VERMONT
DEPARTMENT OF HEALTH

ANNUAL X-RAY INSPECTION REPORT 2008
RADIOLOGICAL HEALTH

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EXECUTIVE SUMMARY

A total of 124 x-ray facilities were inspected in 2007. Out of the 124 facilities 53 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.

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.

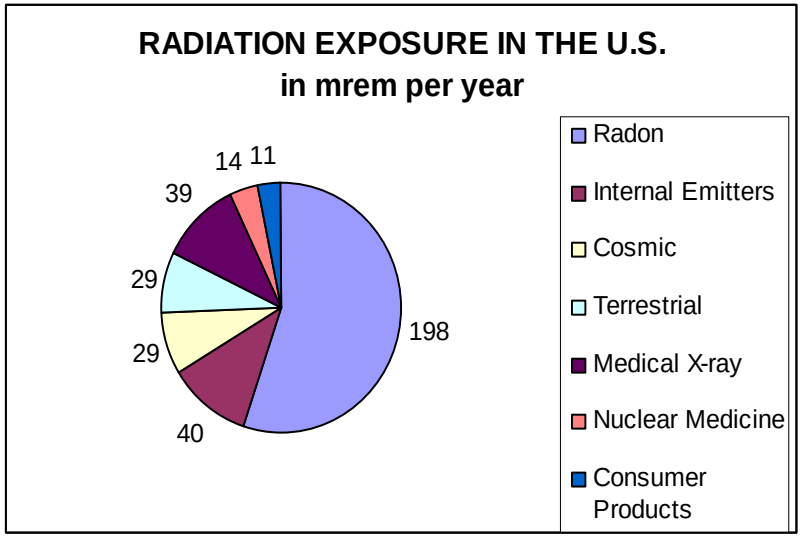
Operator and public exposures are measured in milliroentgen per hour using a Victoreen 471 ion chamber. The exposure per hour is converted to annual dose by converting hours to year and milliroentgen to rem using the number of x-rays the facility takes within a given period of time. 1 milliroentgen is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

Processing	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
Darkroom/Safelight	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
Personnel Monitoring	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
Patient Shielding	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
Collimation	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

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 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

ESE for all x-ray units in facility are not within 20 percent of one another.
Exposure reproducibility is greater than 5%

Public exposure

Public exposure exceeded - 100 millirem per year
Public is not protected from scatter radiation

Operator conditions	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
Physical condition (x-ray unit, shielding, etc)	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
X-ray unit is not registered	
Vermont State licenses are not displayed	
Repeat rate analysis is not performed	

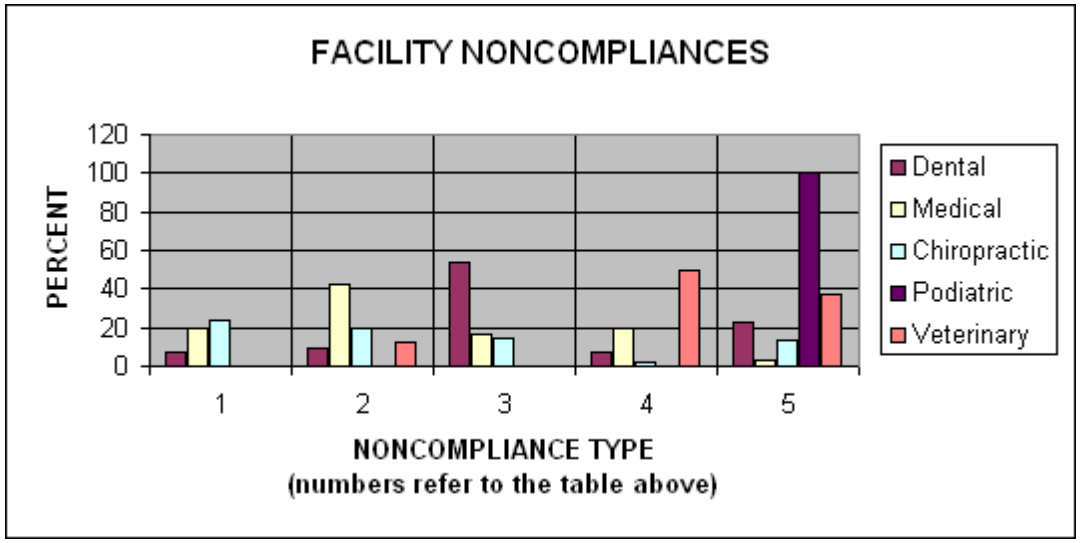
SUMMARY OF ALL INSPECTIONS

Total Number of Inspections Performed 124

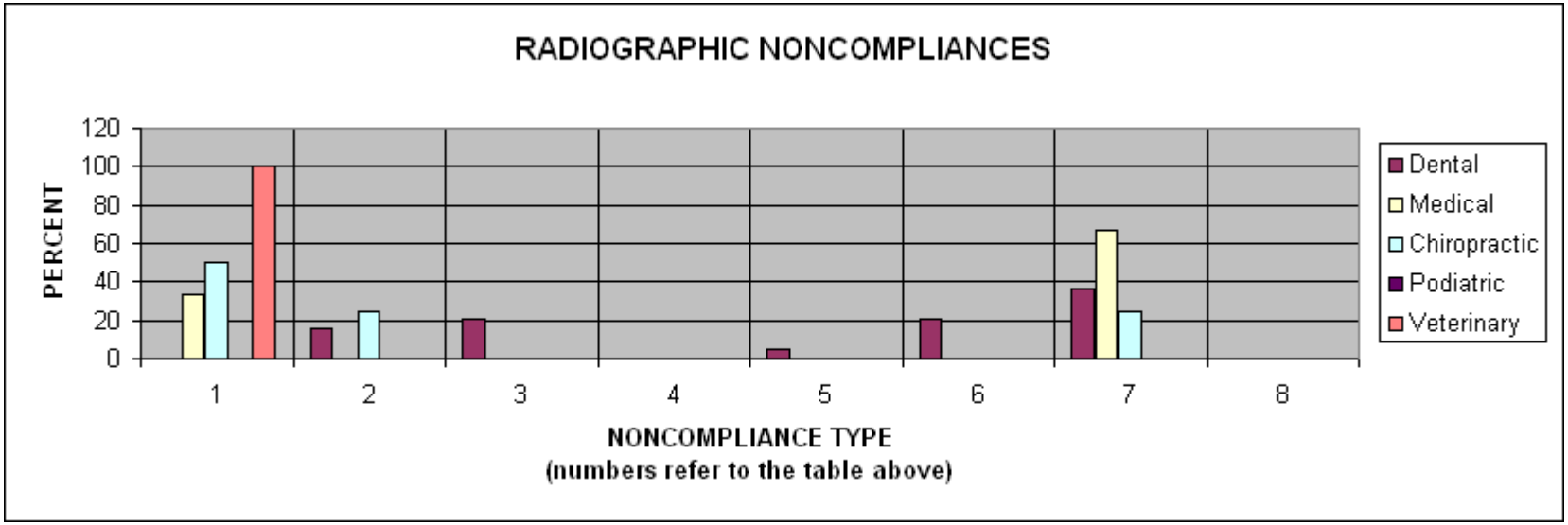
Total Number of Non-compliance Items

TOTAL NONCOMPLIANCES	203
Average number noncompliances per facility	1.6
Range of number of noncompliances/facility	0 - 9

TOTAL FACILITY NONCOMPLIANCES	176	**PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES**
1 Film/Screen	29	16.5
2 Processing	35	19.9
3 Darkroom/Safelight	47	26.7
4 Personnel Monitoring	16	9.1
5 Patient Shielding	29	16.5
6 License Not Displayed	7	4.0
7 Repeat Analysis Not Performed	13	7.4



TOTAL RADIOGRAPHIC NONCOMPLIANCES	27	PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES
1 Collimation	4	14.8
2 Timer	4	14.8
3 kVp & Filtration	4	14.8
4 Patient entrance skin exposure	0	0.0
5 Public exposure	1	3.7
6 Operator conditions	4	14.8
7 Physical condition (x-ray unit, shielding)	10	37.0
8 Unit not registered	0	0.0



Annual Dose to Occupational Worker		
Type of Facility	Average millirem per year	Range millirem per year
Dental	1.24	0.004 - 22
Medical	0.3	0.0004 - 2.13
Chiropractic	0.029	0.0004 - 1.01
Podiatric	0.25	0.0035 - 0.5
Veterinary	0.16	0.0082 - 62

Annual Dose to Public		
Type of Facility	Average millirem per year	Range millirem per year
Dental	4.43	0.018 - 49.3
Medical	1.4	0.0002 - 62
Chiropractic	0.12	0.0005 - 5.4
Podiatric	0.005	0.001 - 0.008
Veterinary	0.37	0.014 - 1.5

DENTAL INSPECTIONS

Total Number of Inspections Performed 58

Non-compliance Items

TOTAL NONCOMPLIANCES	75
Average number noncompliances per facility	1
Range of number of noncompliances	0-5

TOTAL FACILITY NONCOMPLIANCES	56	**PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES**
Film/Screen	4	7.1
Processing	5	8.9
Darkroom/Safelight	30	53.6
Personnel Monitoring	4	7.1
Patient Shielding	13	23.2

TOTAL RADIOGRAPHIC NONCOMPLIANCES	19	**PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES**
Collimation	0	0
Timer	3	15.8
kVp & Filtration	4	21
Patient entrance skin exposure	0	0
Public exposure	1	5.3
Operator conditions	4	21
Physical condition (x-ray unit, shielding)	7	36.8
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	0.45	0.21 - 0.71
Intra-oral E speed film	0.37	0.29 - 0.44
Intra-oral F speed film	0.25	0.10 - 0.49
Intra-oral CR digital	0.22	0.08 - 0.39
Intra-oral DR digital	0.15	0.05 - 0.28
Panoramic film	0.99	0.39 - 1.25
Panoramic digital	0.84	0.23 - 1.20
Cephalometric	0.016	0.006 - 0.016

Annual Dose to Occupational Worker

Exam Type	Average millirem per year	Range millirem per year
Intra-oral	1.50	0.004 - 22
Panoramic	0.60	0.009 - 16.3
Cephalometric	2.39	0.62 - 4.16

Annual Dose to Public

Exam Type	Average millirem per year	Range millirem per year
Intra-oral	5.49	0.018 - 49.3
Panoramic	2.38	0.02 - 13
Cephalometric	1.79	0.10 - 3.47

MEDICAL INSPECTIONS

Total Number of Inspections Performed 32

Non-compliance Items

TOTAL NONCOMPLIANCES	34
Average number noncompliances per facility	1
Range of number of noncompliances	0-8

TOTAL FACILITY NONCOMPLIANCES	31	**PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES**
Film/Screen	6	19.4
Processing	13	41.9
Darkroom/Safelight	5	16.1
Personnel Monitoring	6	19.4
Patient Shielding	1	3.2

TOTAL RADIOGRAPHIC NONCOMPLIANCES	3	**PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES**
Collimation	1	33
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)	2	67
Unit not registered	0	0

Dose to Patients Per Exposure

Type of Exam	**Average millirem per exposure**	**Range millirem per exposure**
PA Chest	1.43	0.42 - 3.13
AP Cervical Spine	3.48	1.22 - 7.35
AP Thoracic Spine	35.6	6.37 - 64.7
AP Lumbar Spine	36.1	13.1 - 99.4
AP Abdomen	na	na
AP Retrograde	na	na
Lateral Skull	1.96	na

Type of Exam	Average millirem per exposure	Range millirem per exposure
Hand	0.11	0.03 - 0.21
Wrist	0.09	0.03 - 0.22
Arm	1.79	0.54 - 2.78
Shoulder	4.89	1.52 - 9.42
Leg	na	na
Knee	5.64	0.41 - 7.91
Ankle	0.18	0.07 - 0.32
DP Foot	na	na
Lateral Foot	na	na
Fluoroscopy	na	na
Fluoroscopy Spot Film	na	na
Sinus	12.2	na

Annual Dose to Occupational Worker

Average millirem per year	Range millirem per year
0.29	0.0004 - 2.13

Annual Dose to Public

Average millirem per year	Range millirem per year
1.4	0.0002 - 62

CHIROPRACTIC INSPECTIONS

Total Number of Inspections Performed 25

Non-compliance Items

TOTAL NONCOMPLIANCES	84
Average number noncompliances per facility	3
Range of number of noncompliances	0 - 9

TOTAL FACILITY NONCOMPLIANCES	80	**PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES**
Film/Screen	19	23.7
Processing	16	20
Darkroom/Safelight	12	15
Personnel Monitoring	2	2.5
Patient Shielding	11	13.8
License Displayed	7	8.8
Repeat Analysis	13	16.2

TOTAL RADIOGRAPHIC NONCOMPLIANCES	4	**PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES**
Collimation	2	50
Timer	1	25
kVp & Filtration	0	0
Patient entrance skin exposure	0	0
Public exposure	0	0
Operator conditions	0	0
Physical condition (x-ray unit, shielding)	1	25
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	2.65	1.38 - 5.79
AP Thoracic Spine	19.9	7.52 - 36.2
AP Lumbar Spine	34.3	9.08 - 63.4
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	1.83	0.38 - 3.85
Ankle	na	na
DP Foot	0.084	0.032 - 0.136
Lateral Foot	na	na

Annual Dose to Occupational Worker

Average millirem per year	Range millirem per year
0.029	0.0004 - 1.01

Annual Dose to Public

Average millirem per year	Range millirem per year
0.12	0.001 - 5.4

PODIATRIC INSPECTIONS

Total Number of Inspections Performed 2

Non-compliance Items

TOTAL NONCOMPLIANCES	1
Average number noncompliances per facility	1
Range of number of noncompliances	0 - 1

TOTAL FACILITY NONCOMPLIANCES	1	**PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES**
Film/Screen	0	0
Processing	0	0
Darkroom/Safelight	0	0
Personnel Monitoring	0	0
Patient Shielding	1	100

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**
DP Foot	0.089	0.054 - 0.125
Lateral Foot	0.179	0.048 - 0.31

Annual Dose to Occupational Worker

Average millirem per year	Range millirem per year
0.252	0.0035 - 0.5

Annual Dose to Public

Average millirem per year	Range millirem per year
0.005	0.001 - 0.008

VETERINARIAN INSPECTIONS

Total Number of Inspections Performed 7

Non-compliance Items

TOTAL NONCOMPLIANCES	9
Average number noncompliances per facility	1
Range of number of noncompliances	0 - 3

TOTAL FACILITY NONCOMPLIANCES	8	**PERCENTAGE OF TOTAL FACILITY NONCOMPLIANCES**
Film/Screen	0	0
Processing	1	12.5
Darkroom/Safelight	0	0
Personnel Monitoring	4	50
Patient Shielding	3	37.5

TOTAL RADIOGRAPHIC NONCOMPLIANCES	1	**PERCENTAGE OF TOTAL RADIOGRAPHIC NONCOMPLIANCES**
Collimation	1	100
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

Exposure to Animals Per Exam

Type of Exam	Average milliroentgen per exposure	Range milliroentgen per exposure
Dog chest	15.7	11.3 - 20
Dog abdomen	57.1	53.1 - 61
Dog extremity	12.1	3.8 - 20.6
Dog dental	128.5	84 - 173
Cat-o-gram	17.8	5.5 - 21
Cat chest/abdomen	na	na
Cat extremity	na	na
Cat dental	59.0	44 - 74
Horse hoof	10.3	na
Horse navicular	na	na
Horse fetlock/pastern/ankle	23.5	na
Horse carpus/knee	na	na
Horse hock	na	na
Horse gaskin/forearm	na	na
Horse canon	na	na
Horse stifle/hip	124.0	na

Annual Dose to Occupational Worker

Position of Operator	Average millirem per year	Range millirem per year
Operator exposure at edge of table	6.9	0.17 - 23.4
Operator exposure at opposite ends of table	4.6	0.93 - 11.7
Operator exposure holding unit	na	na
Operator exposure 3 feet from x-ray unit	2	0.10 - 7.5
Operator exposure 6 feet from x-ray unit	0.51	0.03 - 2
Operator exposure 9 feet from x-ray unit	na	na
Operator exposure at end of exposure cord	0.87	na
Operator exposure behind shield, wall, or door	0.16	0.001 - 0.62
Extremity exposure	25.1	2.2 - 93.8

Annual Dose to Public

Average millirem per year	Range millirem per year
0.37	0.014 - 1.5

NOTE: na = not applicable