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NATIONWIDE EVALUATION OF X-RAY TRENDS (NEXT)

TABULATION AND GRAPHICAL SUMMARY OF THE 1999 DENTAL RADIOGRAPHY SURVEY

November 2003

Republished August 2007

Published by
Conference of Radiation Control Program Directors, Inc.

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TABULATION AND GRAPHICAL SUMMARY OF THE 1999 DENTAL RADIOGRAPHY SURVEY

Prepared by Albert E. Moyal

Division of Mammography Quality and Radiation Programs
Center for Devices and Radiological Health (CDRH)
Office of Health and Industry Programs
U.S. Food and Drug Administration
1350 Piccard Drive
Mail Code: HFZ-240
Rockville, MD 20850
E-mail: AEM@cdrh.fda.gov

In Association with

Conference of Radiation Control Program Directors'
Committee on Nationwide Evaluation of X-ray Trends (NEXT) (H-4)
and
American College of Radiology

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{On August 24, 3007, pages 15 and 16 of this document [Tables 18 and 19 and Figures 13 and 14] were modified to reflect revised data provided by FDA.)

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FOREWORD

The Conference of Radiation Control Program Directors, Inc. (CRCPD) is an organization made up of the radiation control programs in each of the 50 states, the District of Columbia, and Puerto Rico, and of individuals, regardless of employer affiliation, with an interest in radiation protection. The primary purpose and goal of CRCPD is to assist its members in their efforts to protect the public, radiation worker, and patient from unnecessary radiation exposure. CRCPD also provides a forum for centralized communication on radiation protection matters between the states and the federal government, and between the individual states.

One method of providing assistance to the states, as well as to other interested parties, is through technical and administrative publications. Most technical publications of CRCPD are written by various committees, task forces or special working groups. Most administrative publications are written by staff of the Office of Executive Director (OED).

CRCPD's mission is "to promote consistency in addressing and resolving radiation protection issues, to encourage high standards of quality in radiation protection programs, and to provide leadership in radiation safety and education."

This particular publication, *Nationwide Evaluation of X-ray Trends (NEXT) Tabulation and Graphical Summary of the 1999 Dental Radiography*, is the release of this data for informational use. No conclusions are included; these are left for in-depth analysis and publications in technical journals.

Richard Ratliff, Chairperson
Conference of Radiation Control
Program Directors, Inc.

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PREFACE

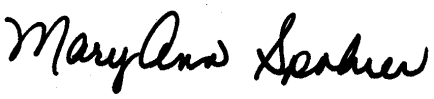
The Nationwide Evaluation of X-ray Trends (NEXT) is a national program conducted annually to measure the x-ray exposure that a standard patient receives for selected x-ray examinations. The NEXT program is a cooperative effort of the Conference of Radiation Control Program Directors, Inc. (CRCPD), an association of state and local radiation control agencies, and the Food and Drug Administration's (FDA) Center for Devices and Radiological Health (CDRH).

This tabulation has been prepared in cooperation with CRCPD's H-4 Committee on Nationwide Evaluation of X-ray Trends (NEXT). The tables and graphs are a summary of the survey data collected by the NEXT program in 1999. The procedures used for the collection of data are those contained within the protocol for the NEXT Dental Survey 1999.

A sample of approximately 340 dental facilities was randomly selected for survey in 40 participating states. The sample size for each state was proportional to the state population. The following states participated in the 1999 survey:

Alabama	Illinois	Mississippi	Pennsylvania
Alaska	Iowa	Missouri	Rhode Island
Arizona	Kansas	Nebraska	South Carolina
Arkansas	Kentucky	New Hampshire	Tennessee
California	Louisiana	New Jersey	Texas
Colorado	Maine	New Mexico	Utah
Connecticut	Maryland	North Carolina	Vermont
Florida	Massachusetts	North Dakota	Virginia
Hawaii	Michigan	Ohio	Washington
Idaho	Minnesota	Oregon	West Virginia
			Wisconsin

We wish to thank the personnel of the State radiation control programs who performed these surveys. Without their cooperation, the collection of this data would not have been possible.



Mary Ann Spohrer, Current Chairperson
Committee on Nationwide Evaluation
of X-ray Trends

ABSTRACT

Moyal, Albert E., CRCPD Committee on Nationwide Evaluation of X-ray Trends, *Nationwide Evaluation of X-ray Trends (NEXT) Tabulation and Graphical Summary of 1999 Dental Radiography Survey*, CRCPD Publication #E-03-6 (November 2003) (70 pp).

This document presents 1999 dental survey data. The tables and graphs are a summary of the data collected as part of the Nationwide Evaluation of X-ray Trends program. No conclusions are included.

CONTENTS

Cephalometric Procedures

Panoramic Procedures

APPENDICES

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INTRODUCTION

The Nationwide Evaluation of X-ray Trends (NEXT) entails a survey of various diagnostic radiology modalities performed annually in a voluntary program at the State level. Previous surveys performed include those for computed tomography (1990, 2000), fluoroscopy (1984, 1991, and 1996), mammography (1985, 1988, and 1992), dental radiography (1993), adult chest (1994), abdomen and lumbosacral spine radiography (1995), and pediatric chest radiography (1998).

In 1999 the NEXT program surveyed facilities that perform intraoral, cephalometric, and panoramic dental radiology. Patient exposure and air kerma was measured for typical clinical conditions, and a radiographic phantom was used to evaluate image quality. Information regarding technique factors (including exposure time and tube potential), patient workload, equipment information, film processing, and x-ray system half-value layer was also collected. Data were obtained from a representative sampling of the population of United States dental facilities including general dental offices, dental surgical facilities, and orthodontal facilities.

INTRAORAL PROCEDURES

Table 1. Type of Dental Practices

Practice	Frequency	Percent
General Practice	316	93.7
Orthodontics	18	5.3
Surgical	3	1.0
Total	**337**	**100**

Table 2. Film Brands Used for Intraoral Imaging

Film Brand	Frequency	Percent
Eastman Kodak	295	89.6
Agfa	17	5.2
Other	17	5.2
Total	**329**	**100**

Table 3. Types of Film Used for Intraoral Imaging

Film Type	Frequency	Percent
*D-Speed (ULT)	237	72.9
*E-Speed (EKS)	54	16.6
Dentus M2	15	4.6
Other	19	5.8
Total	**325**	**100**

* ULT and EKS are manufacturer designations for the respective film speeds

Table 4. Availability of Line Voltage Compensator for Intraoral Imaging

Line Voltage Compensator	Frequency	Percent
Not Available	199	59.9
Available	133	40.1
Total	**332**	**100.0**

Table 5. Generator Phase of Surveyed X-ray Units

Phase	Frequency	Percent
Single	302	91.8
Three Phase	16	4.9
High Frequency	4	1.2
Other	7	2.1
Total	**329**	**100**

Table 6. Number of Intraoral X-ray Units In Use at Each Facility

Number of Units	Frequency	Cumulative Frequency	Percent	Cumulative Percent
1	66	66	19.9	19.9
2	89	155	26.9	46.8
3	94	249	28.4	75.2
4	40	289	12.1	87.3
> 5	42	331	12.7	100

Intraoral Units	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	331	2.9	1.8	1	2	3	3	13

Figure 1.
Number of Intraoral X-ray Units In Use at Each Facility

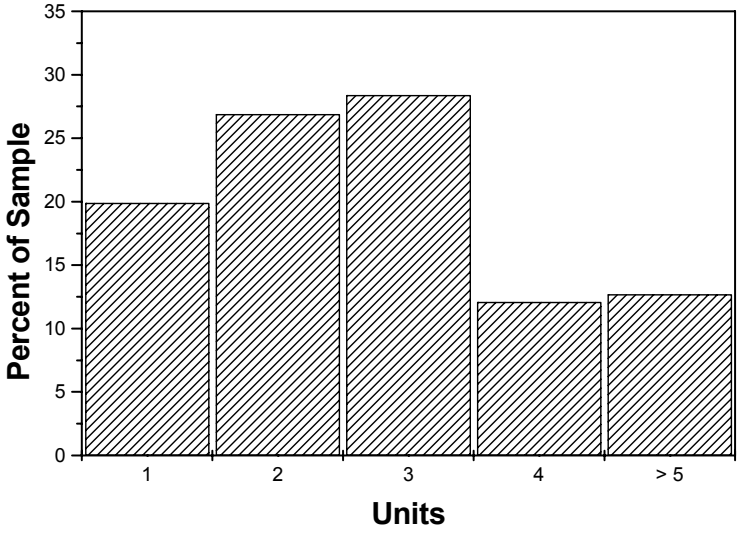


Table 7. Number of Intraoral Patients Examined Per Week at Each Facility

Number of Patients/week	Frequency	Cumulative Frequency	Percent	Cumulative Percent
0 – 24	51	51	15.5	15.5
25 – 49	101	152	30.7	46.2
50 – 74	83	235	25.2	71.4
75 - 99	41	276	12.5	83.9
100 – 125	22	298	6.7	90.6
> 125	31	329	9.4	100

Patients	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	329	53.4	51.2	1	20	40	75	375

Figure 2.
Number of Intraoral Patients Examined Per Week at Each Facility

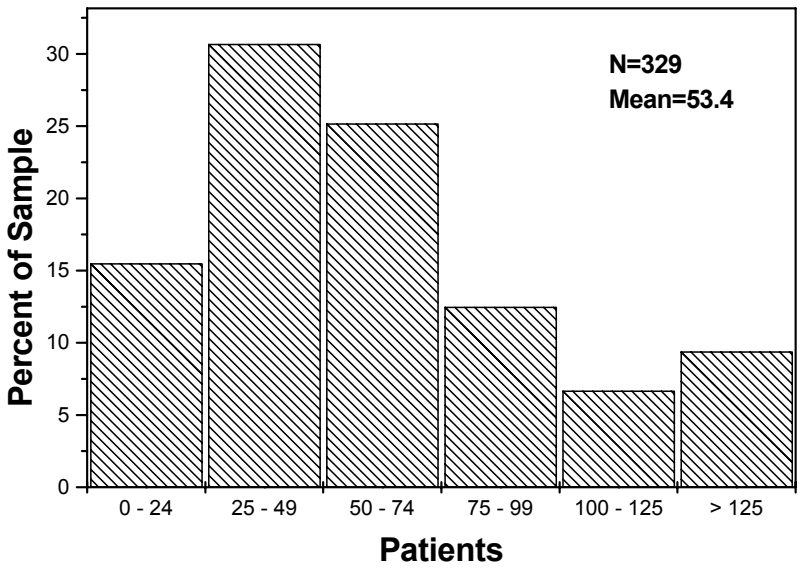


Table 8. Number of Intraoral Patients Examined Weekly with Surveyed X-ray Tube

Patients	Frequency	Cumulative Frequency	Percent	Cumulative Percent
0-12	37	37	11.3	11.3
13-24	100	137	30.4	41.6
25-37	101	238	30.7	72.3
37-49	44	282	13.4	85.7
> 49	47	329	14.3	100

Patients	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	329	26.5	24.8	0	12	20	33	200

Figure 3.
Number of Intraoral Patients Examined Weekly with Surveyed X-ray Tube

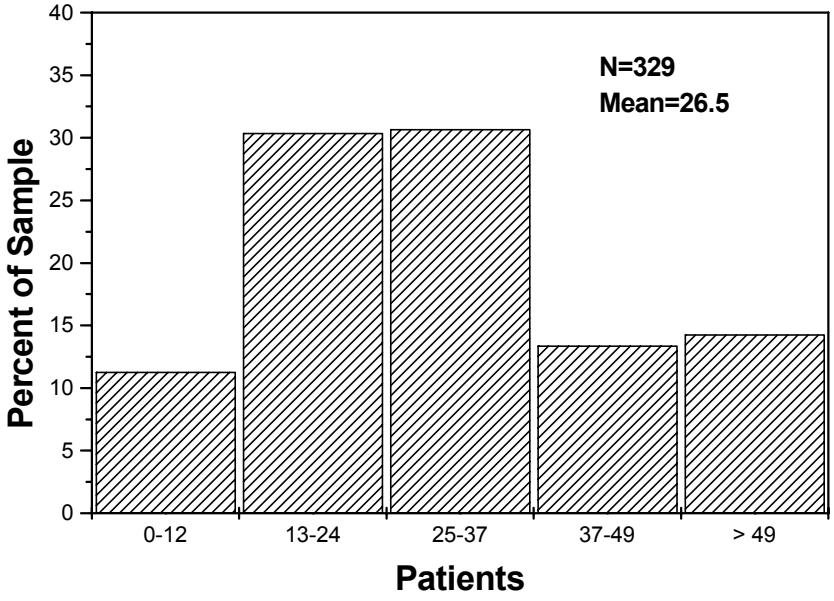


Table 9. Number of Intraoral Films Taken per Patient

Intraoral Films/Patient	Frequency	Cumulative Frequency	Percent	Cumulative Percent
1	27	27	8.2	8.2
2	107	134	32.4	40.6
3	20	154	6.1	46.7
4	117	271	35.5	82.1
5	16	287	4.9	87.0
6	25	312	7.6	94.6
> 7	18	330	5.4	100

Films per Patient	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	330	3.5	2.0	1	2	4	4	20

Figure 4.
Number of Intraoral Films Taken per Patient

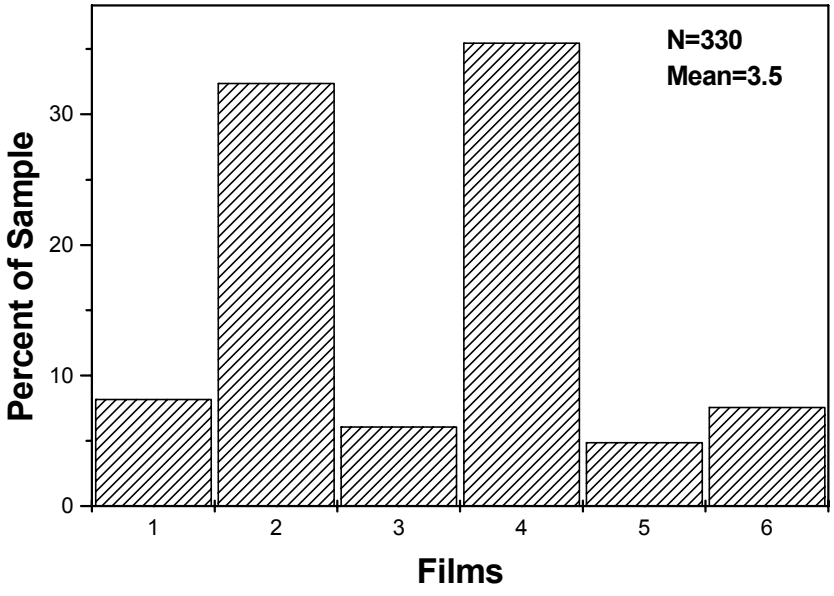


Table 10. Intraoral Entrance Skin Exposure (mR)

ESE (mR)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 50	54	54	16.5	16.5
50 – 124	95	149	29.1	45.6
125 – 199	82	231	25.1	70.7
200 – 274	60	291	18.4	89.1
> 275	36	327	11.0	100

mR	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	327	184.9	101.7	8.4	112.3	172.1	248.8	633.8

Figure 5.
Intraoral Entrance Skin Exposure

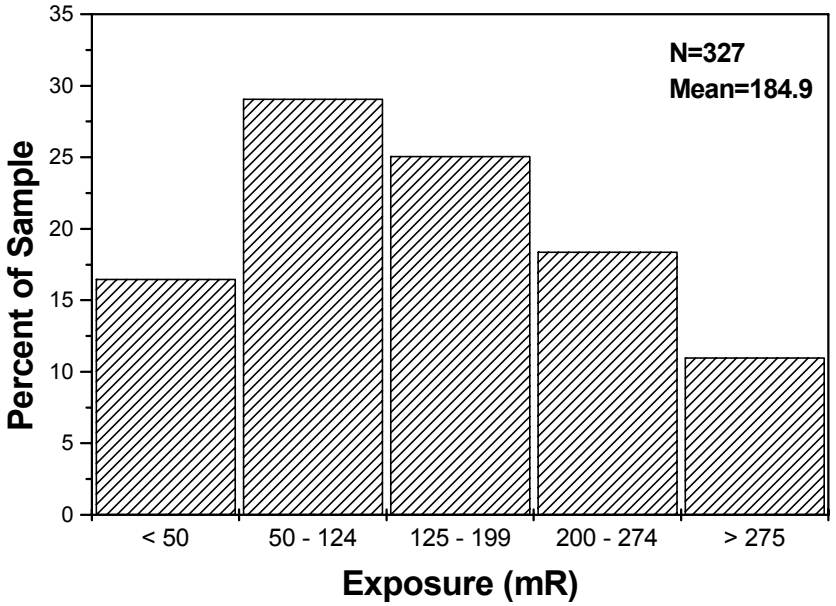


Table 11. Intraoral Entrance Skin Air Kerma (K_a) Free-in-Air

K_a (mGy)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 0.75	13	13	4.0	4.0
0.75 – 1.24	71	124	21.7	37.9
1.25 – 1.74	74	198	22.6	60.5
1.75 – 2.24	54	252	16.5	77.0
2.25 – 2.75	41	293	12.5	89.5
> 2.75	34	327	10.5	100

K_a (mGy)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	327	1.6	0.9	0.1	0.9	1.5	2.2	5.6

Figure 6.

Intraoral Entrance Skin Air Kerma

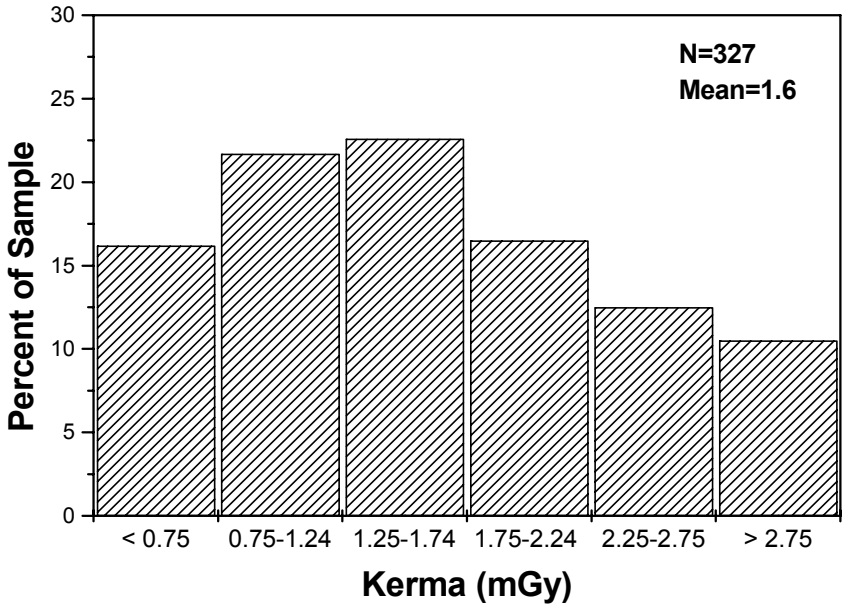


Table 12. Intraoral Entrance Skin Exposure (mR) Using D-Speed Film

ESE (mR)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 50	34	34	14.6	14.6
50 – 124	60	94	25.8	40.4
125 – 199	61	155	26.2	66.6
200 – 275	48	203	20.6	87.2
> 275	30	233	12.8	100

ESE (mR)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	233	194.6	103.5	8.4	119.3	185.6	261.7	633.8

Figure 7.
Intraoral Entrance Skin Exposure D-Speed Film

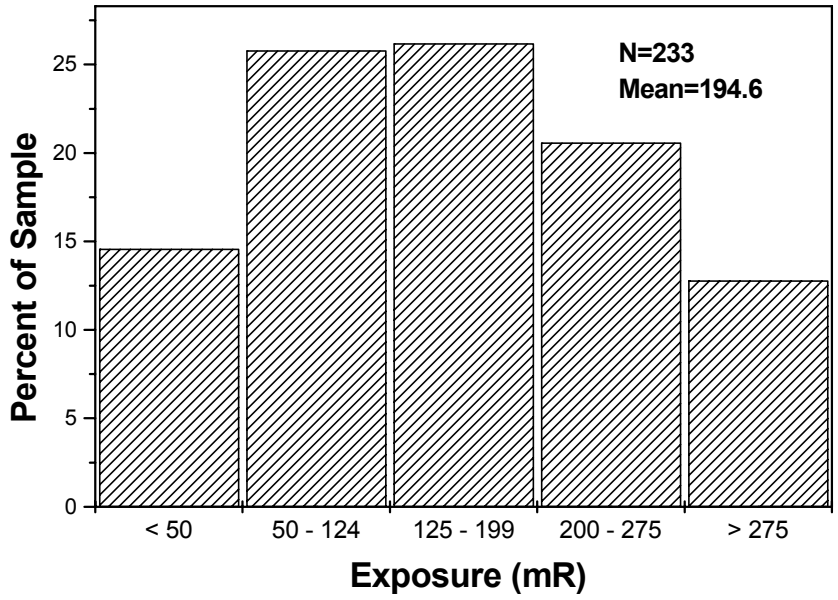


Table 13. Intraoral Entrance Skin Air Kerma (K_a) Free-in-Air Using D-Speed Film

K_a (mGy)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 0.40	15	15	6.4	6.4
0.40 – 1.19	57	72	24.5	30.9
1.20 – 1.99	77	149	33.1	64.0
2.00 – 2.79	59	208	25.3	89.3
2.80 – 3.60	20	228	8.6	97.9
> 3.60	5	233	2.1	100

K_a (mGy)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	233	1.7	0.9	0.1	1.0	1.6	2.3	5.5

Figure 8.
Intraoral Entrance Skin Air Kerma D-Speed Film

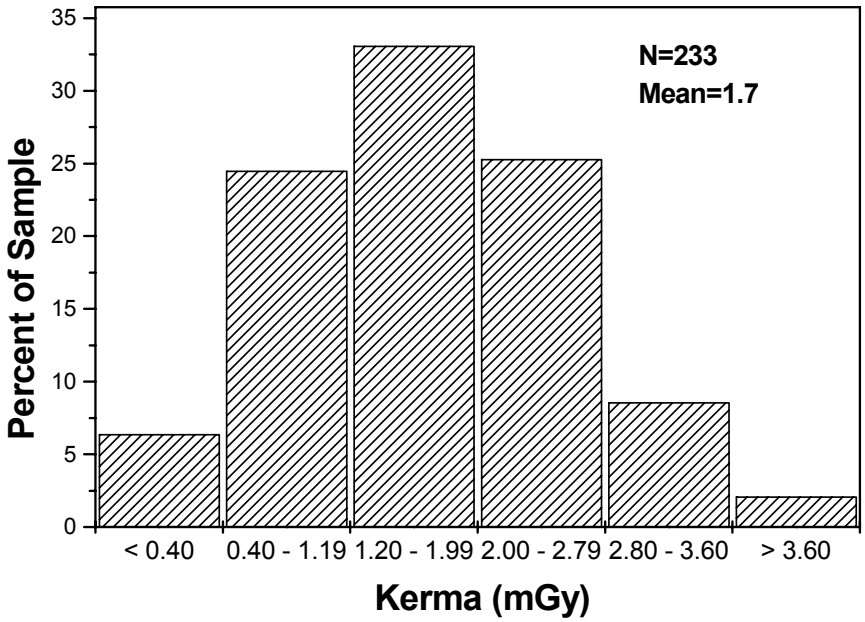


Table 14. Intraoral Entrance Skin Exposure (mR) Using E-Speed Film

ESE (mR)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 50	7	7	13.2	13.2
50 – 99	18	25	34.0	47.2
100 – 149	12	37	22.6	69.8
150 – 200	8	45	15.1	84.9
> 200	8	53	15.1	100

ESE (mR)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	53	148.4	73.0	8.5	109.3	132.2	183.4	331.8

Figure 9.
Intraoral Entrance Skin
Exposure using E-Speed Film

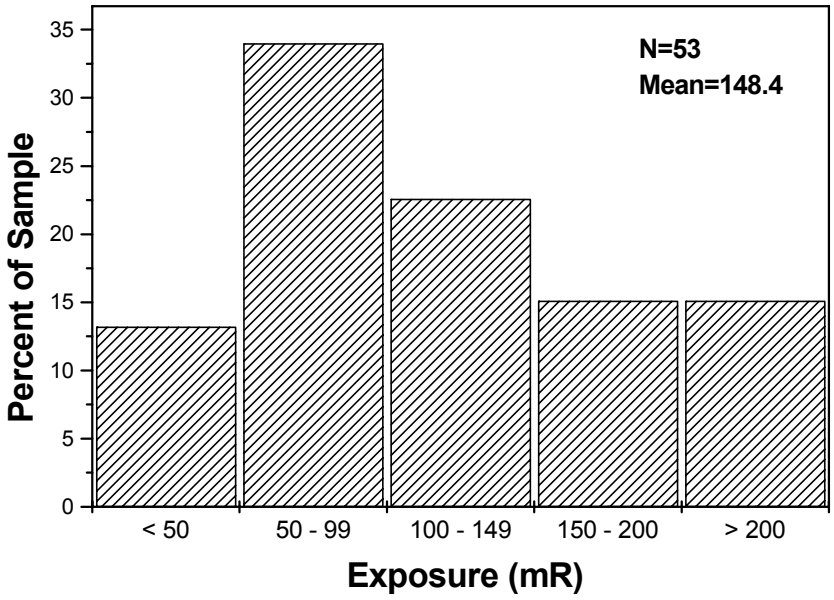


Table 15. Intraoral Entrance Skin Air Kerma (K_a) Free-in-Air Using E-Speed Film

K_a (mGy)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 0.75	2	2	3.8	3.8
0.75 – 1.24	8	10	15.1	18.9
1.25 – 1.74	18	28	34.0	52.9
1.75 – 2.24	16	44	30.3	83.2
2.25 – 2.75	3	47	5.6	88.8
> 2.75	6	53	10.2	100

K_a (mGy)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	53	1.3	0.6	0.1	1.0	1.2	1.6	2.9

Figure 10. Intraoral Entrance Skin Air Kerma using E-Speed Film

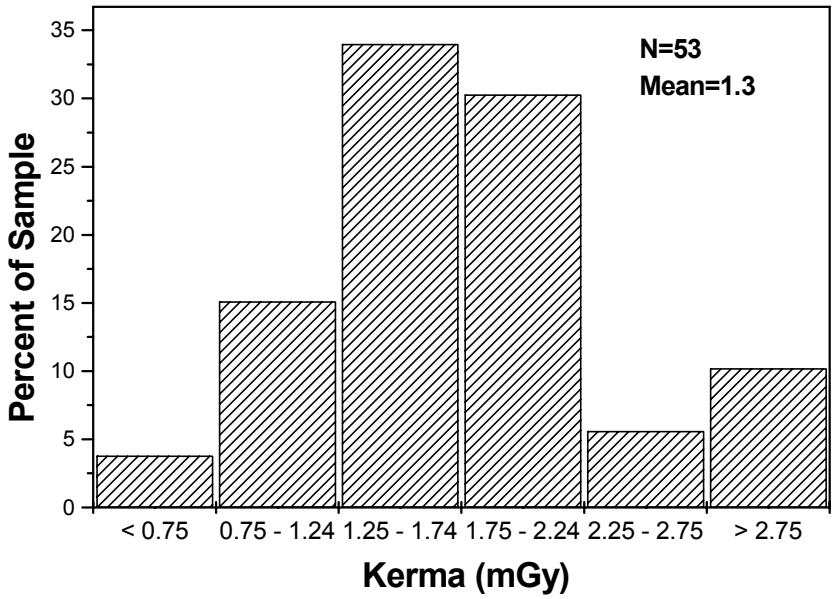


Table 16. Intraoral Entrance Skin Exposure (mR) Using Unknown Speed Class of Film

ESE (mR)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 25	5	5	12.2	12.2
25 – 99	11	16	26.8	39.0
100 – 174	11	27	26.8	65.8
175 – 250	9	36	22.0	87.8
> 250	5	41	12.2	100

ESE (mR)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	41	177.2	113.9	24.6	88.4	165.0	233.0	509.6

Figure 11. Intraoral Entrance Skin Exposure using Unknown Speed Class of Film

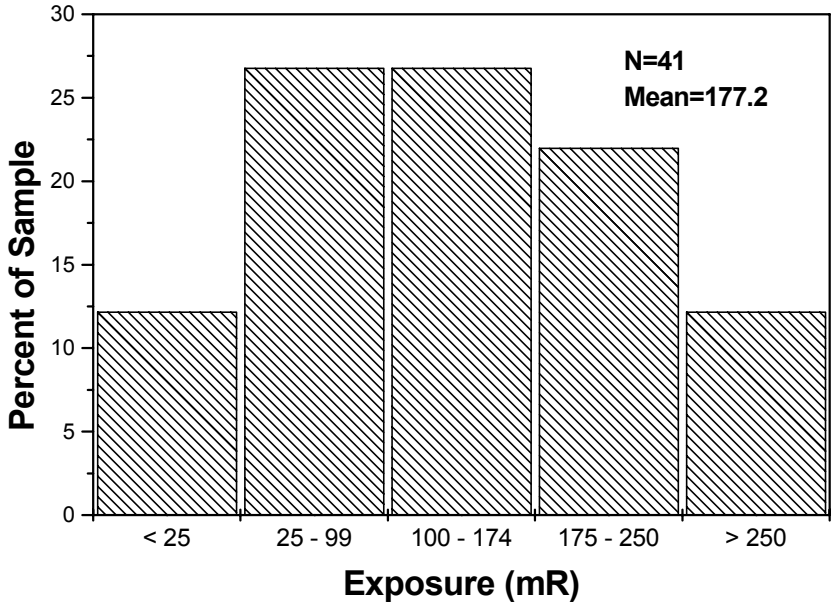


Table 17. Intraoral Entrance Skin Air Kerma (K_a) Free-in-Air Using Unknown Speed Class of Film

K_a (mGy)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 0.30	2	2	4.9	4.9
0.30 – 0.89	11	13	26.8	31.7
0.90 – 1.49	9	22	22.0	53.7
1.50 – 2.09	9	31	22.0	75.7
2.10 – 2.70	6	37	14.6	90.3
> 2.70	4	41	9.7	100

K_a (mGy)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	41	1.6	1.0	0.2	0.8	1.4	2.0	4.5

Figure 12.
Intraoral Entrance Skin Air Kerma using Unknown Speed Class of Film

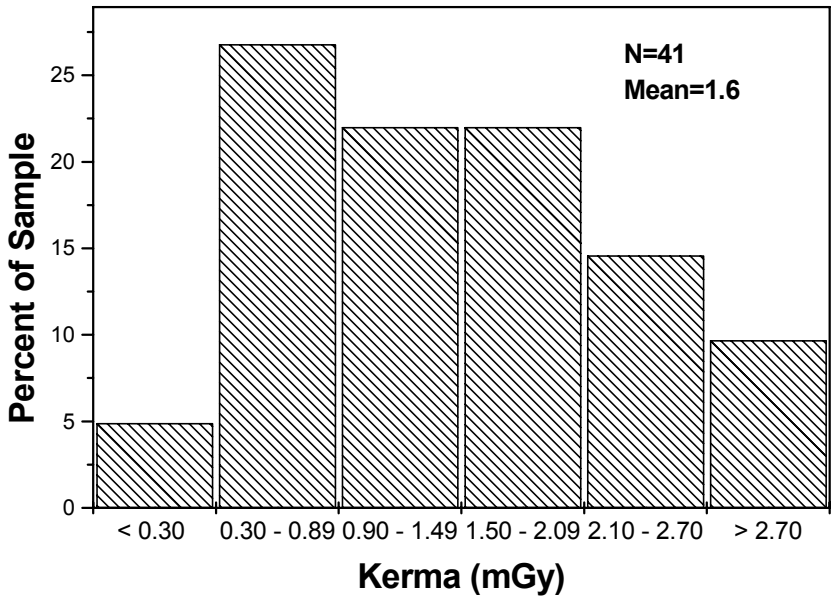
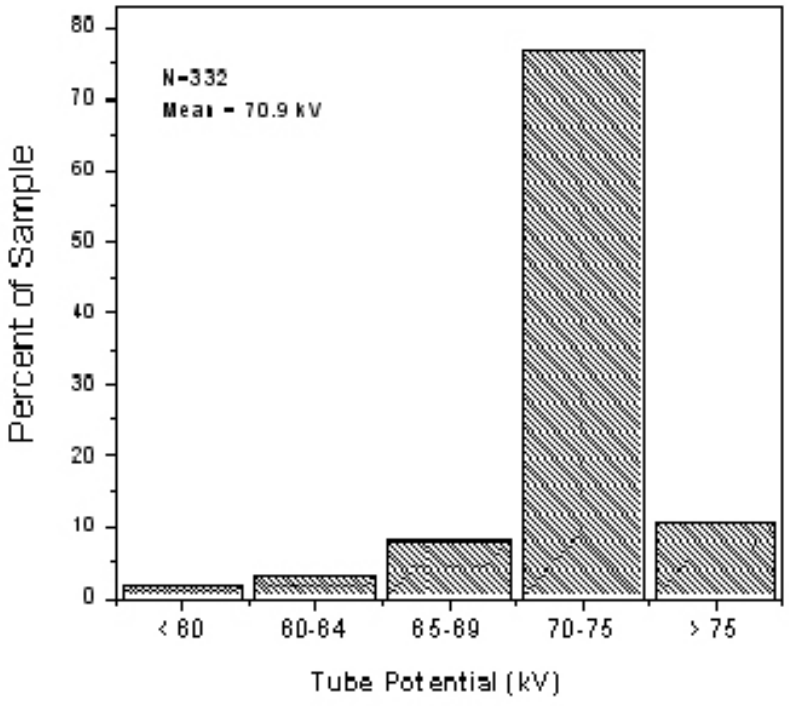


Table 18. Intraoral Tube Potential Selected

Tube Potential (kV)	Frequency	Cum Freq	Percentage	Cum Percent
< 60	5	5	1.5	1.5
60-64	10	15	3.0	4.5
65-69	27	42	8.1	12.6
70-75	255	297	76.8	89.4
> 75	35	332	10.6	100.0

Tube Potential (kV)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	332	70.9	6.3	50	70	70	70	95

Figure 13.
Intraoral Tube Potential Selected



[This page was modified 8/24/07.]

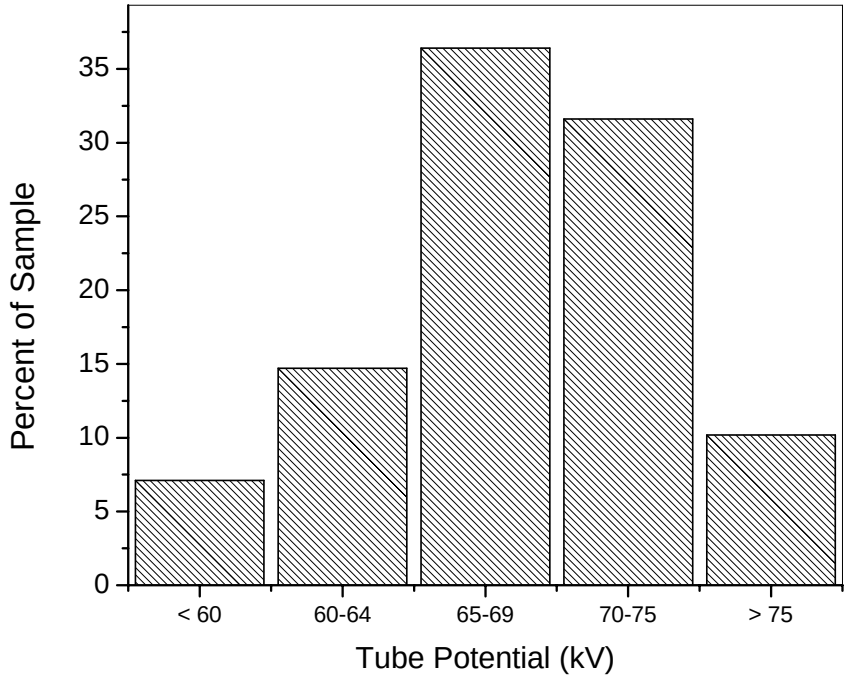
Table 19. Intraoral Tube Potential Measured *

Tube Potential (kV)	Frequency	Cum Freq	Percentage	Cum Percent
< 60	21	21	7.1	7.1
60-64	43	64	14.7	21.8
65-69	107	171	36.4	58.2
70-75	93	264	31.6	89.8
> 75	30	294	10.2	100.0

Tube Potential (kV)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	294	68.7	7.3	47	65	69	71	98

*** Measured with a kVp meter**

Figure 14.
Intraoral Tube Potential Measured



[This page was modified 8/24/07.]

Table 20. Absolute Value of Difference in Intraoral Tube Potential: Measured vs. Selected

kV Difference	Frequency	Cumulative Frequency	Percent	Cumulative Percent
0	58	58	20.0	20.0
0 – 2	115	173	36.7	59.7
3 – 5	49	222	16.9	76.6
6 – 8	25	247	8.6	85.2
> 8	43	290	14.8	100

kV Difference	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	290	3.8	4.0	0.1	1.2	2.4	4.9	22.8

Figure 15.

Absolute Value of Difference in Tube Potential: Measured vs. Selected

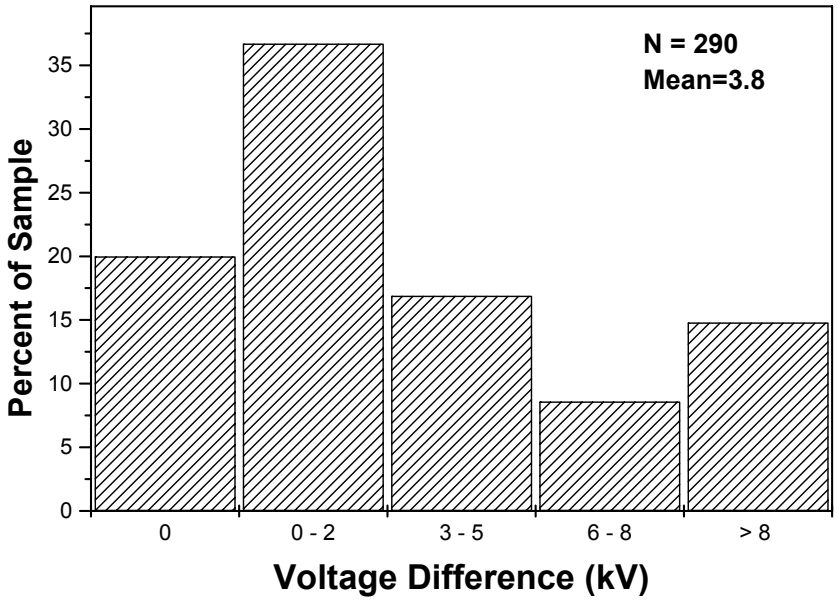


Table 21. Intraoral Tube Potential Using Copper Filtration Method*

Tube Potential (kV)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 60	20	20	18.7	18.7
60-64	8	28	7.5	26.2
65-69	16	44	15.0	41.2
70-75	35	79	32.7	73.9
75-80	15	94	14.0	87.9
> 80	13	107	12.1	100

Tube Potential (kV)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	107	72.2	9.2	50	67	74	78	91

***Using Copper Filtration Transmission Method (see protocol) to measure kVp of Intraoral X-ray unit .**

Figure 16. Intraoral Tube Potential: Copper Filtration Method

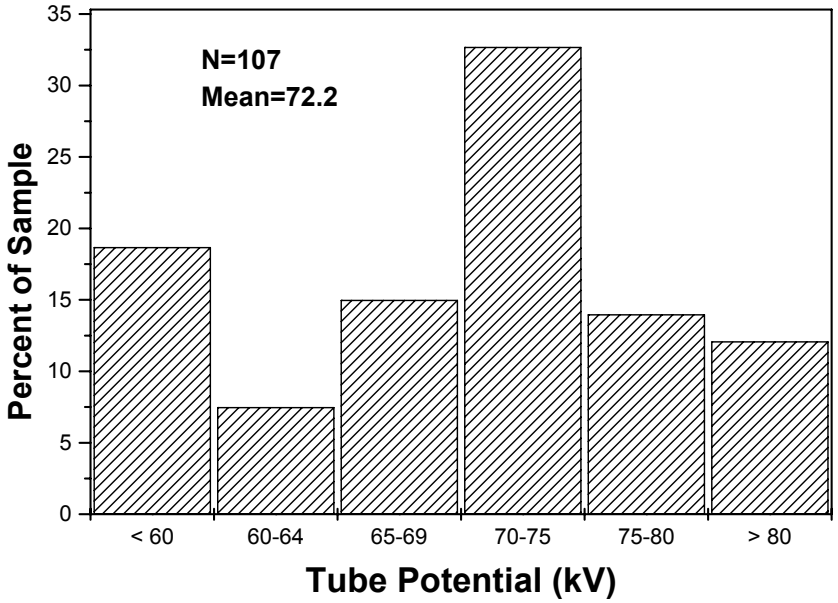


Table 22. Absolute Value of Difference in Intraoral Tube Potential: Selected vs. Measured (Using Copper Filtration Method)

kV Difference	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 1	19	19	18.1	18.1
1.0 – 3.9	31	50	29.5	47.6
4.0 – 6.9	24	74	22.9	70.5
7.0 – 10	13	87	12.4	82.9
> 10	18	105	17.1	100

KV Difference	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	105	6.6	4.5	0.1	3	5.7	9	20

Figure 17.
Absolute Value of Difference in Tube Potential: Selected vs. Measured (using Copper Method)

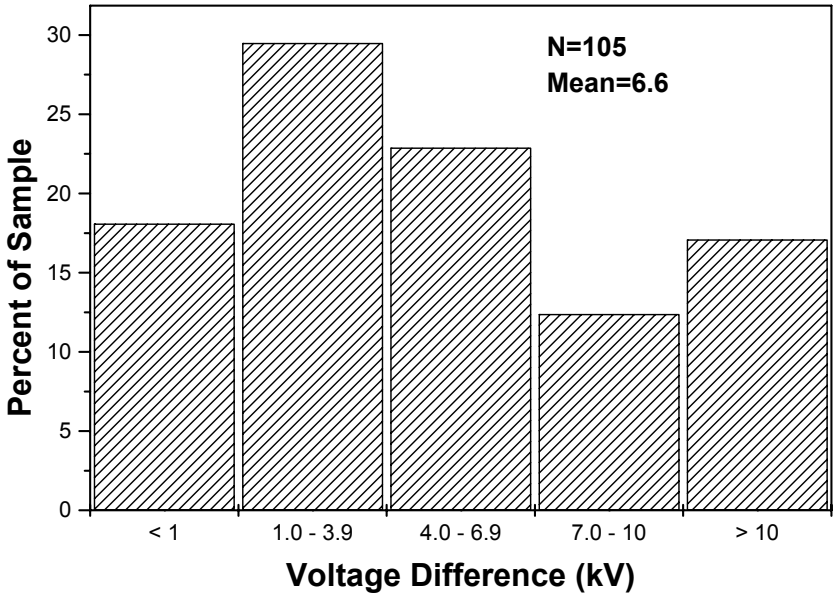


Table 23. Intraoral Half-Value Layer (mm Al) at Clinical Tube Potential

HVL (mm Aluminum)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 1.8	68	68	20.7	20.7
1.8 – 2.1	101	169	30.8	51.5
2.2 – 2.4	100	269	30.5	82.0
2.5 – 2.7	27	296	8.2	90.2
> 2.7	32	328	9.8	100

mm Al	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	328	2.3	0.5	1.3	2.0	2.2	2.5	4.6

Figure 18.
Intraoral Half-Value Layer (mm Al) at Clinical Tube Potential

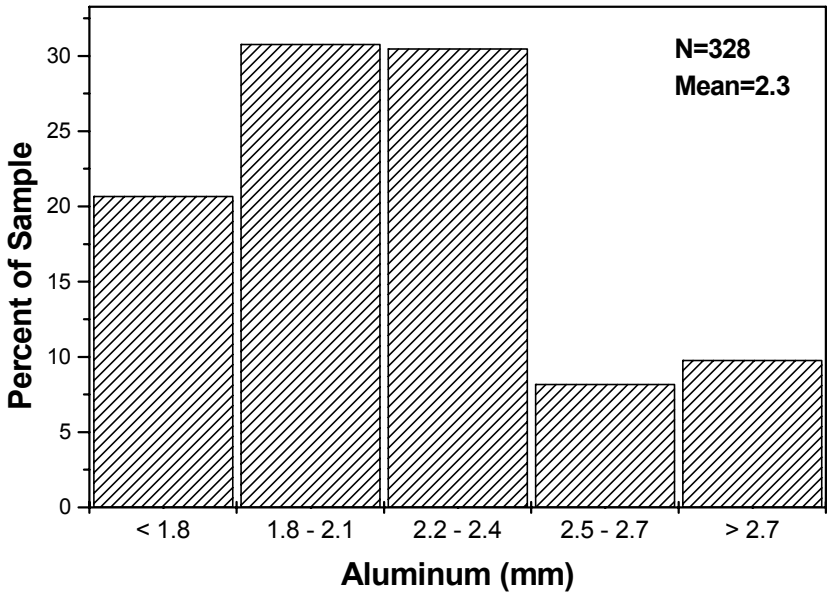


Table 24. Intraoral Exposure Time Selected

Time (ms)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 100	40	40	12.2	12.2
100–199	45	85	13.8	26.0
200–299	101	186	30.9	56.9
300–399	50	236	15.3	72.2
400–499	42	278	12.8	85.0
500–600	23	301	7.1	92.1
>600	26	327	7.9	100

Time (ms)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	327	364.6	213.5	2.4	233	330	470	1500

Figure 19.
Intraoral Exposure Time Selected

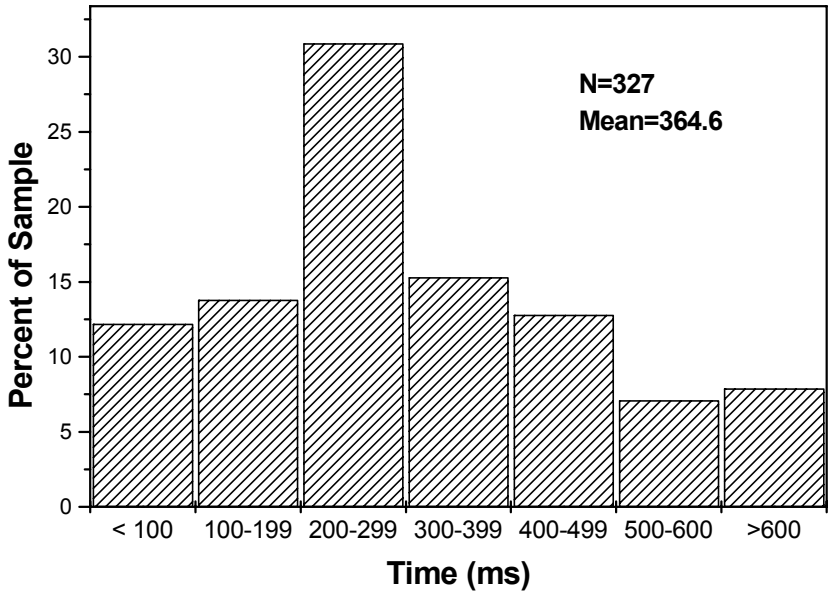


Table 25. Intraoral Exposure Time Measured

Time (ms)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 100	29	29	8.8	8.8
100–199	60	89	18.2	26.0
200–299	81	170	24.5	50.5
300–399	58	228	17.6	69.1
400–499	40	268	12.1	81.2
500–600	37	305	11.2	92.4
>600	25	330	7.6	100

Time (ms)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	330	384.8	226.4	37.6	237.6	336.5	487.6	1863.3

Figure 20.
Intraoral Exposure Time Measured

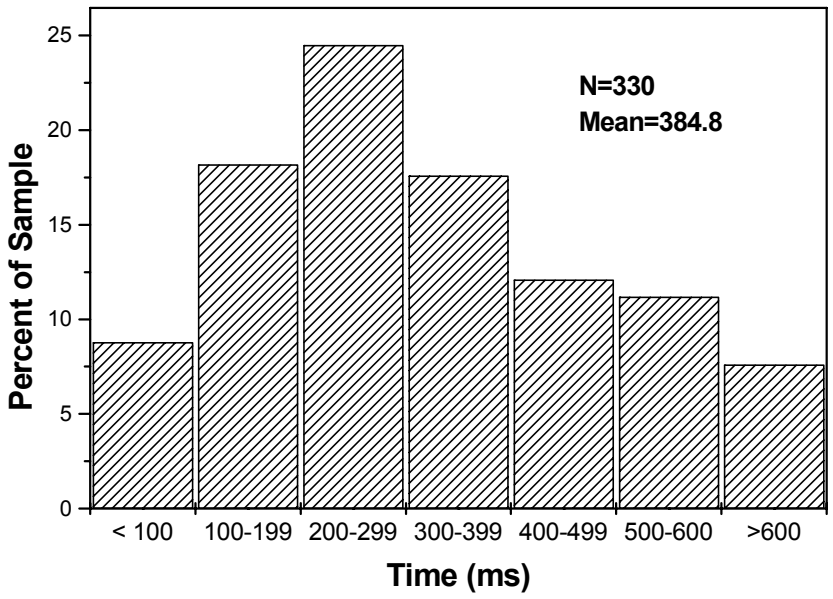


Table 26. Absolute Value of Difference of Intraoral Exposure Time: Selected Time vs. Measured Time

Time Difference (ms)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 50	54	54	17.4	17.4
50 – 149	79	133	25.1	42.5
150 – 249	68	201	21.6	64.1
250 – 349	50	251	15.8	79.9
350 – 449	28	279	8.7	88.6
450 – 550	22	301	7.0	95.6
> 550	14	315	4.4	100

Time Difference (ms)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	315	230.8	215.4	1	78	188	320	1663

Figure 21. Absolute Value of Difference of Intraoral: Exposure Time: Selected time vs. Measured Time

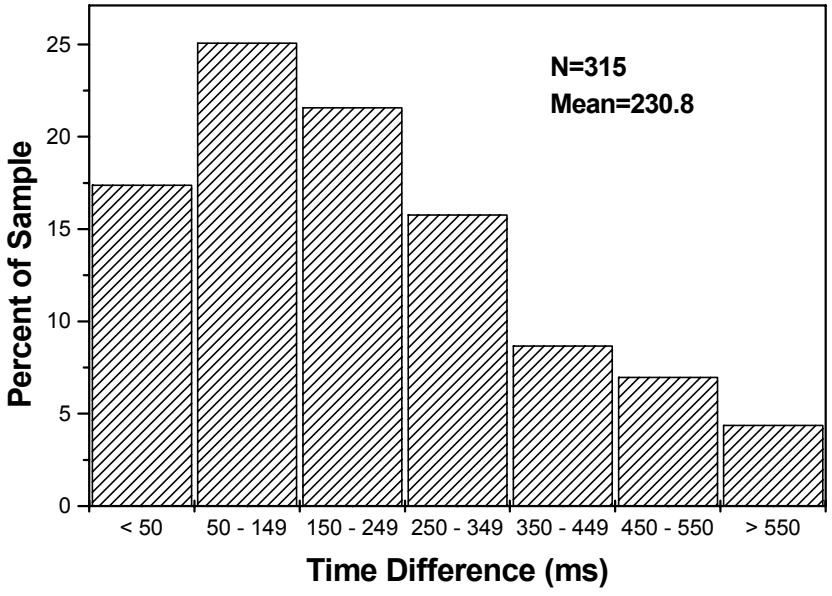


Table 27. Intraoral Tube Current Selected

Tube Current (mA)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
6.5	4	4	1.2	1.2
7.0	125	129	37.9	39.2
7.5	10	139	3.0	42.2
8.0	31	170	9.4	51.6
8.5	0	170	0.0	51.6
9.0	1	171	0.3	51.9
9.5	0	171	0.0	51.9
10.0	81	252	24.6	76.5
10.5	0	252	0.0	76.5
11.0	78	330	23.5	100

mA	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	330	9.7	3.2	5.0	7.0	8.0	10.0	15.0

Figure 22.
Intraoral Tube Current Selected

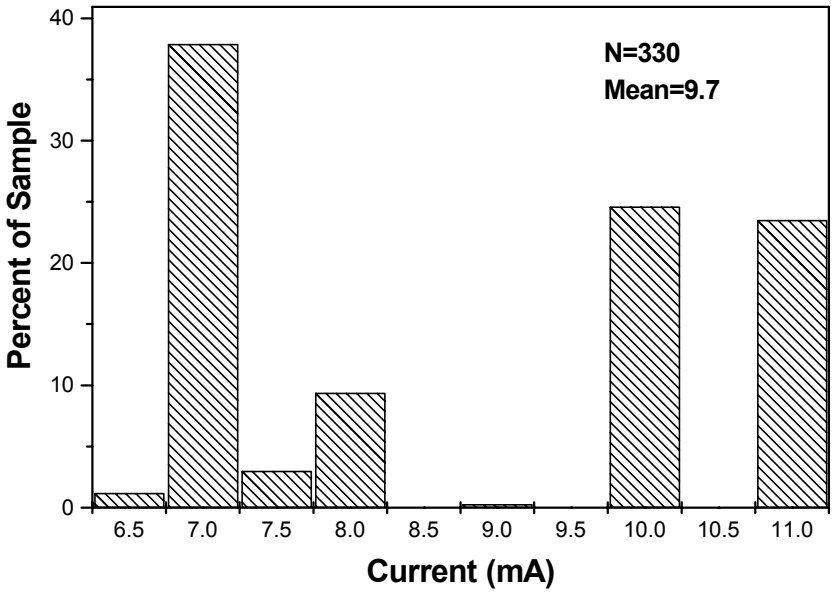


Table 28. Intraoral mAs Values Selected

mAs	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 1.0	26	26	8.0	8.0
1.0 – 1.9	94	120	28.9	36.9
2.0 – 2.9	75	195	23.1	60.0
3.0 – 3.9	50	245	15.4	75.4
4.0 – 4.9	30	275	9.2	84.6
5.0 – 6.0	13	288	4.0	88.6
> 6.0	37	325	11.4	100

mAs	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	325	3.6	2.4	0.3	2.2	3.0	4.4	15.0

Figure 23.
Intraoral mAs Values Selected

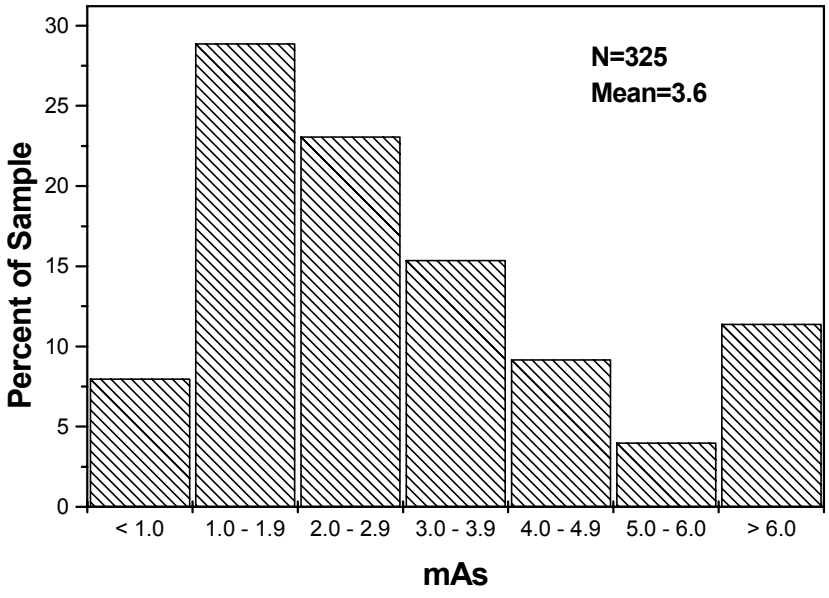


Table 29. Darkroom Fog Optical Density* for Intraoral Facilities

Optical Density	Frequency	Cumulative Frequency	Percent	Cumulative Percent
0.00	110	110	48.5	48.5
.01 – .029	46	156	20.3	68.8
.03 – .049	28	184	12.3	81.1
.05 – .069	9	193	4.0	85.1
.07 – .090	6	199	2.6	87.7
> .090	28	227	12.3	100

Optical Density	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	227	0.07	0.24	0.0	0.0	0.01	0.03	1.78

***Measured Using facility intraoral film**

Figure 24.
Darkroom Fog Optical Density for Intraoral Facilities

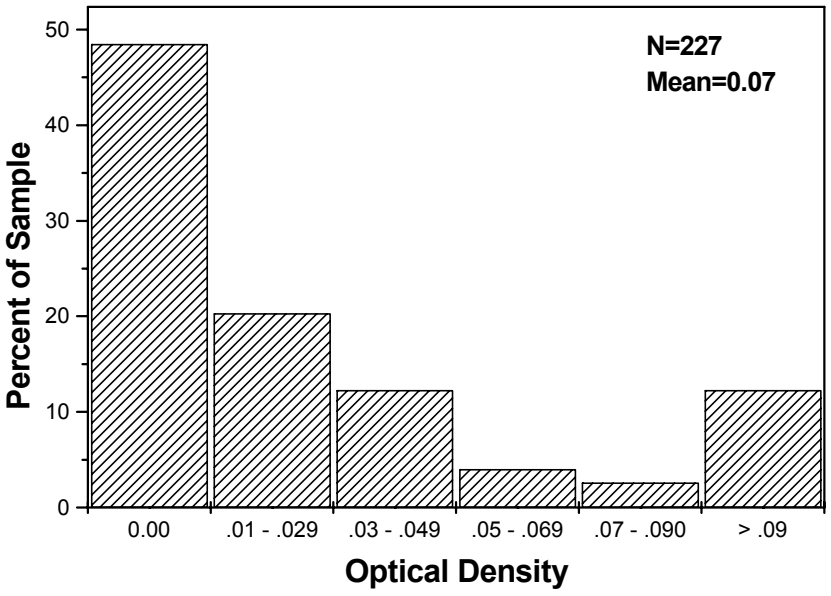


Table 30. Fog Optical Density* Using Daylight Processing System for Intraoral Facilities

Optical Density	Frequency	Cumulative Frequency	Percent	Cumulative Percent
0.00	19	19	25.0	25.0
.01 – .10	30	49	39.5	64.5
.11 – .20	8	57	10.6	75.1
.21 – .30	4	61	5.3	80.4
.31 – 40	4	65	5.3	85.7
.41 –.51	2	67	2.6	88.3
> 0.51	9	76	11.7	100

Optical Density	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	76	0.16	0.29	0.0	0.0	0.03	0.18	1.52

***Measured Using facility intraoral film**

Figure 25.

Fog Optical Density using Daylight Processing System

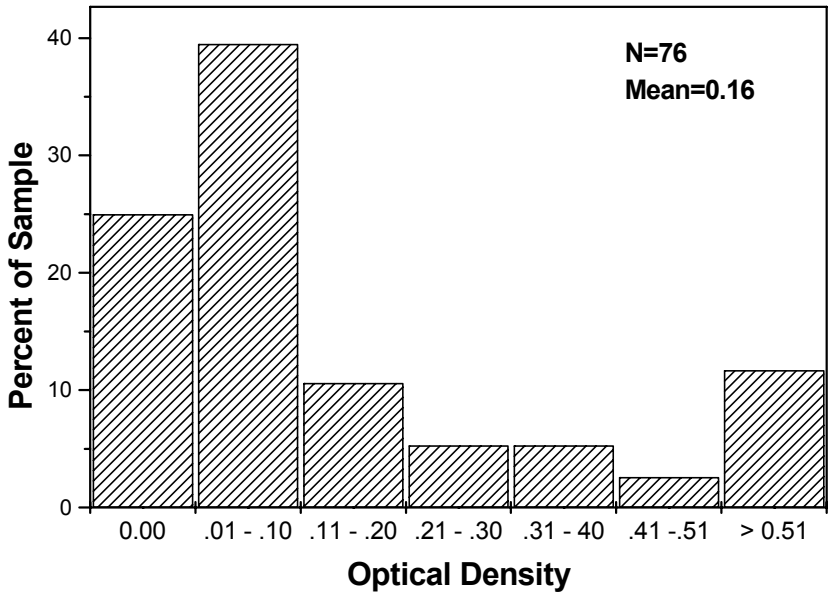


Table 31. Intraoral Phantom Film Optical Density*

Optical Density	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 0.50	9	9	2.8	2.8
0.50 – 1.49	103	112	31.8	34.6
1.50 – 1.99	132	244	40.7	75.3
2.00 – 2.50	56	300	17.3	92.6
> 2.50	24	324	7.4	100

Optical Density	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	324	1.49	0.49	0.01	1.17	1.43	1.74	3.55

***Measured Using facility intraoral film**

Figure 26.
Intraoral Phantom Film Optical Density

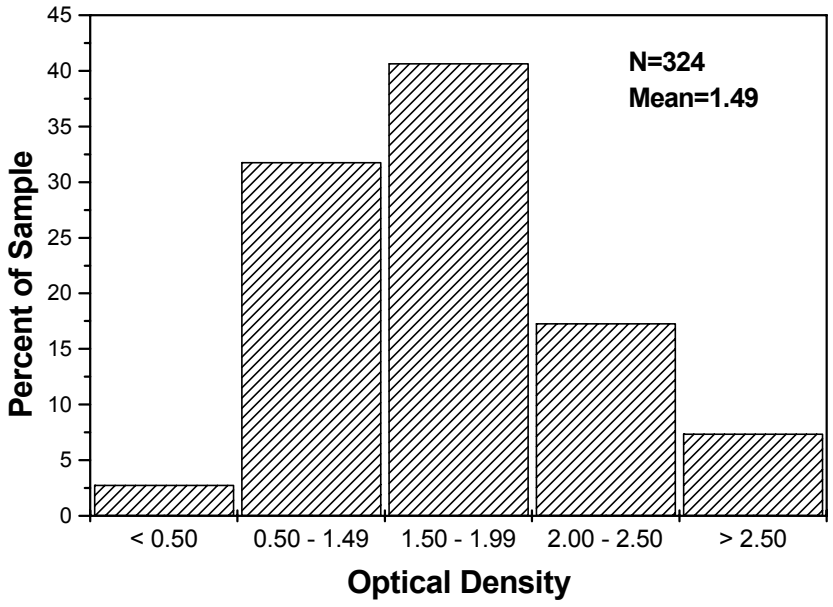


Table 32. Optical Density Difference between 3.0 cm Hole Image and Intraoral Phantom* Film Background

Optical Density	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 0.30	16	16	4.9	4.9
0.30 – 0.49	36	52	11.1	16.0
0.50 – 0.69	69	121	21.3	37.3
0.70 – 0.89	79	200	24.4	61.7
0.90 – 1.09	71	271	21.9	83.6
1.10 – 1.30	30	301	9.3	92.9
> 1.30	23	324	7.1	100

Optical Density	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	324	0.8	0.3	0.1	0.6	0.8	1.0	2.2

*** See Appendix A for Phantom Diagram and Specifications**

Figure 27.

Optical Density Difference between 3.0 cm Hole Image and Intraoral Phantom Film Background

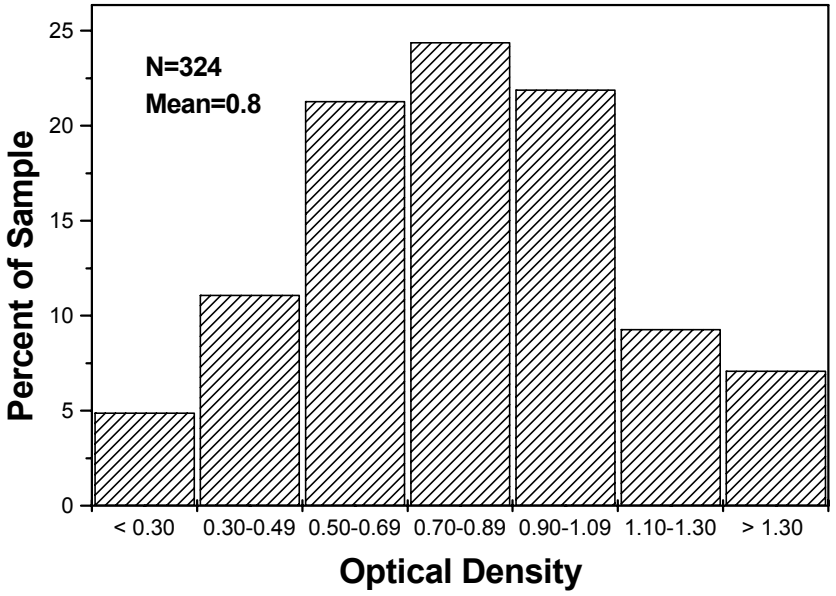


Table 33. Optical Density Difference between 2.0 cm Hole Image and Intraoral Phantom* Film Background

Optical Density	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 0.20	21	21	6.5	6.5
0.20 – 0.39	92	113	28.4	34.9
0.40 – 0.59	126	239	38.9	73.8
0.60 – 0.79	58	297	17.9	91.7
0.80 – 1.00	15	312	4.6	96.3
> 1.00	12	324	3.7	100

Optical Density	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	324	0.5	0.3	0.1	0.1	0.5	0.6	3.0

*** See Appendix A for Phantom Diagram and Specifications**

Figure 28.

Optical Density Difference between 2.0 cm Hole Image and Intraoral Phantom* Film Background

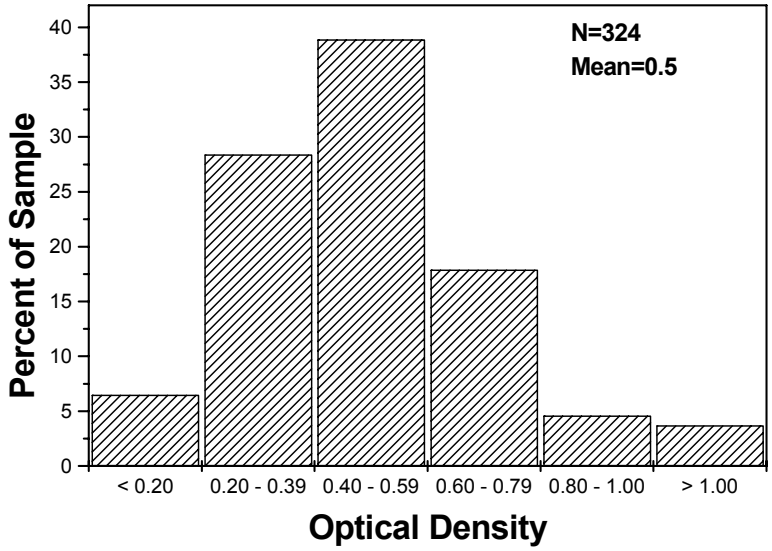


Table 34. Optical Density Difference between 1.0 cm Hole Image and Intraoral Phantom* Film Background

Optical Density	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 0.20	16	16	5.0	5.0
0.20 – 0.39	91	107	28.2	33.2
0.40 – 0.59	121	228	37.5	70.7
0.60 – 0.79	58	286	18.0	88.7
0.80 – 1.00	15	301	4.6	93.3
> 1.00	22	323	6.7	100

Optical Density	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	323	0.6	0.4	0.1	0.4	0.5	0.6	3.5

*** See Appendix A for Phantom Diagram and Specifications**

Figure 29.

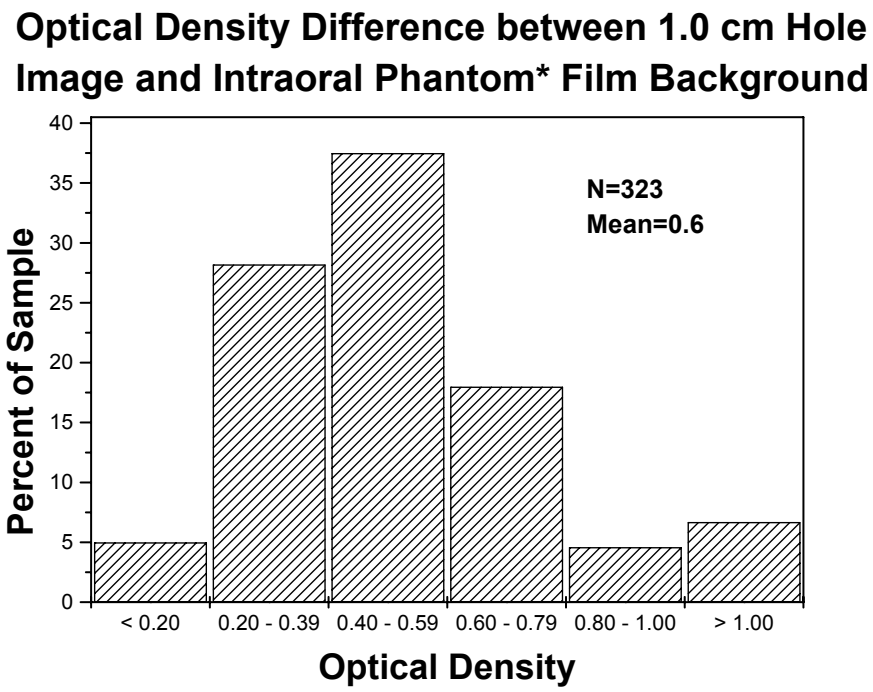


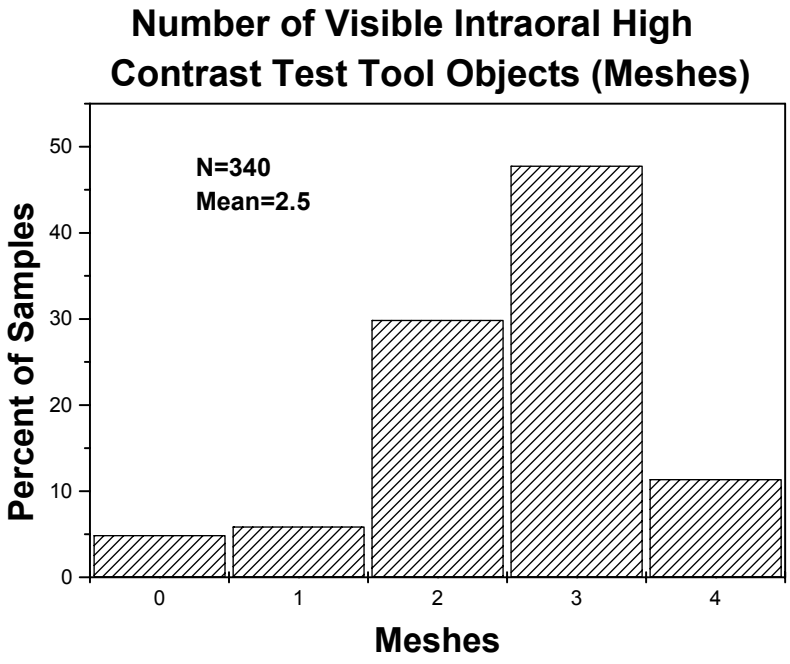
Table 35. Number of Visible Intraoral High Contrast Test Tool Objects (Meshes)*

Visible Test Tool Meshes	Frequency	Cumulative Frequency	Percent	Cumulative Percent
0	16	16	4.9	4.9
1	35	51	5.9	10.8
2	97	148	29.9	40.7
3	155	303	47.8	88.6
4	37	340	11.4	100

Visible Meshes	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	340	2.5	0.9	0	2	3	3	4

***Measured Using facility intraoral film**

Figure 30.



Lines / inch	Mesh number
100	1
120	2
150	3
200	4

See Appendix A for illustration of holes and meshes of phantom

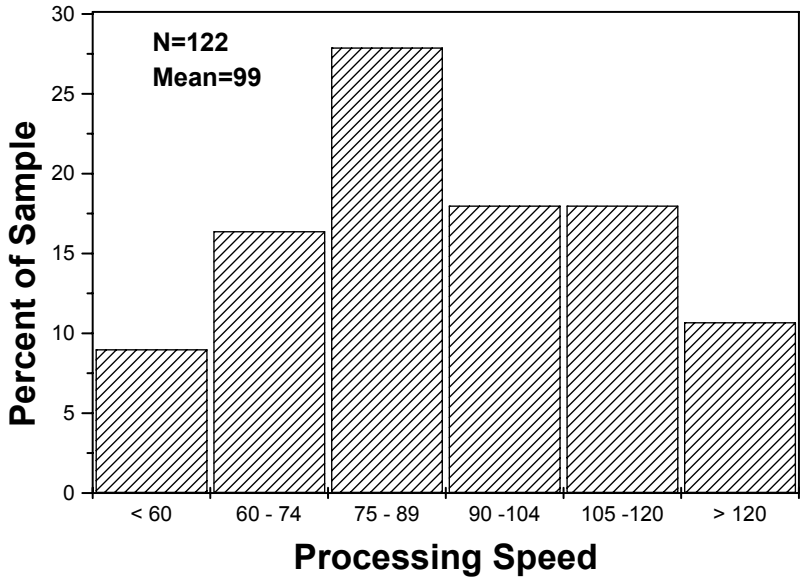
Table 36. Intraoral Automatic Film Processing Speed*

Processor Speed	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 60	11	11	9.0	9.0
60 – 74	20	31	16.4	25.4
75 – 89	34	65	27.9	53.3
90 – 104	22	87	18.0	71.3
105 – 120	22	109	18.0	89.3
> 120	13	122	10.7	100

Processor Speed	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	122	99	24	40	81	97	115	175

***Measured using FDA supplied STEP film.**
See Appendix B for method used.

Figure 31.
Intraoral Automatic Film Processing Speed



Qualification of Processing Speed
Below 80: Unacceptable
80-120: Acceptable
Above 120: Unacceptable

Table 37. Intraoral Film Processor Temperature Measured

Processor Temperature (F°)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 70	12	12	7.7	7.7
70 – 74.9	19	31	12.3	20.0
75 – 79.9	23	54	14.8	34.8
80 – 84.9	58	112	37.4	72.2
85 – 90.0	34	146	21.9	94.1
> 90	9	155	5.9	100

Temperature (F°)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	155	79	5	65	76	81	83	96

Figure 32.

Intraoral Film Processor Temperature Measured

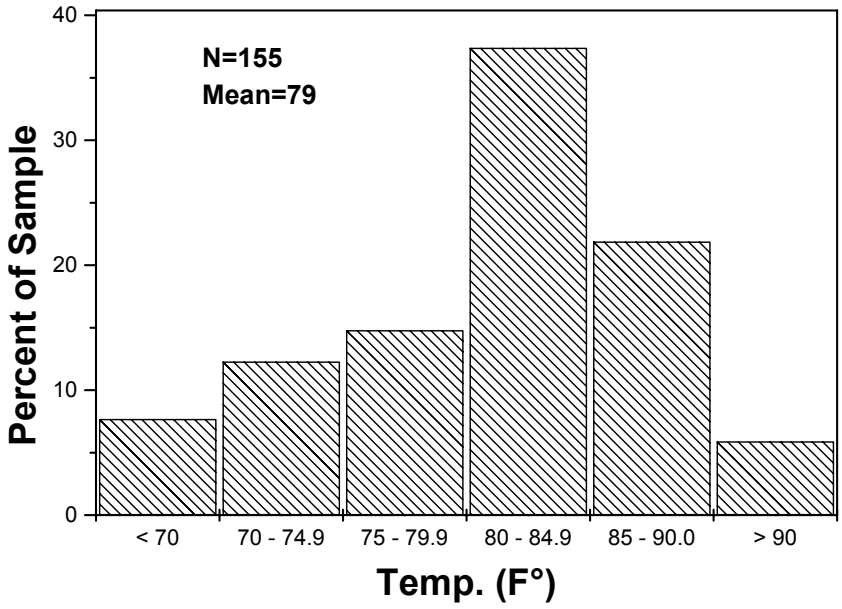


Table 38. Intraoral Film Processor Displayed Temperature

Processor Temperature (F°)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 70	19	19	10.0	10.0
70 – 74.9	6	25	3.1	13.1
75 – 79.9	28	53	14.7	27.8
80 – 84.9	93	146	48.7	76.5
85 – 90.0	36	182	18.9	95.4
> 90	9	191	4.6	100

Temperature (F°)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	191	81	9	65	76	82	82	145

Figure 33.

Intraoral Film Processor Displayed Temperature

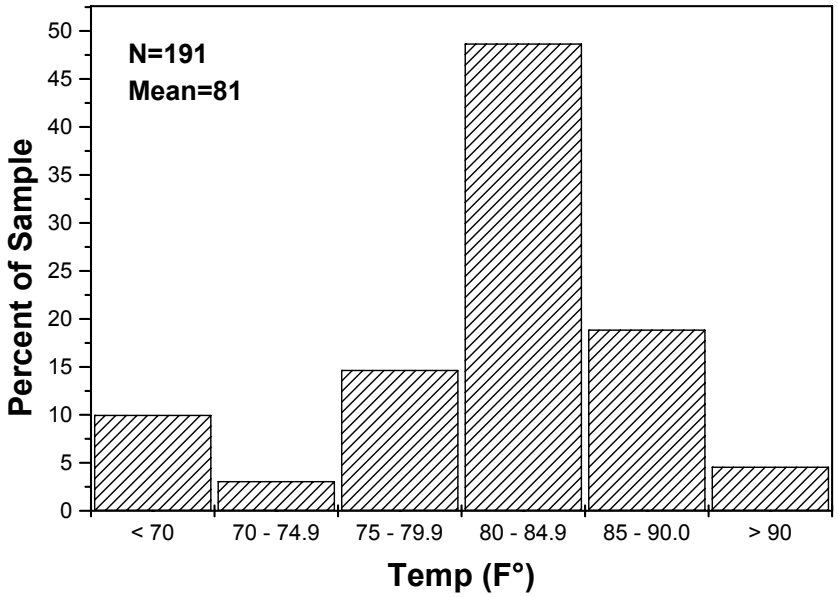


Table 39. Absolute Value of Difference of Processor Temperature: Displayed vs. Measured

Temperature (F°) Difference	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 1.0	31	31	29.3	29.3
1.0 – 2.9	52	83	49.1	78.4
3.0 – 4.9	7	90	6.6	85.0
5.0 – 7.0	7	97	6.6	91.6
> 7.0	9	106	8.4	100

Temperature (F°)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	106	2.5	3.1	0.1	0.8	1.3	2.3	15.0

Figure 34.

Absolute Value of Difference of Processor Temperature: Displayed vs. Measured

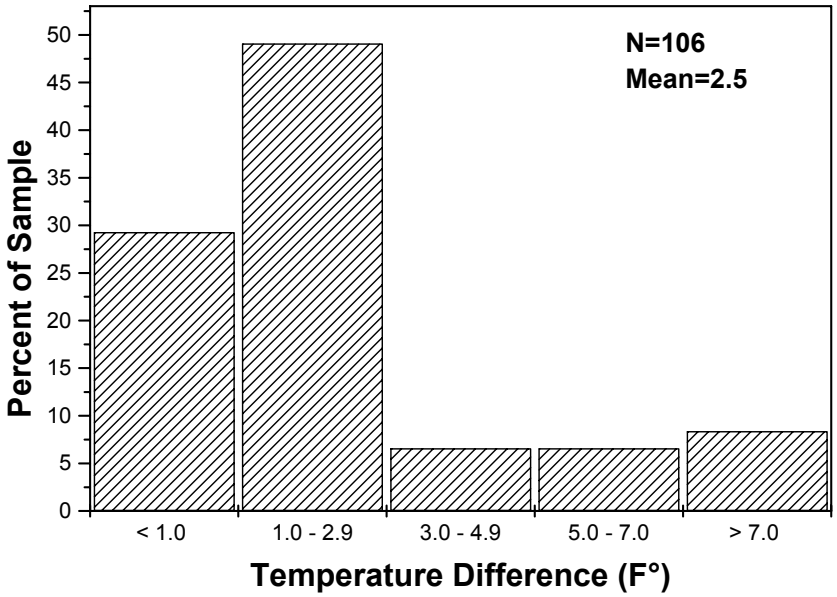


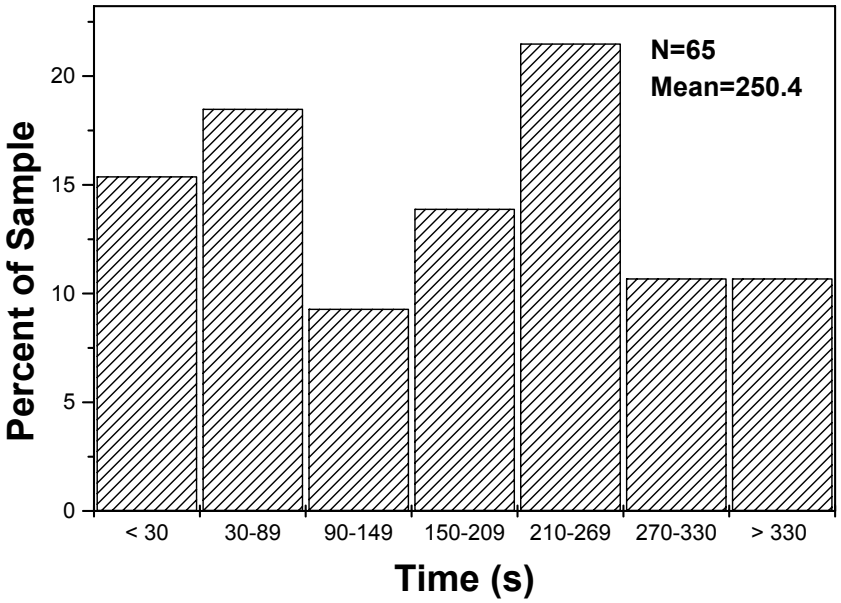
Table 40. Intraoral Manual Film Processing Developer Immersion Time

Processing Time (s)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 30	10	10	15.4	15.4
30-89	12	22	18.5	33.9
90-149	6	28	9.3	43.2
150-209	9	37	13.9	57.1
210-269	14	51	21.5	78.6
270-330	7	58	10.7	89.3
> 330	7	65	10.7	100

Processing Time (s)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	65	250	294	30	70	180	270	1380

Figure 35.

Intraoral Manual Processing Developer Immersion Time



CEPHALOMETRIC PROCEDURES

Table 41. Number of Patients Examined Per Week (at Each Facility)

Patients per Week	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 3	7	7	31.8	31.8
3 – 9	5	12	22.7	54.5
10 – 16	5	17	22.7	77.2
17 – 23	1	18	4.6	81.8
24 – 30	2	20	9.1	90.9
> 30	2	22	9.1	100

Patients per Week	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	22	14.5	26.3	1	2	7	12	125

Figure 36.

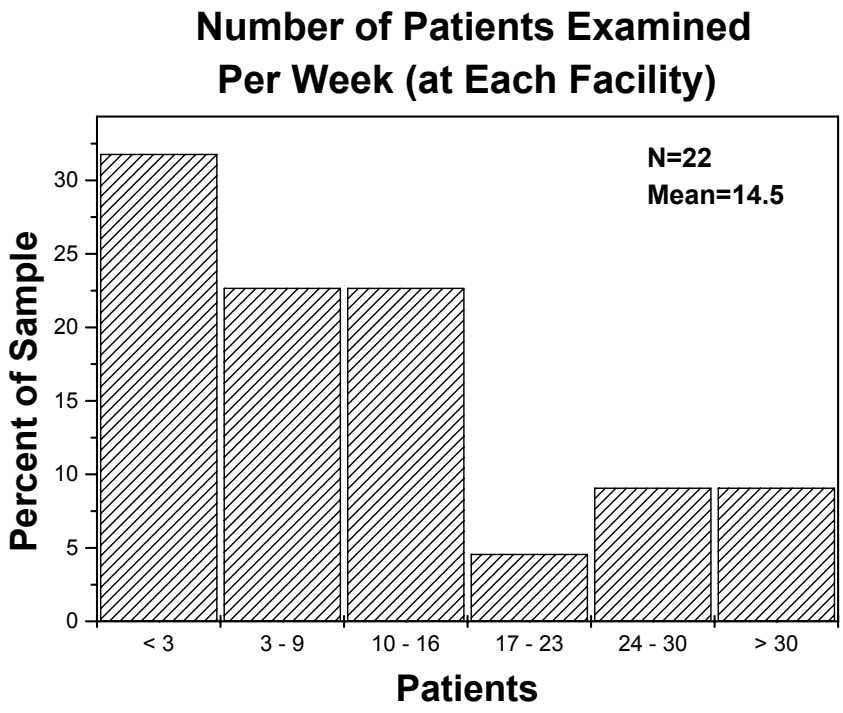


Table 42. Cephalometric Entrance Skin Exposure (mR)

ESE (mR)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 6	3	3	15.0	15.0
6 – 10	2	5	10.0	25.0
11 – 15	5	10	25.0	50.0
16 – 20	4	14	20.0	70.0
21 – 26	2	16	10.0	80.0
> 26	4	20	20.0	100

ESE (mR)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	20	17.4	13.6	1.4	7.8	15.0	23.0	48.8

Figure 37.

Cephalometric Entrance Skin Exposure

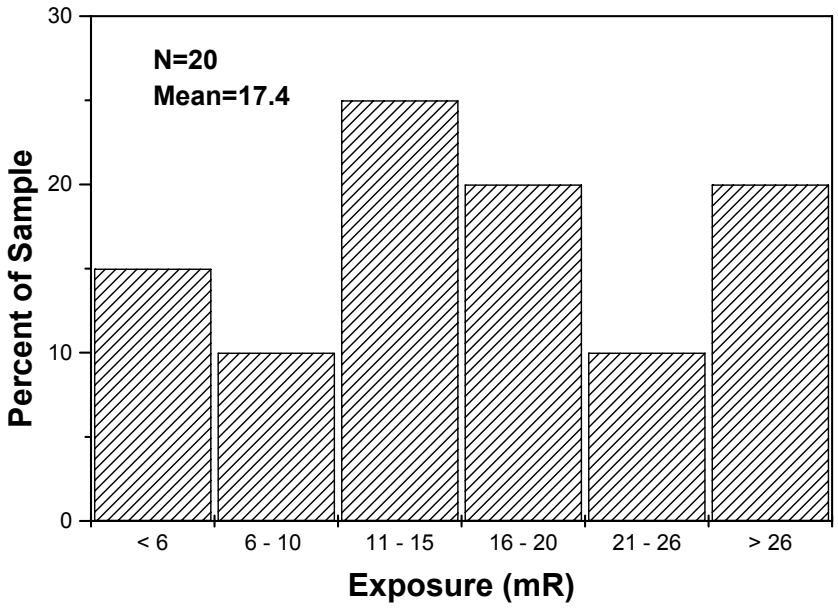


Table 43. Cephalometric Entrance Skin Air Kerma (K_a) Free-in-Air

K_a (mGy)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 0.05	2	2	10.0	10.0
0.05 – 0.09	3	5	15.0	25.0
0.10 – 0.14	5	10	25.0	50.0
0.15 – 0.19	4	14	20.0	70.0
0.20 – 0.25	2	16	10.0	80.0
> 0.25	4	20	20.0	100.0

K_a (mGy)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	20	0.15	0.11	0.01	0.07	0.13	0.20	0.43

Figure 38.
Cephalometric Entrance Skin Air Kerma

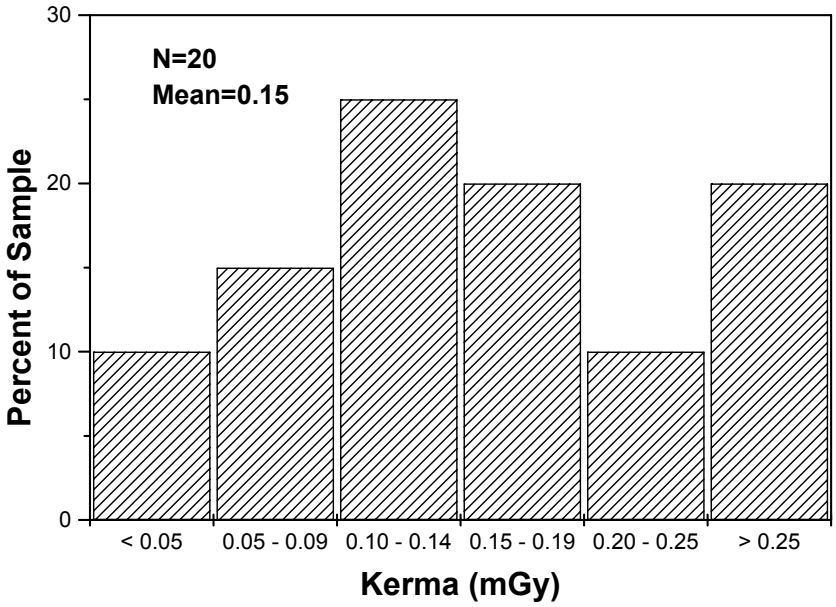


Table 44. Cephalometric Tube Potential Selected

Tube Potential (kV)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 65	1	1	4.8	4.8
65 – 70	9	10	42.9	47.6
71 – 76	4	14	19.1	66.7
77 – 82	2	16	9.5	76.2
82 – 88	3	19	14.3	90.5
>88	2	21	9.5	100

kV	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	21	75	8	62	70	75	80	90

Figure 39.

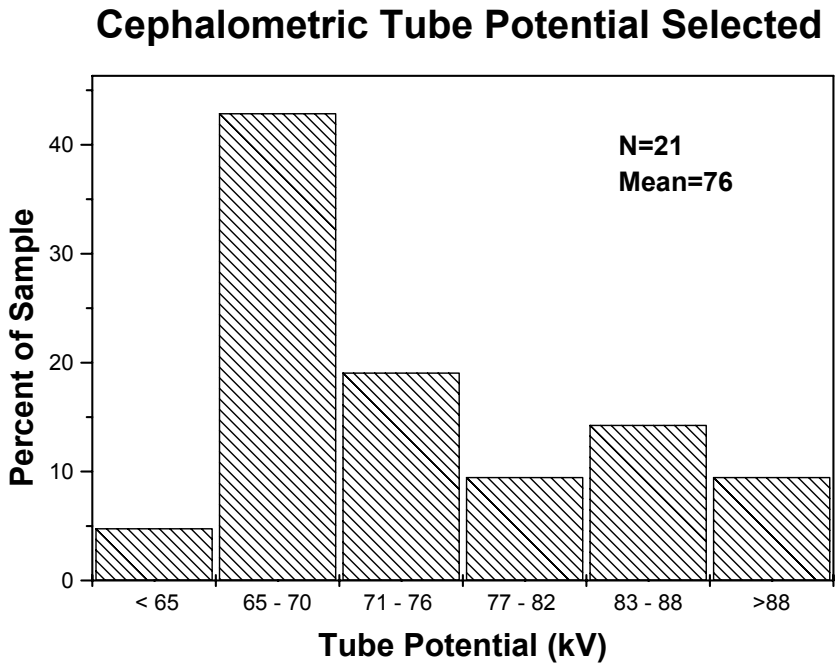


Table 45. Cephalometric Tube Potential Measured*

kVp	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 65	2	2	12.5	12.5
65 – 69	8	10	50.0	62.5
70 – 75	2	12	12.5	75.0
> 75	4	16	25.0	100

kVp	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	16	72	5	65	69	70	77	81

***Measured with kVp Meter**

Figure 40.

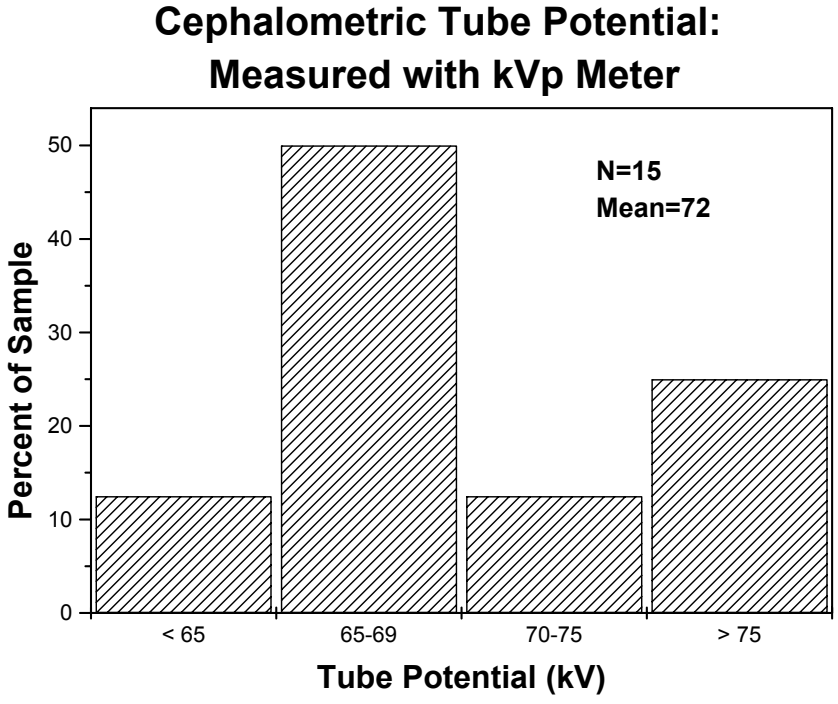


Table 46. Absolute Value of Difference in Cephalometric Tube Potential: Measured vs. Selected

Difference in kV	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 1	4	4	25.0	25.0
1 – 3	5	9	31.3	56.3
4 – 6	1	10	6.3	62.6
6 – 8	3	13	18.7	82.3
> 8	3	16	18.7	100

Difference in kV	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	16	4.4	5.0	0.6	0.7	2.9	5.8	17

Figure 41.

Absolute Value of Difference in Tube Potential: Measured vs. Selected

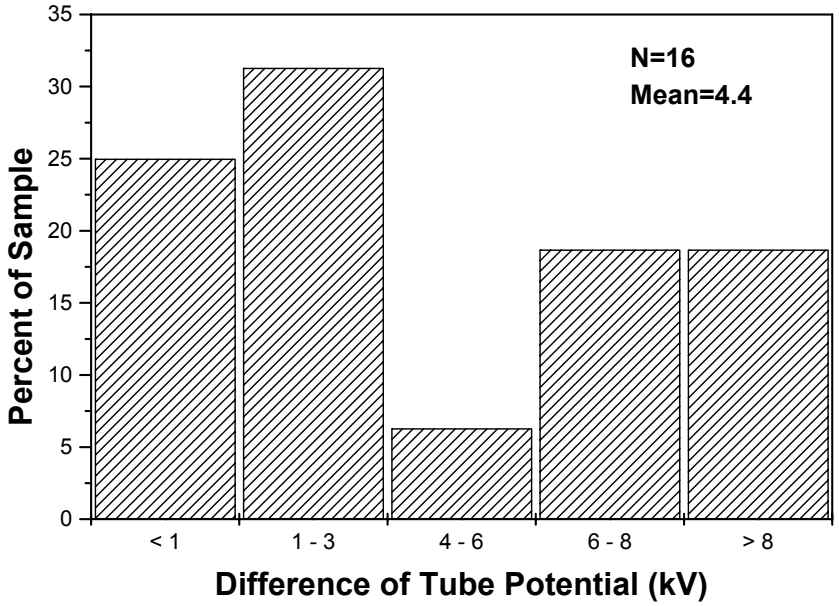


Table 47. Cephalometric Half-Value Layer (mm Al) at Clinical Tube Potential

Half Value Layer (mm Al)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 2.0	3	3	16.7	16.7
2.0-2.3	5	8	27.8	44.4
2.4-2.6	1	9	5.6	50.0
2.7-3.0	6	15	33.3	83.3
> 3.0	3	18	16.7	100

mm Al	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	18	2.7	0.6	1.5	2.2	2.7	3.0	3.8

Figure 42.

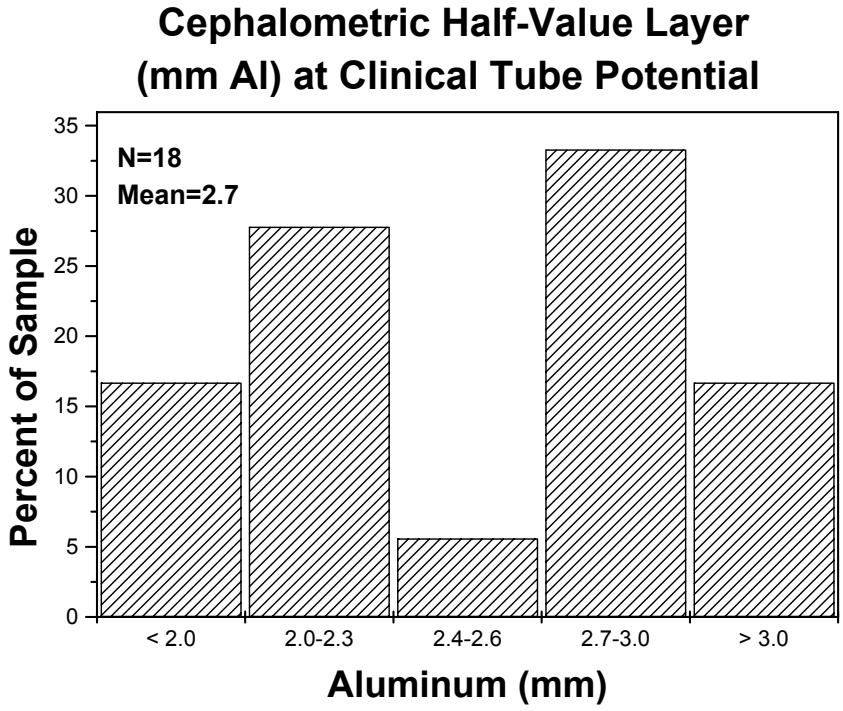


Table 48. Cephalometric Tube Current Selected

MA	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 8	4	4	19.1	19.1
8 – 10	1	5	4.7	23.8
11 – 13	4	9	19.1	42.9
14 – 16	3	12	14.3	57.2
15 – 17	8	20	38.1	95.3
> 17	1	21	4.7	100

mA	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	21	11.8	4.9	2.0	10.0	12.0	15.0	25.0

Figure 43.
Cephalometric Tube Current Selected

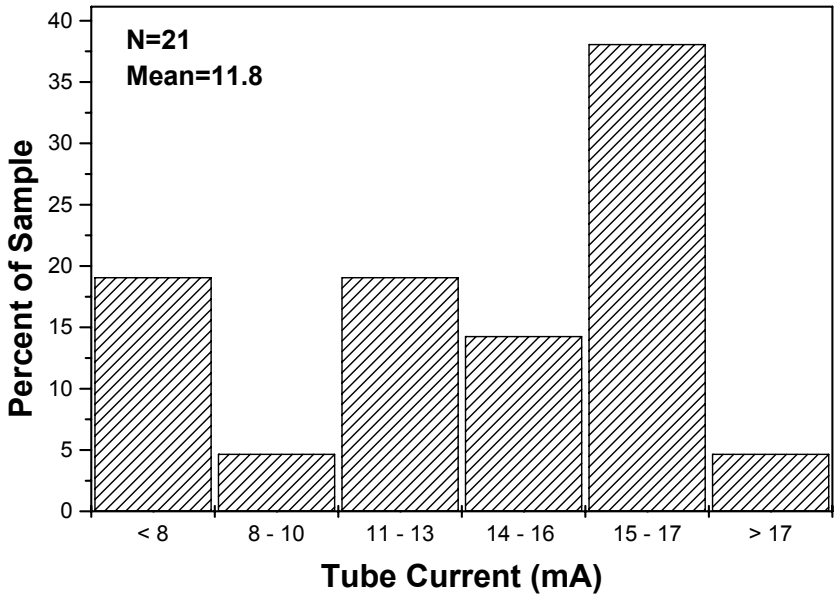


Table 49. Cephalometric Exposure Time Selected

Time (ms)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 400	2	2	11.1	11.1
400 – 699	3	5	16.7	27.8
700 – 999	8	13	44.4	72.2
1000 – 1300	4	17	22.2	94.4
> 1300	1	18	5.6	100

Time (ms)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	18	851	386	57	615	806	1160	1730

Figure 44.
Cephalometric Exposure Time Selected

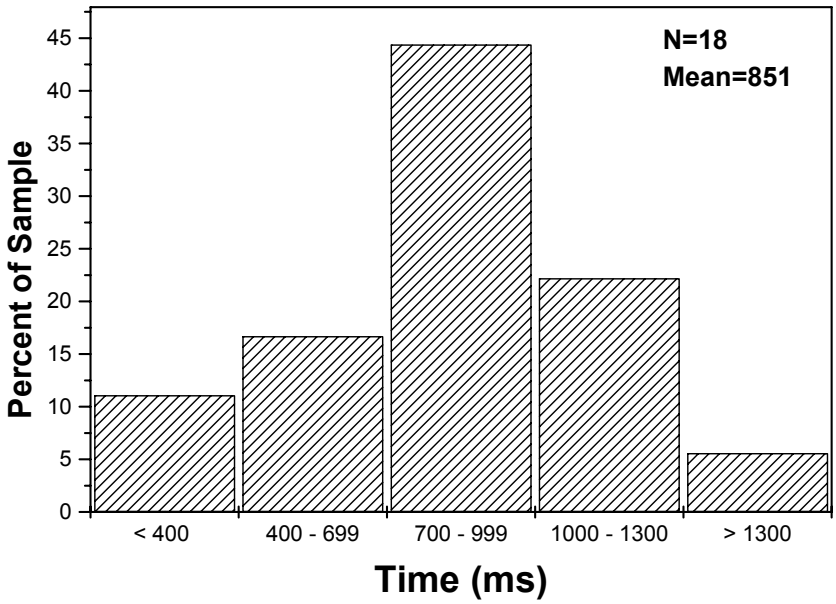


Table 50. Cephalometric mAs Values Selected

mAs	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 4.0	4	4	20.0	20.0
4.0 – 7.9	5	9	25.0	45.0
8.0 – 11.9	5	14	25.0	70.0
12.0 – 16.0	2	16	10.0	80.0
> 16.0	4	20	20.0	100

mAs	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	20	12.3	8.1	0.5	7.6	11.0	15.3	31.3

Figure 45.
Cephalometric mAs Values Selected

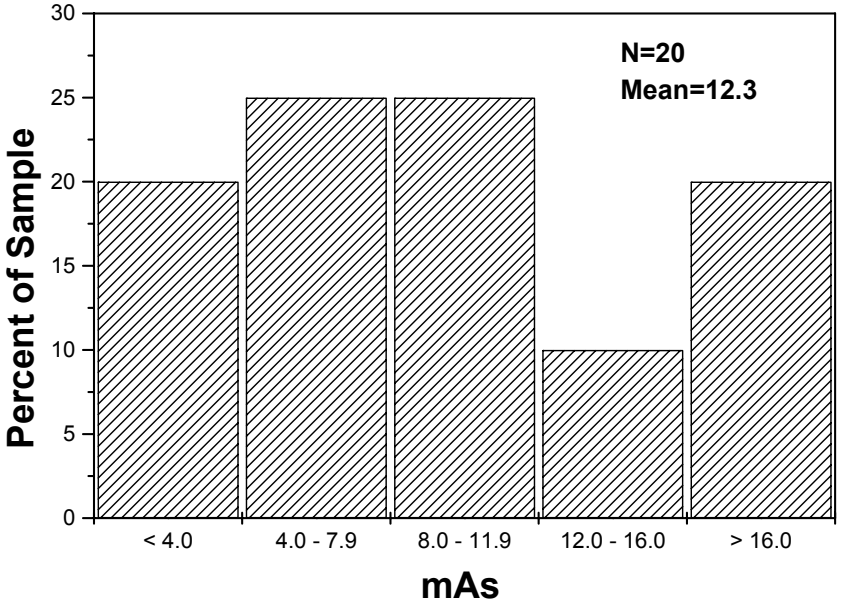


Table 51. Darkroom Fog Optical Density* for Cephalometric Facilities

Optical Density	Frequency	Cumulative Frequency	Percent	Cumulative Percent
0.0	12	12	23.1	23.1
.01 – .10	18	30	34.6	57.7
.11 – .20	5	35	9.6	67.3
.21 – .30	6	41	11.5	78.8
.31 – .40	5	46	9.6	88.4
.41 – .51	3	49	5.8	94.2
> 0.51	3	52	5.8	100

Optical Density	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	52	0.14	0.2	0	0	0.04	0.2	1.0

*Measured Using the Facility's Cephalometric Medical X-ray Film

Figure 46.
Darkroom Fog Optical Density for Cephalometric Facilities

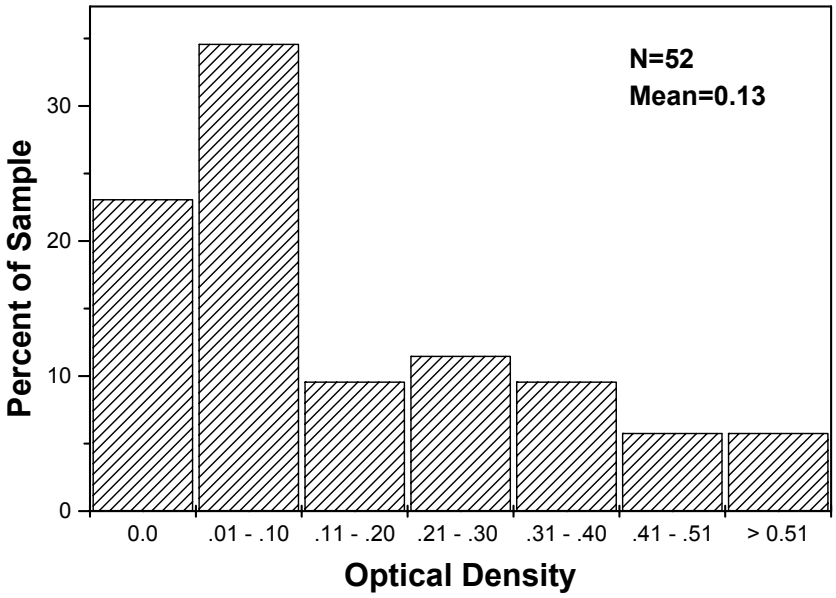


Table 52. Film Brands Used for Cephalometric Imaging

Film Brand	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Kodak	13	13	61.9	61.9
Agfa	2	15	9.5	71.4
3 M	2	17	9.5	80.9
Other	4	21	19.0	100

Table 53. Film Types Used for Cephalometric Imaging

Film Type	Frequency	Cumulative Frequency	Percent	Cumulative Percent
TMG	10	10	47.6	47.6
TML	2	12	9.5	57.1
RPX	2	14	9.5	66.6
Other	7	21	33.4	100

Table 54. Screen Brands Used for Cephalometric Imaging

Screen Brand Manufacturer	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Kodak	15	15	68.2	68.2
Wolf	2	17	9.1	77.3
Other	5	22	23.7	100

Table 55. Screen Types Used for Cephalometric Imaging

Screen Type	Frequency	Cumulative Frequency	Percent	Cumulative Percent
LNX (Lanex Regular Green)	14	14	63.6	63.6
HSP(Optex High Speed Blue)	2	16	9.1	72.7
Other	6	22	27.3	100

Table 56. Use of Grid during Cephalometric Procedures

Grid Use	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Yes	2	2	9.1	9.1
No	20	22	90.9	100

Table 57. Selection of Cone Type for Cephalometric Procedures

Cone Type	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Open Ended	14	15	71.5	71.5
Collimator	2	17	9.5	81.0
Pointed	1	18	4.8	85.8
Unknown	3	21	14.2	100

PANORAMIC PROCEDURES

Table 58. Number of Patients Examined per Week (at each Facility)

Number of Patients	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 2	21	21	13.6	13.6
2 – 6	66	87	42.9	56.5
7 – 11	17	104	11.0	67.5
12 – 16	23	127	14.9	82.4
17 – 21	4	131	2.6	85.0
22 – 26	14	145	9.1	94.1
> 26	9	154	5.9	100

Patients / Week	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	154	9	11	1	3	5	10	90

Figure 47.

Number of Patients Examined Weekly per Facility

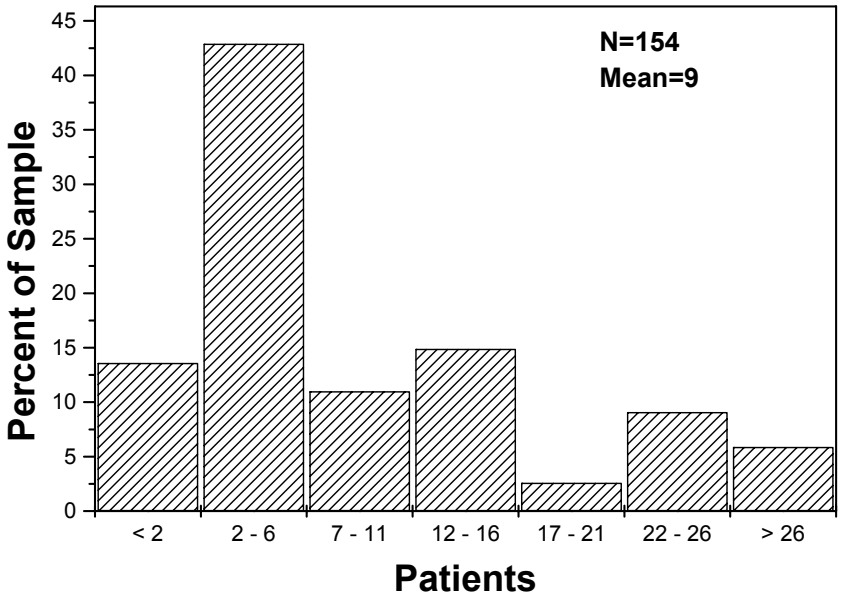


Table 59. Panoramic Tube Potential Selected

Tube Potential (kV)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 65	8	8	5.6	5.6
65 – 69	24	32	16.9	22.5
70 – 74	36	68	25.4	47.9
75 – 79	32	100	22.5	70.4
80 – 84	16	116	11.3	81.7
85 – 90	22	138	15.5	97.2
> 90	4	142	2.8	100

kV	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	142	79	8.1	55	74	80	85	96

Figure 48.

Panoramic Tube Potential Selected

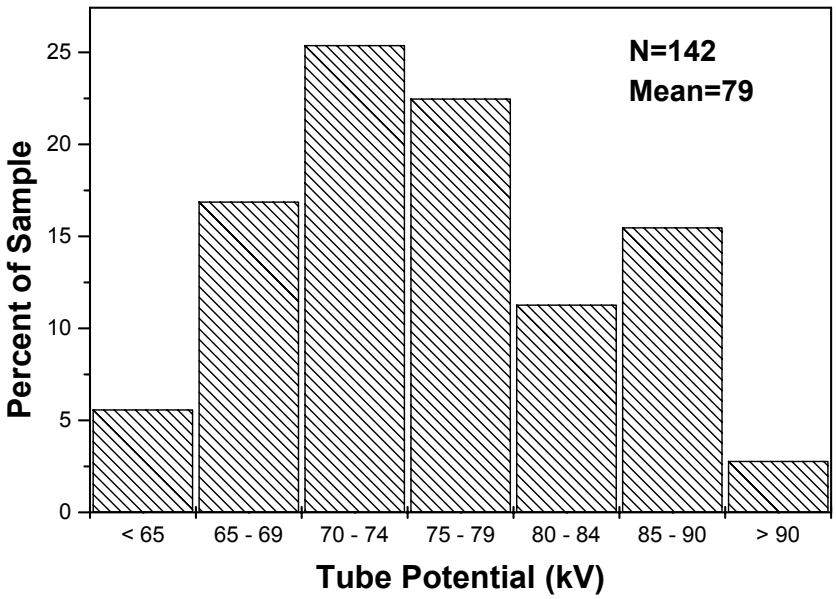


Table 60. Panoramic Tube Current Selected

Tube Current (mA)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 4	21	21	14.8	14.8
4 – 6	58	79	40.9	55.7
7 – 9	21	100	14.8	70.5
10 – 12	19	119	13.4	83.9
> 12	23	142	16.1	100

mA	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	142	8.1	5.6	3.2	5.0	6.0	10	60

Figure 49.
Panoramic Tube Current Selected

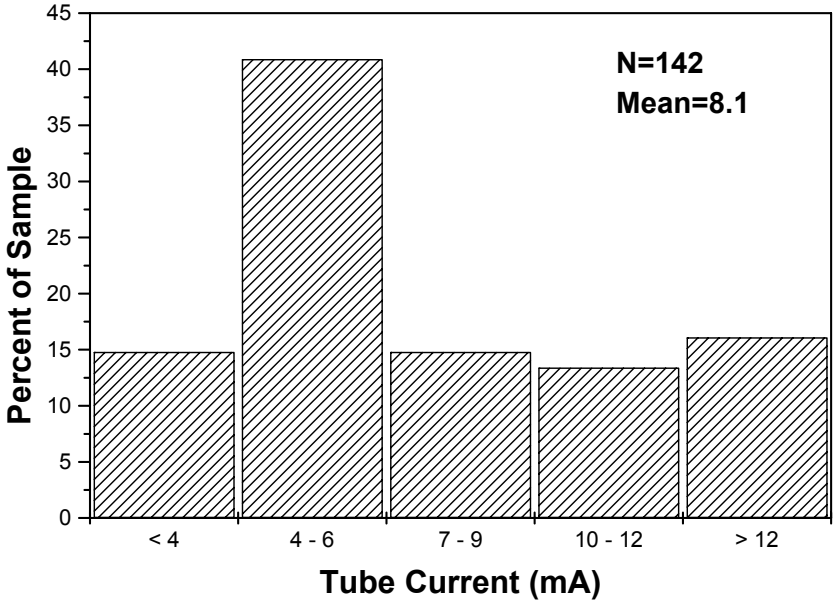


Table 61. Panoramic Exposure Time Selected

Time (s)	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 13.0	19	19	14.0	14.0
13.0 – 15.9	40	59	29.4	43.4
16.0 – 18.9	39	98	28.7	72.1
19.0 – 22.0	27	125	19.9	92.0
> 22.0	11	136	8.0	100

Time (s)	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	136	17.0	4.40	11.0	14.8	16.5	19.0	51.0

Figure 50.

Panoramic Exposure Time Selected

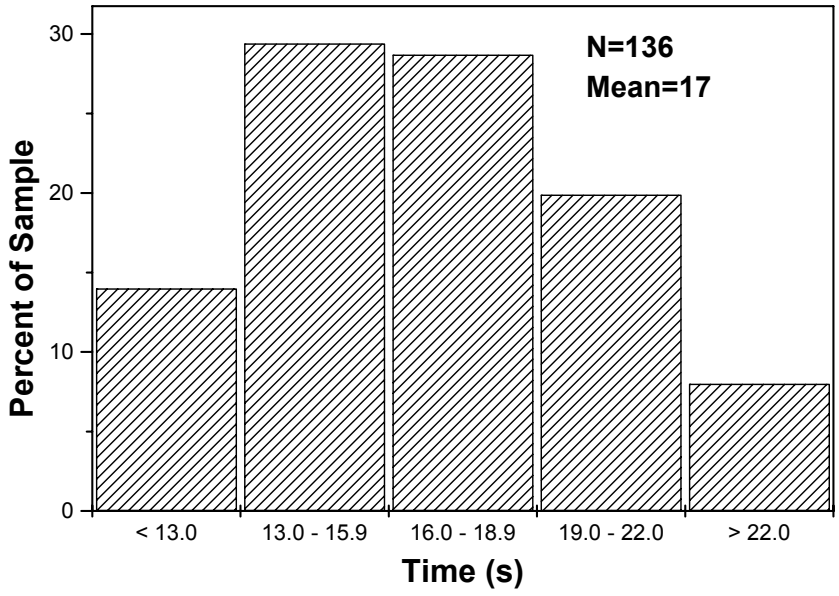


Table 62. Panoramic mAs Values Selected

mAs	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 100	34	34	24.5	24.5
101 – 150	53	87	38.1	62.6
151 – 200	19	106	13.7	76.3
201 – 250	18	124	12.9	89.2
> 250	15	139	10.8	100

mAs	N	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
	139	123	60.7	9.6	75	100	165	333

Figure 51.

Panoramic mAs Values Selected

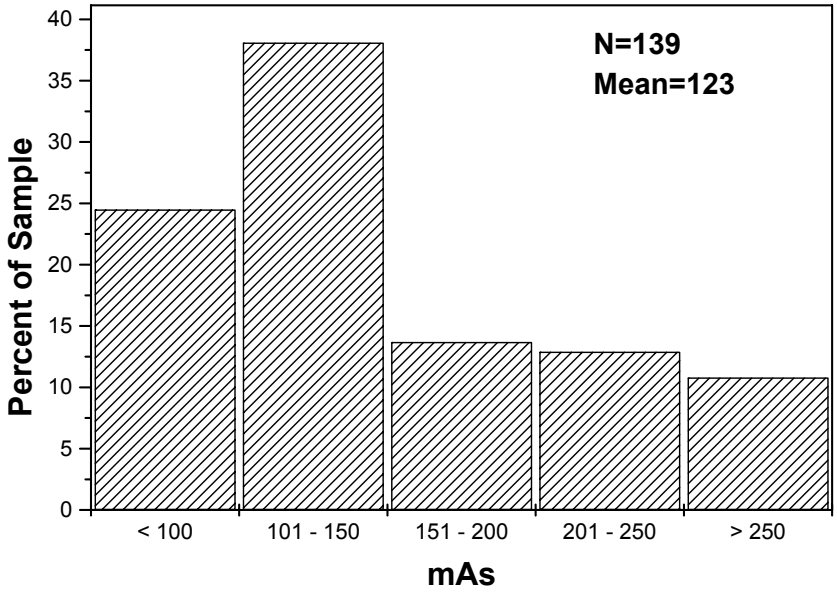


Table 63. Panoramic Generator Phase of X-ray Unit

Phase	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Single Phase	118	118	85.5	85.5
Three Phase	6	124	4.3	89.8
High Frequency	3	127	2.2	92.0
Other	11	138	8.0	100

Table 64. Film Brands Used for Panoramic Imaging

Film Brand Manufacturer	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Kodak	119	119	82.1	82.1
Other	11	130	7.6	89.7
Unknown	15	145	10.3	100

Table 65. Film Types Used for Panoramic Imaging

Film Type	Frequency	Cumulative Frequency	Percent	Cumulative Percent
TMG	72	72	49.7	49.7
D75	22	94	15.2	64.9
D76	7	101	4.8	69.7
RPX	10	111	6.9	76.6
Other	11	122	7.5	84.1
Unknown	23	145	15.9	100

Table 66. Screen Brands Used for Panoramic Imaging

Film Type	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Kodak	90	90	62.1	62.1
Gendex	10	100	6.9	69.0
Dupont	15	115	10.3	79.3
Other	18	133	12.5	91.8
Unknown	12	145	8.2	100

Table 67. Screens Types Used for Panoramic Imaging

Film Type	Frequency	Cumulative Frequency	Percent	Cumulative Percent
LNX	67	67	46.5	46.5
LNM	6	73	4.2	50.7
HPS	11	84	7.6	58.3
XRG	8	92	5.6	63.9
Other	22	114	15.4	79.3
Unknown	30	144	20.8	100

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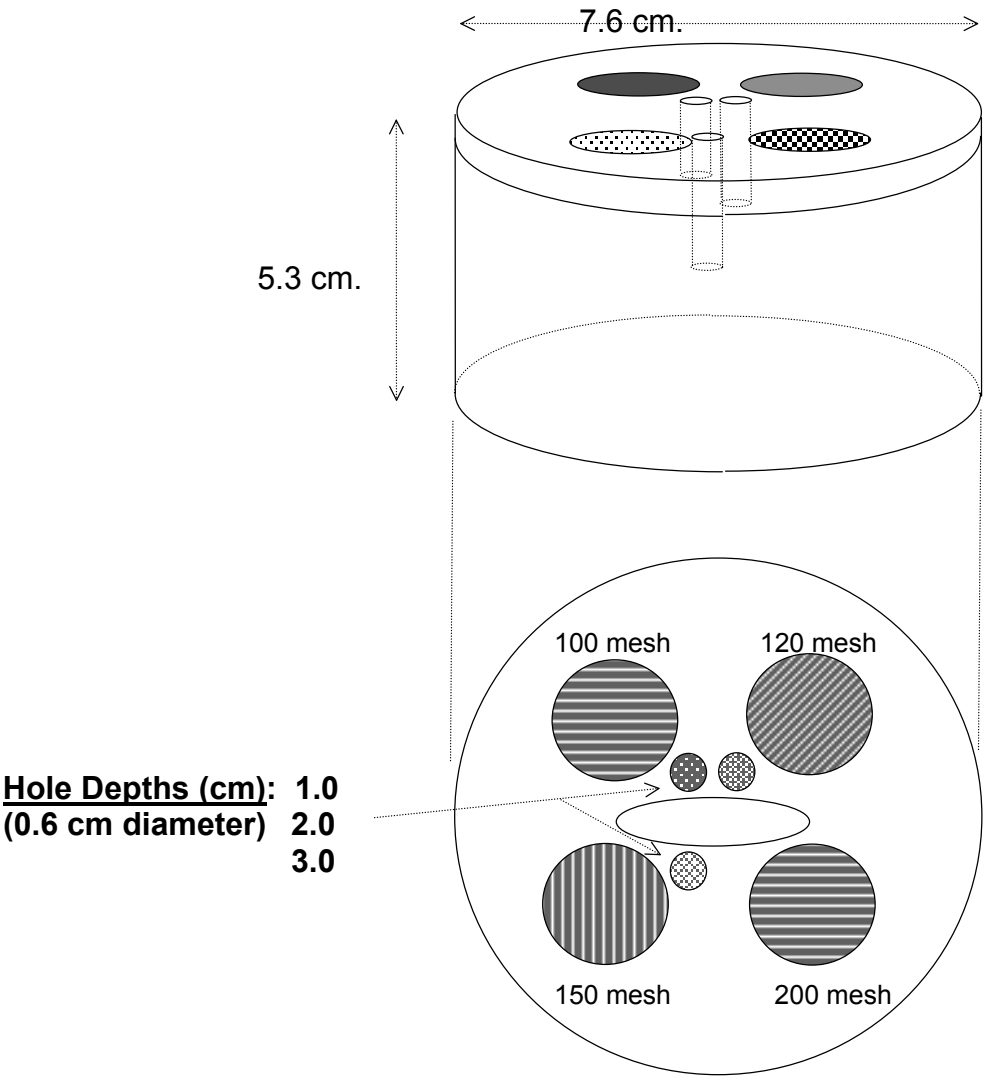
APPENDIX A: DIAGRAM OF DENTAL PHANTOM



The phantom is composed of Plexiglas containing image quality objects embedded within for evaluating high contrast resolution (copper meshes) and low contrast sensitivity (holes). A human tooth is also embedded in the center area of the phantom.

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APPENDIX B. SUMMARY OF DENTAL MEASUREMENT PROCEDURES (Abridged Protocol)

INTRAORAL IMAGING PROCEDURE

Entrance Skin Exposure / Air Kerma

Objective

To measure the typical intraoral Entrance Skin Exposure (ESE) and Entrance Skin Air Kerma (ESAK) Free-in-Air for an average patient.

Required Test Equipment

- Phantom cradle
- MDH meter

Set-up

1. Place the NEXT CDRH dental phantom cradle on some form of support (a tripod if available). The phantom cradle should be placed so that it is level and secure to avoid the possibility of damage due to a fall. If a tripod is utilized, it can be attached to the underside of the phantom cradle using the tripod mounting screw.

2. The phantom cradle should be placed at a height that enables easy positioning of the intraoral tube so that the cone lies level and parallel to the phantom cradle. The probe holder should be opposite from the cone.

3. Attach the MDH probe to the probe holder. It should be attached to the probe holder so that the sensitive volume of the chamber is centered in the phantom cradle. The end or tip of the intraoral tube cone should then be placed in the phantom cradle so that the cone just makes contact with the MDH probe.

ONCE YOU HAVE ALIGNED THE MDH PROBE AND UNIT, DO NOT MOVE THEM UNTIL ALL MEASUREMENTS HAVE BEEN COMPLETED.

Test Steps

1. Initialize the MDH
   A) Turn on and warm up.

   B) Set the selector switch to the “Pulse Exposure” mode.

C) The pulse fraction threshold should be set at 0.2 for all single phase unit measurements. The majority of the units you encounter will be single-phase. If a unit is determined to be a three-phase unit, change the pulse fraction threshold to 0.5. For units that have pre-exposure filaments, set the pulse fraction threshold at 0.8.

D) Make an exposure with the technique factors set at the facility's standard technique and record this exposure as exposure #1. Do not record the time for this exposure.

THE NEXT THREE EXPOSURES WILL PROVIDE INFORMATION ON REPRODUCIBILITY. AS A REMINDER, DO NOT MANUALLY RE-SET THE MDH METER TO ZERO BETWEEN EXPOSURES.

2. Make an exposure. Record the exposure as exposure #2. Switch the MDH meter to "Pulse Duration" mode and record the measured time. Once completed, switch the MDH back to "Pulse Exposure."

3. Repeat this procedure for exposures #3 and #4.

4. Calculate and record the average (E_{avg}) of the four exposure values.

5. Measure and record the Source to Cone Tip Distance or (SSD).

6. Measure and record the Cone Tip to Cheek Distance (CCD).

7. Calculate and record the ESE using the formula:
ESE = (E_{avg}) * ((SSD) / (SSD + CCD)) **2;

Beam Quality Assessment

Objective

To determine the half-value layer (HVL) of the x-ray beam. This would determine the total HVL of the x-ray tube assembly. The HVL is also a measure of beam quality, which is necessary to calculate patient dose.

Required Test Equipment

- Phantom cradle
- MDH meter
- 1100 Aluminum Alloy Filters: one 0.5 mm Al, two 1.0 mm Al, and four 2.0 mm Al.

Set-up

1. Use the same technique settings for this section that were used for collecting the intraoral unit exposure data in the last section.

2. Slide the end of the cone away from the probe in the phantom cradle so that it is aligned with the edge of the filter slot.

3. In order to position the dental cone, first insert a thickness of aluminum into the slot and bring the cone tip as close to the aluminum as possible. The cone tip should make contact with the aluminum.

Test Steps

1. Remove the aluminum and make an exposure. Record the output (in mR) in the boxes provided for the output for 0.0 mm of aluminum.

2. Insert a 1.0 mm aluminum filter in the slot of the phantom cradle. Make a second exposure and record the mR for 1.0 mm Al.

3. Insert an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 2.0 mm Al.

4. Insert an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 3.0 mm Al.

5. Insert an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 4.0 mm Al.

6. Using the graph on the back of the worksheet, plot the exposure versus the aluminum thicknesses used. Determine the HVL to the nearest tenth of a millimeter of aluminum by drawing the best straight line fit to all but the first (0.0 mm Al) data points.

   Find the point on the line where the exposure is half that of the 0.0 mm aluminum exposure. The thickness of Al corresponding to this point is the HVL.

Optical Density and Image Quality

Objectives

- To determine the Optical Density (OD) of the phantom film. The phantom film OD, which correlates with clinical film density, is a check on the exposure techniques to assure they are adequate to deliver a clinical image.

- To determine the imaging capabilities of the facility.

Required Test Equipment

- Dental Phantom
- Film Packet
- Densitometer
- View Box

Test Steps

1. Insert the Dental phantom loaded with a film packet between the cone and the MDH probe.

2. Make an exposure using the same technique as an exposure measurement (See above).

3. Develop the film that utilized the facility's standard technique settings. Measure and record the optical density at the area adjacent to the lone contrast object of the phantom image.

4. Measure and record the densities of the three low contrast objects.

5. Count and record the number of different gauge wire meshes that are visible. A wire mesh pattern is not counted if the "tiny" spaces that result from the mesh running vertically and horizontally are not seen.

Darkroom Fog Evaluation

Objective

To determine the optical density of darkroom fog for Intraoral film processing.

The following procedure is to be used to sensitize film for determining darkroom fog levels. A darkroom fog test tool has been provided for this measurement.

Required Test Equipment

- Image Test Tool
- Film Packets
- Densitometer
- View Box

Set-up

An optical density of 1.0 on one of the fog test tool steps is needed in order to evaluate fog. Because of this, two films will need to be taken.

1. Take the fog test tool and invert it. A visible depression lies underneath the steps of the test tool.

2. Place a packet of the facility's film in this depression making sure that the tube side or flat side of the film packet is in contact with the test tool. Take the test tool and turn it back over. The steps of the test tool should be facing upright toward the x-ray tube.

3. Bring the cone from the Intraoral unit down so that it makes contact with the test tool. The cone should cover the steps of the test tool.

Test Step

1. For the first film, make an exposure using the facility's standard technique. Remove the film from the fog test tool, mark the film and place it in a shielded area.

2. For the second film, insert a new packet of the facility's film into the depression area of the fog test tool and setup as you did previously. The kVp should remain unchanged. Divide the mAs setting by 10 and make this exposure.

3. In the darkroom, unwrap these exposed films from their packaging and insert the films into the test tool. The long side of the films should be inserted into the slots located on the left and right hand sides of the test tool. The slots are located in the flat part of the test tool and not the step portion. Be sure that you are approximately bisecting the latent image.

4. Position the films and test tool in an area of the darkroom closest to a safelight. This should represent an area where film is routinely handled and has the highest probability of safelight exposure. Expose the uncovered half of the films to normal safelight conditions for two minutes. Make sure that you do not accidentally shield the films from other potential fog sources such as light leaks or digital light sources.

5. After two minutes have elapsed, quickly remove the films from the step-wedge and feed them into the processor.

6. If a visible line appears down the center of the film, then fog is present. Using the densitometer, measure the densities of both the left and right hand sides of the film at various steps. Record the greatest density difference.

CEPHALOMETRIC IMAGING PROCEDURE

Entrance Skin Exposure / Air Kerma

Objective

To measure the typical cephalometric entrance skin exposure (ESE) and entrance skin air kerma (ESAK) free-in-air for an average patient.

Required Test Equipment

- Phantom
- MDH meter

Set-up

1. Place the MDH so that it is mounted securely in the primary beam roughly midway between the image receptor and the tube, but preferably nearer the image receptor. *Positioning the probe near the tube may make it difficult to ensure that the probe is fully within the useful beam.*

> *You may need to be creative here -*
>
> - Try lowering the gantry to permit use of a cart or chair, etc.
> - On some units (on a Pan/Ceph combo for example) you can hang the MDH probe down into the beam.

2. If the unit has a collimator light, utilize it to insure that the entire sensitive volume of the probe lies in the beam.

> ONCE YOU HAVE ALIGNED THE MDH PROBE AND UNIT, DO NOT MOVE THEM UNTIL ALL MEASUREMENTS HAVE BEEN COMPLETED.

Test Steps

1. Initialize the MDH
   A) Turn on and warm up.

   B) Set the selector switch to the “Pulse Exposure” mode.

C) The pulse fraction threshold should be set at 0.2 for all single phase unit measurements. The majority of the units that you encounter will be single-phase. If a unit is determined to be three-phase, change the pulse fraction threshold to 0.5. For units that have pre-exposure filaments, set the pulse fraction threshold at 0.8.

D) Make an exposure with the technique factors set at the facility's standard technique and record this exposure as exposure #1. Do not record the time for this exposure.

THE NEXT THREE EXPOSURES WILL PROVIDE INFORMATION ON REPRODUCIBILITY. AS A REMINDER, DO NOT MANUALLY RE-SET THE MDH METER TO ZERO BETWEEN EXPOSURES.

2. Insert an unloaded cassette and make an exposure. Record the exposure as exposure #2. Switch the MDH meter to "Pulse Duration" mode and record the measured time. Switch the MDH meter back to "Pulse Exposure".

3. Repeat this procedure for exposures #3 and #4.

4. Calculate and record the average (E_{avg}) of the four exposure values.

5. Measure the source-to-image distance (SID) and record this value on the survey form along with the units of measure (cm).

6. Measure the source-to probe-distance (SPD) and use the same units (in/cm) as you did for SID.

7. Calculate and record the ESE using the formula:
   ESE = (E_{avg}) *((SPD)/ (SID - 17.5)) **2;

   (The Source-to-Skin-Distance (SSD) is approximated to be 17.5 cm)

Beam Quality Assessment

Objective

To determine the cephalometric half-value layer (HVL) of the x-ray beam. This would determine the total HVL of the x-ray tube assembly. The HVL is also a measure of beam quality, which is necessary to calculate patient dose.

Required Test Equipment

- MDH meter
- 1100 Aluminum Alloy Filters: one 0.5 mm Al, two 1.0 mm Al, and four 2.0 mm Al.

Set-up
Use the same set-up for this section that you used for collecting the cephalometric unit exposure data in this section.

Test Steps
1. Make an exposure without aluminum. Record the output (in mR) in the boxes provided for the output for 0.0 mm of aluminum.

2. Tape a 1.0 mm aluminum filter to the end of the cone. Make a second exposure and record the mR for 1.0 mm Al.

3. Add an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 2.0 mm Al.

4. Add an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 3.0 mm Al.

5. Add an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 4.0 mm Al.

6. Using the graph on the back of the worksheet, plot the exposure versus the aluminum thicknesses used. Determine the HVL to the nearest tenth of a millimeter of aluminum by drawing the best straight line fit to all but the first (0.0 mm Al) data points.

   Find the point on the line where the exposure is half that of the 0.0 mm aluminum exposure. The thickness of Al corresponding to this point is the HVL.

Darkroom Fog Evaluation

Objective
To determine the optical density of darkroom fog for cephalometric film processing. This is performed in addition to the intraoral darkroom fog evaluation since intraoral film has a sensitometric response that is different from cephalometric film.

Required Test Equipment
- Fog folder
- Loaded film cassette
- Image Test Tool
- Densitometer
- View Box

Set-up
An optical density of 1.2 on one of the fog test tool steps is needed in order to evaluate cephalometric fog.

1. Load a film cassette.

2. Position the tube so that it has a source-to-image distance of 40 inches. Orient the tube so that it is facing downwards.

3. Place the image test tool on the center of the cassette with the long side of the wedge parallel with the long side of the cassette.

4. Adjust the light field, or collimator, to the approximate size of the image test tool.

Test Step
1. Take can exposure using 70 kVp and 5 mAs. This should be adequate to give a density of 1.2 from one of the steps when the film is developed.

2. In the darkroom unwrap the exposed film from its packaging and insert the film halfway into the fog folder.

3. Position the film and fog folder in an area of the darkroom closest to a safelight. This should represent an area where film is routinely handled and has the highest probability of safelight exposure. Expose the uncovered half of the film to normal safelight conditions for two minutes. Make sure that you do not accidentally shield the film from other potential fog sources such as light leaks or digital light sources.

4. After two minutes have elapsed, quickly remove the film from the fog folder and feed it into the processor.

5. If a visible line appears down the center of the film, then fog is present. Using the densitometer, measure the densities of both the left and right hand sides of the film at various steps. Record the greatest density difference.

FILM PROCESSING EVALUATION (Cephalometric and Intraoral)

Objective
To determine the efficiency of processing at the facility surveyed

Required Test Equipment
- Sensitometer
- Control Film
- Processor
- Densitometer

Set-up

1. With a calibrated sensitometer, flash each of the four sides of the calibration film.

2. Process the film.

Test Steps

1. Determine the speed density by adding 1.00 to the optical density of the base (background) plus fog of the film. Record this optical density on the STEP worksheet.

2. Select the two steps of the calibration film (i.e. Steps 9 and 10) that have optical densities above and below the speed density. Record these two steps on the worksheet.
3. Measure the optical densities of the two selected steps for all four sides of the film.

4. Average the four measured densities for each step. Record these two average densities on the worksheet.

5. Using these two average densities, refer to the STEP worksheet and determine the resulting speed of the film processor.

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- We promote and foster uniformity of radiation control laws and regulations;
- We encourage and support programs that will contribute to radiation control for all;
- We assist the membership in their technical work and development; and
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CRCPD
205 Capital Avenue
Frankfort, KY 40601
502/227-4543
Web Site: www.crcpd.org