exposure	Range millirem per exposure
Intra-oral D speed film	0.26	0.002 - 0.68
Intra-oral E speed film	0.25	0.02 - 1.24
Intra-oral F speed film	0.16	0.02 - 0.40
Intra-oral CR digital	0.14	0.01 - 0.33
Intra-oral DR digital	0.11	0.001 - 0.58
Panoramic film	0.90	0.08 - 1.92
Panoramic digital	0.76	0.23 - 1.52
Cephalometric	0.02	0.01 - 0.09

Annual Dose to Occupational Worker

Exam Type	Average millirem per year	Range millirem per year
Intra-oral	2.91	0.0006 - 50
Panoramic	2.20	0.0045 - 47
Cephalometric	0.14	0.001 - 0.25

Annual Dose to Public

Exam Type	Average millirem per year	Range millirem per year
Intra-oral	8.37	0.005 - 122
Panoramic	6.73	0.002 - 141
Cephalometric	0.77	0.005 - 6.75

MEDICAL INSPECTIONS

Total Number of Inspections Performed

2

Non-compliance Items

TOTAL NONCOMPLIANCES	0
Average number noncompliances per facility	0
Range of number of noncompliances	0

TOTAL FACILITY NONCOMPLIANCES	0	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	0	0
Processing	0	0
Darkroom/Safelight	0	0
Personnel Monitoring	0	0
Patient Shielding	0	0

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	na	na
AP Cervical Spine	1.96	na
AP Thoracic Spine	na	na
AP Lumbar Spine	32.1	na
AP Abdomen	na	na
AP Retrograde	na	na
Lateral Skull	na	na

Type of Exam	Average millirem per exposure	Range millirem per exposure
Hand	0.01	na
Wrist	0.01	0.011 - 0.013
Arm	na	na
Shoulder	7.51	na
Leg	na	na
Knee	4.33	3.76 - 4.91
Ankle	na	na
DP Foot	na	na
Lateral Foot	na	na
Fluoroscopy	na	na
Fluoroscopy Spot Film	na	na

Annual Dose to Occupational Worker

Average millirem per year	Range millirem per year
0.2	0.11 - 0.30

Annual Dose to Public

Average millirem per year	Range millirem per year
0.22	na

CHIROPRACTIC INSPECTIONS

Total Number of Inspections Performed

13

Non-compliance Items

TOTAL NONCOMPLIANCES	21
Average number noncompliances per facility	1.5
Range of number of noncompliances	0 - 4

TOTAL FACILITY NONCOMPLIANCES	16	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	5	1.4
Processing	4	1.2
Darkroom/Safelight	4	1.2
Personnel Monitoring	0	
Patient Shielding	3	0.8

TOTAL RADIOGRAPHIC NONCOMPLIANCES	5	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
Collimation	2	1.6
Timer	0	0
kVp & Filtration	0	0
Patient entrance skin exposure	0	0
Public exposure	0	0
Operator conditions	1	0.8
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	na	na
AP Cervical Spine	2.44	0.03 - 5.05
AP Thoracic Spine	19.5	2.1 - 35.8
AP Lumbar Spine	29.8	0.5 - 47.1
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	8.0	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
0.021	0.001 - 0.055

Annual Dose to Public

Average millirem per year	Range millirem per year
0.048	0.001 - 0.095

PODIATRIC INSPECTIONS

Total Number of Inspections Performed

10

Non-compliance Items

TOTAL NONCOMPLIANCES	20
Average number noncompliances per facility	2
Range of number of noncompliances	0 - 6

TOTAL FACILITY NONCOMPLIANCES	19	PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	0	0
Processing	11	3.2
Darkroom/Safelight	7	2
Personnel Monitoring	0	0
Patient Shielding	1	0.2

TOTAL RADIOGRAPHIC NONCOMPLIANCES	1	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
Collimation	0	0
Timer	0	0
kVp & Filtration	1	0.8
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
DP Foot	0.098	0.026 - 0.155
Lateral Foot	0.115	0.023 - 0.144

Annual Dose to Occupational Worker

Average millirem per year	Range millirem per year
0.067	0.0019 - 0.34

Annual Dose to Public

Average millirem per year	Range millirem per year
0.77	0.003 - 2.81

VETERINARIAN INSPECTIONS

Total Number of Inspections Performed

47

Non-compliance Items

TOTAL NONCOMPLIANCES	127
Average number noncompliances per facility	2.7
Range of number of noncompliances	0 - 10

TOTAL FACILITY NONCOMPLIANCES		PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES
Film/Screen	14	4
Processing	11	3.2
Darkroom/Safelight	22	6.3
Personnel Monitoring	42	12.1
Patient Shielding	5	1.4

TOTAL RADIOGRAPHIC NONCOMPLIANCES		PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
Collimation	16	12.5
Timer	4	3.1
kVp & Filtration	4	3.1
Patient entrance skin exposure	3	2.3
Public exposure	0	0
Operator conditions	3	2.3
Physical condition (x-ray unit, shielding)	3	2.3
Unit not registered	0	0

Exposure to Animals Per Exam

Type of Exam	Average milliroentgen per exposure	Range milliroentgen per exposure
Dog chest	20.2	1.6 - 185
Dog abdomen	23.2	1.9 - 185
Dog extremity	9.5	0.6 - 181
Dog dental	52.3	1 - 131
Cat-o-gram	8.0	0.79 - 66
Cat chest/abdomen	8.1	0.79 - 66
Cat extremity	4.0	0.5 - 37
Cat dental	46.8	1 - 147
Horse hoof	26.9	6.1 - 113
Horse navicular	19.7	7.3 - 29
Horse fetlock/pastern/ankle	27.5	4.4 - 88
Horse carpus/knee	26.1	4.4 - 88
Horse hock	31.0	3.7 - 87
Horse gaskin/forearm	15.5	14 - 17
Horse canon	27.2	10 - 88
Horse stifle/hip	74.5	26 - 220

Annual Dose to Occupational Worker

Position of Operator	Average millirem per year	Range millirem per year
Operator exposure at edge of table	16.7	0.14 - 391
Operator exposure at opposite ends of table	13.9	0.1 - 250
Operator exposure holding unit	3.3	0.001 - 82
Operator exposure 3 feet from x-ray unit	3.2	0.0001 - 27.4
Operator exposure 6 feet from x-ray unit	1.2	0.0001 - 0.1
Operator exposure 9 feet from x-ray unit	0.049	0.0001 - 27.4
Operator exposure at end of exposure cord	1.4	0.0005 - 23.5
Operator exposure behind shield, wall, or door	1.2	0.0005 - 23.5
Extremity exposure	29.1	.01 - 803

Annual Dose to Public

Average millirem per year	Range millirem per year
0.31	0.0008 - 3.5

NOTE: na = not applicable