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PATIENT EXPOSURE AND DOSE GUIDE - 2003

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PATIENT EXPOSURE AND DOSE GUIDE - 2003

A Report by
Committee on Quality Assurance
in Diagnostic X-ray (H-7)

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ABSTRACT

Committee on Quality Assurance in Diagnostic X-ray, *Average Patient Exposure Guide – 2003*, CRCPD Publication E-03-2 (January 2003) (21pp).

The exposure guides provide average patient exposures at skin entrance (ESE) that reflect the "state of current practice" in a cross section of radiography facilities ranging from small private practices to large hospitals. Where applicable, these guides are presented in terms of various imaging system speeds that were indicated by the bulk of available data as those most commonly utilized. The values provided in these guides should not be considered as absolute limits.

This publication was supported in part by grant number FD-U-000005 from the Food and Drug Administration. The information contained in this document is for guidance. The implementation and use of the information and recommendations contained in this document are at the discretion of the user. The implications from the use of this document are solely the responsibility of the user.

This document has been developed by a working group of the Conference of Radiation Control Program Directors, Inc. (CRCPD) and accepted by the Board of Directors for publication. The contents contained herein, however, may not necessarily represent the views of the entire membership of the CRCPD or any federal agency supporting the work contained in this document. The mention of commercial products, their sources, or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products by the CRCPD or any federal agency.

FOREWORD

The Conference of Radiation Control Program Directors, Inc. (CRCPD) is an organization comprised of representatives from the radiation control programs of nearly all of the 50 states (Wyoming has no radiation control program), the District of Columbia, and Puerto Rico. The primary purpose and goal of the CRCPD is to assist its members in their efforts to protect the public, radiation workers, and patients from unnecessary radiation exposure. The CRCPD also provides a forum for centralized communication on radiation protection matters between the states and the federal government, and among the individual states.

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

This publication, *Patient Exposure and Dose Guide–2003*, is intended to provide the states and other interested parties with national norms of entrance skin exposure (ESE) and dose values for routine radiography examinations as a basis for comparison in order to assist facilities in identifying the need for change.

Cynthia C. Cardwell
Chairperson, Conference of Radiation
Control Program Directors, Inc.

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PREFACE

The largest contributor to total population radiation exposure from man-made radiation sources is diagnostic (dental and medical) imaging. The Conference of Radiation Control Program Directors, Inc. (CRCPD) continues to work toward minimizing unnecessary radiation exposure.

One aid in minimizing unnecessary exposure in diagnostic imaging is through the use of patient exposure guides. The first CRCPD publication with recommended exposure guides was published in 1980 and provided exposure ranges for five routine diagnostic x-ray projections. The document was revised in 1988 to reflect the changes made in diagnostic radiology since 1980. The revised document included three new projections (Full Spine A/P, Chest P/A, and Mammography CC) and presented the data in terms of various imaging system speeds. The second revision in 1992**(1)** updated exposure values and added new sections on computed tomography and fluoroscopy. This 2003 Guide contains revisions in exposure values where additional data supported the change, and also adds the pediatric chest projection.

Radiation exposure and dose guides in diagnostic radiology, which include "reference values" or "diagnostic reference levels," defined by national and international radiation protection organizations– such as ICRP**(2)**-as third quartile points of measured distributions of exposure, are intended to provide norms for comparison. The guides should not be considered as absolute limits. Lower values may be achievable while maintaining or actually improving image quality. Higher values may be warranted as indicated by sound clinical judgment.

The CRCPD urges all state and local radiation control programs to utilize this Guide in their efforts to minimize patient exposure. The CRCPD further urges all state and local radiation control programs to record ESE measurements in a format similar to that presented here so that such data can be included in future revisions.

John P. Winston, Chairperson
Committee on Quality Assurance in
Diagnostic X-ray

ACKNOWLEDGMENTS

Special recognition is given to the state radiation control programs, the U.S. Department of Health and Human Services–Food and Drug Administration-Center for Devices and Radiological Health, and to Mary Ann Spohrer, chairperson of the Committee on Nationwide Evaluation of X-ray Trends (NEXT), for assistance in the development of these guides.

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INTRODUCTION

This document is intended to serve as an aid in minimizing unnecessary radiation exposure during routine diagnostic x-ray procedures. Unnecessary radiation exposure may be minimized in several ways, including optimization of the imaging chain. This document does not address the medical justification of an exposure, because it is assumed that has already been addressed. Optimization of the imaging chain means keeping the patient dose as low as reasonably achievable while obtaining the necessary diagnostic information. The use of radiation exposure norms to evaluate the effectiveness in minimizing patient dose during routine diagnostic imaging in a facility has proved essential in critiquing the balance between image quality and patient exposure.

In 1980, CRCPD published patient exposure guides for five routine diagnostic x-ray projections. The document was developed by the CRCPD Quality Assurance Task Force (H-7), now know as the Committee on Quality Assurance in Diagnostic X-ray (H-7). That publication provided the first recommended exposure guides for minimizing radiation exposure to patients while maintaining or improving image quality. It was then noted that exposure guides should be revised periodically to reflect advances in technology in the practice of radiology, and in 1988 and 1992, revised guides were published. Changes in imaging technology and improved awareness in quality assurance aspects of diagnostic radiography now warrant a third revision in the Guide.

State agencies are encouraged to reference these values when evaluating a medical facility's radiation safety program. The values listed in the tables of this document **should not be considered absolute limits** for diagnostic procedures. It is intended that the third quartile value be used as an achievable level in facilities using film-screen technology. Lower values, such as the median values provided, may be achievable while maintaining or actually improving image quality. Higher values may be warranted as indicated by sound clinical judgment.

Other organizations, including the AAPM (American Association of Physicists in Medicine, ACR (American College of Radiology), and ICRP (International Council on Radiation Protection), have published or soon will publish similar values. In deriving the values in this document, the H-7 Committee solicited entrance skin exposure (ESE) data from every state. Very little information was available in a format consistent with that of the data presented in the Guide. Consequently, the Committee relied primarily on the 1992 Guide and data from the Nationwide Evaluation of X-ray Trends (NEXT)**(3)**, derived from nationwide surveys in which most states participated. Where the NEXT data indicated a different exposure value than the 1992 Guide, the Committee decided to use the NEXT figure. When a review of the data indicated no significant differences or no additional information from the 1992 Guide, the Committee elected to retain the 1992 value. The Committee elected to maintain the values in the units appearing in the NEXT publications and provide the conversion factor needed to convert them to entrance air kerma (mGy).

For adult chest, abdominal, and lumbosacral spine radiography, NEXT values reflect examination conditions for patients of average size whose x-ray attenuation characteristics are represented with clinically validated reference phantoms. The NEXT chest phantom corresponds to an overall patient mean PA thickness of 22.5 cm**(4)**, whereas the NEXT abdomen and lumbo-sacral spine phantom is associated with an overall patient mean AP thickness of 21.5 cm**(5)**. The fluoroscopy phantom was adapted from the abdomen phantom, and pilot data indicate that the pediatric chest phantom corresponds to a child of 15 months, 11 kg (25 lbs). Caution should be used when referring to the European Commission pediatric reference values as their patient is a five-year old child.

Data provided in this Guide reflects the "state of current practice" in a cross section of radiology facilities ranging from small private practices to large hospitals and medical institutions. The Committee understands that such data do not reflect "state of the art" practices because they lag behind rapid advances in technology and include information from facilities utilizing equipment and procedures (including a wide distribution of kVps, source-to-image distances (SID), grids, processor performance, etc.) that are less than optimal.

Exposure values in the guide are from measurements free-in-air, i.e., without backscatter. Mammographic mean glandular dose values were inferred from free-in-air measurements coupled to normalized dose values derived from simulations of radiation transport in a mathematical model of breast tissue compressed to a thickness of 4.2 cm**(6)**. (The RMI model 156 breast phantom yields the corresponding skin entrance exposure in automatic exposure controlled mammographic systems.) For CT (computed tomography), multiple scan average dose (MSAD) values were determined from measurements in an FDA CT dosimetry head phantom**(7)**, whereas effective dose values were inferred from measurements free-in-air on the axis of rotation that are coupled to normalized doses derived from simulations of radiation transport in an anthropomorphic, hermaphrodite mathematical phantom**(8)**.

Digital radiography, commonly referred to as "state of the art," may require more radiation exposure than film-screen radiography to produce the image. This will undoubtedly change with advancements in technology. ESE data on digital systems is limited and not included in this document. When evaluating exposure on digital systems, it is important to remember that the degree of image quality may or may not be selectable by the user. Patient dose may be higher than necessary if the clinical requirements do not justify the degree of quality, or the processing software and other parts of the imaging chain (e.g., x-ray unit) are not optimized. The ease of image acquisition may also lead to more exposures than clinically necessary.

Tables seven through ten provide a summary of a phone survey conducted by the H-7 Committee. Each state radiation control program was contacted by a Committee member and asked if they have any patient exposure limits in their regulations. If not, they were asked whether they have maximum ESE values that trigger a written recommendation to investigate the finding.

The Committee appreciates the comments received during the development of this guide. The Committee encourages all programs to initiate and record ESE measurements in a format similar to that presented in this guide so the Committee can request these data for inclusion in future revisions.

TYPICAL PATIENT EXPOSURE AND DOSE VALUES

Table 1. Dental Intraoral (Bitewing) ESE (Entrance Skin Exposure)

Film Speed	Median ESE (mR)	3rd Quartile ESE (mR)
All	172	249
D Speed	186	262
E Speed	132	183

Notes:

- Exposures collected using the standard technique the facility uses for an adult posterior bitewing (intraoral).
- All measurements were made in air, without backscatter.
- The ESE values may be converted to entrance air kerma (mGy) by multiplying by 0.00876 mGy/mR.
- Source: 1999 NEXT (Nationwide Evaluation of X-ray Trends) Dental Survey (preliminary data).
- There are three common film speeds available for intraoral radiography: D, E, and F-speed. The D-speed film is the oldest and slowest of the three, but still remains prevalent in dental practice. The E-speed film is considered to be about twice as fast as D-speed, and the current F-speed is about 20 % faster than the E-speed in roller transport processing. The E and F-speed films are about 30 % faster than D-speed when developed manually. Due to the existence of the three film speeds and the variability of fixed kVp dental equipment, a good reference for appropriate ESE evaluation is the information provided in the U.S. Department of Health and Human Services publication number (FDA) 85-8245, August 1985. A modified version of the table from this publication is in the Appendix.
- Digital imaging is growing in intraoral radiography, and the ESE is typically much lower than traditional x-ray film radiography. Facilities using digital imaging typically follow manufacturer guidelines and set the x-ray technique at the lowest exposure time possible. Therefore, an optimal exposure-image value may be limited by the ability of the x-ray unit. Adequate ESE information does not exist at this time, but facilities should be capable of acquiring an image at an ESE considerably lower than the median value listed for E speed in Table 1.

Table 2. Dental Cephalometric ESE

Projection	Patient Thickness (cm)	Grid	SID (cm)	Median ESE (mR)	3rd Quartile ESE (mR)
Dental Cephalometric	15	No	168	15	23

Notes:

- The 1999 NEXT Dental Protocol refers to a 17.5 cm lateral skull thickness for the cephalometric exam.
- All measurements were made in air, without backscatter.
- The ESE values may be converted to entrance air kerma (mGy) by multiplying by 0.00876 mGy/mR.
- Source: 1999 NEXT Dental Survey (preliminary data).

Table 3. Mammography Mean Glandular Dose

Projection	Compressed Breast Thickness (cm)	Grid	Median (mGy)	3rd Quartile (mGy)
Craniocaudal View	4.2	Yes	1.75	1.97

Note:

- Data source: 2001 Mammography Quality Standards Act (MQSA) database. (RMI 156 phantom equivalent to a 4.2 cm compressed breast tissue (50% glandular/50% adipose) for screen-film)).

Table 4. Medical ESE Values for Selected Radiographic Exams

Projection	Patient Thickness (cm)	Grid	SID (cm)	Median ESE (mR)	3rd Quartile ESE (mR)
Chest (P/A)	23 23	No Yes	183 183	9 13	13 18
Pediatric Chest (P/A)	15 month old / 11 kg infant	No Yes		4 8	5 10
Pediatric Chest (A/P)	15 month old / 11 kg infant	No Yes		5 8	9 14
Abdomen (A/P)	23	Yes	102	271	396
Lumbar Spine (A/P)	23	Yes	102	342	477
Full Spine (A/P)	23	Yes	183	260 (200 Speed) 145 (400 Speed)	
Cervical Spine (A/P)	13	Yes	102	135 (200 Speed) 95 (400 Speed)	
Skull (Lat)	15	Yes	102	145 (200 Speed) 70 (400 Speed)	

Notes:

- Patient thickness corresponds to the dimensions of the average adult patient as clinically validated by the NEXT program.
- All measurements were made in air, without backscatter.
- The ESE values may be converted to entrance air kerma (mGy) by multiplying by 0.00876 mGy/mR.
- Chest data source: 1994 NEXT Chest Radiography Survey.
- Pediatric chest data source: 1998 NEXT Pediatric Chest Survey (preliminary data)
- Abdomen and Lumbar Spine data source: 1995 NEXT Abdomen and Lumbosacral Spine Survey (hospital data only).
- Full spine, cervical spine, and skull projections are based on data for manual mode techniques only collected by the H-7 Committee prior to the 1992 edition of this manual. ESE's are not necessarily inversely proportional to imaging system speed.
- For the full spine projection, if the facility used a wedge filter, the exposure was measured in the center of the x-ray field with the filter in the beam.

Table 5. Computed Tomography (CT) Dose

Projection	Multiple Scan Average Dose (mGy)	
	Median	3rd Quartile
Head	49.0	62.5
	Effective Dose (mSv)	
	Median	3rd Quartile
Head (Axial)	1.6	2.4
Head (Helical)	0.9	1.5
Abdomen+Pelvis (Axial)	16.7	21.9
Abdomen+Pelvis (Helical)	10.7	16.5
Chest (Axial)	8.5	11.8
Chest (Helical)	6.2	10.6
Chest+Abdomen+Pelvis (Axial)	27.2	35.9
Chest+Abdomen+Pelvis (Helical)	13.3	16.4
Abdomen (Axial)	6.9	10.8
Abdomen (Helical)	4.9	8.5
Pelvis (Axial)	5.5	10.1
Pelvis (Helical)	5.8	7.8

Notes:

- The values are preliminary and subject to change once analysis of the survey results is complete.
- Source: 2000-2001 NEXT Computerized Tomography Survey.
- Multiple Scan Average Dose (MSAD) values were derived from exposure data collected using a 16 cm diameter, 15 cm long, polymethyl methacrylate head phantom, using the technique factors the facility normally employed for a routine CT head procedure of a typical adult patient. The CT ion chamber was positioned on the axis of rotation within the phantom. For the purpose of comparison to 1990 NEXT MSAD values, a conversion factor of 7.8 mGy/R was used to evaluate MSAD as dose to acrylic obtained from measured values of exposure. A 100 mm long ionization chamber was used for the measurements and there were no corrections for integration range.
- Effective dose values were derived from the values for air kerma measured free-in-air (no phantom present) and published conversion factors were determined by the technique factors used by the facility for a typical adult patient.

Table 6. Fluoroscopic Entrance Exposure Rates and Spot Film ESE

Unit Type	Median EER (R/min)	3rd Quartile EER (R/min)	Single Spot Film Median ESE (mR)	Single Spot Film 3rd Quartile ESE (mR)	Record Mode Median EER (R/min)	Record Mode 3rd Quartile EER (R/min)
Under Table [a] (Phantom without Cu)	5.06	6.96	325	459		
Under Table [a] (Phantom with Cu)	8.54	9.40	2060	3280		
Above Table [b] (Phantom without Cu)	5.18	6.10	246.5	441.8		
Above Table [b] (Phantom with Cu)	9.12	11.22	1315.9	2866.4		
Mobile C-arm [c] (Phantom without Cu)	2.30	3.05			1.66	4.20
Mobile C-arm [c] (Phantom with Cu)	4.50	5.36				
Cardiac Catheterization [d] (Phantom without Cu)	3.45	6.91			17.20	38.48

Footnotes:

a. Entrance Exposures Rates (EER) were calculated at one cm above the tabletop for Under Table Units.

b. EER were calculated at 30 cm above the tabletop for Above Table Units.

c. EER were calculated at 30 cm from image intensifier for mobile C-arm units.

d. EER were calculated at 30 cm from image intensifier with source assembly at minimum source-to-skin distance (SSD) (when equipped with variable SID) for Cardiac Catheterization Units.

Notes:

- Values may be converted to entrance air kerma (mGy) by using the conversion: 0.00876 mGy/mR.
- Source: 1996 NEXT Fluoroscopy Survey (hospitals only).
- Typical patient simulated by 19.3 cm thick lucite plus 0.4 cm aluminum phantom, equivalent to a 21.5 cm patient.
- Typical patient (with barium) simulated by phantom plus 1.6 mm copper (Cu) filter, which simulates a nominal 2 mm thickness of BaSO4 contrast.
- All exposure rates measured free-in-air, using a large image intensifier mode, usually 22.4 cm.
- The resolution of the fluoroscopic imaging system should also be evaluated periodically, whenever deterioration in the imaging system is suspected, and when the measured exposure rate is significantly lower than these values.
- The efficiency of the imaging system should be evaluated when the measured exposure rate significantly exceeds these values.
- The spot film exposures are with a grid and a film-screen speed of 400.

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SUMMARY OF ESE LIMITS BY THE STATES

In 2001 the CRCPD H-7 Committee on Diagnostic X-ray conducted a telephone survey of the states. Each state radiation control program was contacted by a Committee member and asked if they have any patient exposure limits in their regulations. If not, they were asked whether they have maximum ESE values that trigger a written recommendation to investigate the finding.

Tables seven through ten provide a summary of this phone survey.

The Committee encourages all programs to initiate and record ESE measurements in a format similar to that presented in this guide so the Committee can request these data for inclusion in future revisions.

Table 7. ESE Limits in State Regulation for Common Dental Projections (mR)

	IN	IL	LA	MN	NY	OK	OH	OR	SC	TX	VT	VA
D Speed Film												
50 kVp	Consultants Recommend	550	The action level is twice the NEXT average	575	575	600	600	575	690	600	700	575
55 kVp		520		500	500			500	600			500
60 kVp		470		440	440			440	528	450		440
65 kVp		415		400	400			400	480			400
70 kVp		360		350	350			350	420			350
75 kVp		310		260	280			280	312			260
80 kVp		260		230	230			230	276			230
85 kVp		235		200	200			200	240			200
90 kVp		210		180	180			180	216			180
95 kVp		195		160	160			160	192			160
100 kVp		180		140	140			140	168			140
E Speed Film												
50 kVp	Consultants Recommend	280	The action level is twice the NEXT average	320	320	600	300	320	384	600	700	320
55 kVp		250		270	280			280	324			270
60 kVp		220		230	230			230	276	450		230
65 kVp		190		200	200			200	240			200
70 kVp		165		170	170			170	204			170
75 kVp		140		140	140			140	168			140
80 kVp		115		120	120			120	144			120
85 kVp		105		105	105			105	126			105
90 kVp		95		90	90			90	108			90
95 kVp		85		80	80			80	64			80
100 kVp		70		70	70			70	56			70
Cephalometric	Same as above								45			

Notes:

- Source: 2001 H-7 Committee Survey.
- The intraoral values for D and E speed film are for a typical bitewing projection.
- New York does not have the values listed in regulation. The values appear in guidance and when exceeded, they cite the ALARA (as low as reasonably achievable) and QA (quality assurance) regulations.
- Louisiana does not have values listed in regulation. If the measured ESE exceeds twice the NEXT average, the facility is cited under ALARA-related regulations.
- Indiana does not have values listed in regulation. Private inspectors submit recommendation to the state to cite the facility based on "public danger."

Table 8. ESE Limits in State Regulation for Common Medical Projections (mR)

Projection	State										
	IN	**IL**	**LA**	**NY**	**OH**	**OK**	**OR**	**SC**	**TX**	**VT**	**VA**
PA Chest (Grid, 200 Speed)	Consultants Recommend	*35	The action level is twice the NEXT average	30	*40	*35	33	38	*30	*30	*50
PA Chest (Grid, 400 Speed)				18			18	23			
PA Chest (Non-Grid, 200 Speed		*30		18	*30	*30	18	23	*20	*30	*50
PA Chest (Non-Grid, 400 Speed)				6			11	8			
Abdomen (200 speed)		*600		588	*600	*600	620	735	*450	*750	*1100
Abdomen (400 speed)				360			433	450			
Full Spine (200 speed)				312	*400		260	390	*300		
Full Spine (400 speed)				174			145	218			
LS Spine (200 speed)		*800		540	*700	*800	600	675	*550	*1000	*1400
LS Spine (400 speed)				420			487	525			
Thoracic Spine					*400			*612	*325	*900	
Cervical Spine (200 speed)		*200		162	*200	*200	135	203	*120	*250	
Cervical Spine (400 speed)				114			95	142			
Lateral Skull (200 speed)		*250		174	*200	*250	145	218	*150	*300	
Lateral Skull (400 speed)				84			70	105			
D/P Foot		*100			*100			*111	*50		
Retrograde Pyelogram (per AP film)								*893		*900	

Footnote:

* Regulatory dose limit without regard to image receptor speed.

Notes:

- Source: 2001 H-7 Committee Survey.
- New York does not have the values listed in regulation. The values appear in guidance and when exceeded, they cite the ALARA and QA regulations.
- Louisiana does not have values listed in regulation. If the measured ESE is two times the NEXT average, the facility is cited under ALARA-related regulations.
- Indiana does not have values listed in regulation. Private inspectors submit recommendation to the state to cite the facility based on "public danger."

Table 9. Dental ESE Values States Use as Action Limits for Making a Recommendation to Investigate (mR)

	State																		
	AL	**AK**	**AZ**	**CA**	**FL**	**HI**	**IN**	**MA**	**MI**	**MS**	**NM**	**NC**	**ND**	**PA**	**TN**	**UT**	**VT**	**WA**	**WI**
D Speed		See Note a.	See Note b.	See Note c.	500	See Note d.	See Note e.	See Note f.	See Note f.	See Note b.	See Note b.	See Note b.	See Note g.	See Note f.		See Note f.	See Note h.	See Note g.	See Note b.
50 kVp	661.25														450				
55 kVp	575																		
60 kVp	506																		
65 kVp	460														300				
70 kVp	402.5														250				
75 kVp	299																		
80 kVp	264.5																		
85 kVp	230																		
90 kVp	207														150				
95 kVp	184																		
100 kVp	161																		
E Speed																			
50 kVp	368														450				
55 kVp	310.5																		
60 kVp	264.5																		
65 kVp	230														300				
70 kVp	195.5														250				
75 kVp	161																		
80 kVp	138																		
85 kVp	120.75																		
90 kVp	103														150				
95 kVp	92																		
100 kVp	80.5																		
Digital					200														
Cephalometric	17.25				50				25										

Notes are on the next page.

Footnotes, Table 9:

a. Recommendation made if ESE is above the median NEXT value.

b. Recommendation made if ESE is above the average NEXT value.

c. Recommendation made if ESE is 1.5 times the California Average Skin Exposure (CASE).

d. Recommendation made if ESE is 2 times the NEXT average.

e. Recommendation made if private consultant suggests it in an inspection report sent to the state regulatory agency.

f. Recommendation made if ESE is above values listed in HHS Publication No. 85-8245.

g. Recommendation made if ESE is above the values in the CRCPD *Average Patient Exposure/Dose Guide*-1992, CRCPD Publication 92-4.

h. Recommendation made if ESE exceeds 2/3 to 1/2 Vermont regulatory limit.

Notes:

- The intraoral values for D and E speed film are for a typical bitewing projection.
- Source: 2001 H-7 Committee Survey.

Table 10. Medical ESE Values States Use as Action Limits for Making a Recommendation to Investigate (mR)

	AL	AK	AZ	CA	FL	HI	IN	MA	MI	MS	MO	NJ	NM	NC	ND	PA	UT	VT	WA	WI
PA Chest (Grid, 200 Speed)	28.75	See Note a.	See Note b.	See Note c.	*50	See Note d.	See Note e.	35	*25	See Note b.	*35	*5-30	See Note b.	See Note b.	See Note f.	See Note d.	See Note g.	See Note h.	See Note f.	See Note b.
PA Chest (Grid, 400 Speed)	17.25																			
PA Chest (Non-Grid, 200 Speed)	17.25				*50			30	*20		*3 5	*5-30								
PA Chest (Non-Grid, 400 Speed)	11.5																			
Abdomen (200 Speed)	563.5				*700			600												
Abdomen (400 Speed)	345																			
LS Spine (200 Speed)	655.5				*800			800	*500		*800	*100-600								
LS Spine (400 Speed)	379.5																			
C Spine (200 Speed)	155.25				*200			200	*125											
C Spine (400 Speed)	109.25																			
Lat. Skull (200 Speed)	166.75				*200			250												
Lat. Skull (400 Speed)	80.5																			
DP Foot					*60			100	*35			*5-40								
Hand					*20				*15											
Full Spine (200 Speed)	299																			
Full Spine (400 Speed)	166.75																			
AP Retrograde Pylogram					*550															

Notes are on the next page.

Footnotes, Table 10

* Trigger level regardless of the film-screen speed.

a. Recommendation made if ESE exceeds median NEXT value.

b. Recommendation made if ESE exceeds average NEXT value.

c. Recommendation made if ESE exceeds 1.5 times the California Average Skin Exposure (CASE) and film-screen speed is taken into consideration.

d. Recommendation made if ESE exceeds 3rd quartile of NEXT data.

e. Recommendation made if private consultant suggests it in inspection report to state.

f. Recommendation made if ESE exceeds values listed in the CRCPD Publication 92-4 Average Patient Exposure/Dose Guide, 1992.

g. Recommendation made if ESE exceeds data from Utah facilities during 1994-98 survey.

h. Recommendation made if ESE exceeds 2/3 to 1/2 of Vermont regulatory limit.

Note:
Source: 2001 H-7 Committee Survey.

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APPENDIX

Table A-1. Technique/Exposure Guides for the Dental Bitewing Projection

kVp	D-Speed film	E-Speed film
	ESE (mR)	ESE (mR)
50	425-575	220-320
55	350-500	190-270
60	310-440	165-230
65	270-400	140-200
70	240-350	120-170
75	170-260	100-140
80	150-230	90-120
85	130-200	80-105
90	120-180	70-90
95	110-160	60-80
100	100-140	50-70

Notes:

- Source: HHS Publication No. (FDA) 85-8245, August 1985.
- Values may be converted to entrance air kerma (mGy) by multiplying by 0.00876 mGy/mR.
- Exposures are specified as free-in-air exposures without backscatter.
- The bitewing guides represent the range of exposures (under the indicated conditions) that will produce, in the judgment of a panel of experienced dental radiologists, acceptable quality radiographs. The radiographs of a 3M™ dental phantom were produced under well-controlled conditions (in terms of both exposure and processing). The radiographs were taken at 10 mA at the indicated kVp's using a GE 90 II x-ray machine. In the 50-70 kVp range, 1.5 mm Al of filtration was used and in the 75 – 100 kVp range the filtration was 2.5 mm Al.
- Note that the indicated kVp can be significantly different from the actual kVp. If the actual kVp can be determined, use this value when referring to the table, rather than the indicated kVp.

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