ALASKA LEGISLATURE COMMITTEE FILES 1997-1998 8672
9616 SENATE LABOR & COMMERCE

applicable training program sponsored by a manufacturer of dental radiological equipment.

(b) The board may not adopt a standard under this section that is more stringent than a standard applicable under federal law or regulations or that is more strict than a manufacturer's standard that is applicable to the same aspect of the dental radiological equipment except that, if a federal standard is different from the manufacturer's standard on the same subject, the board shall adopt the stricter of the two standards unless adoption of the other standard would not present a risk of harm to the public or to the operator of the equipment.

(c) A dentist may not use, or allow a person under the dentist's supervision to use, dental radiological equipment in this state unless the owner or lessee of the equipment has registered the equipment's control panel with the board and the control panel displays a seal indicating that it has been registered. The board may charge the owner or lessee of the dental radiological equipment a fee for the registration of each control panel registered under this subsection. For each registered control panel, the board shall issue to the owner or lessee a registration seal that indicates that the registration requirement has been met.

(d) The board shall require that inspection of dental radiological equipment occur once within every five calendar years and require that records concerning the inspection be provided to the board by the owner or lessee of the equipment and kept on file where the equipment is located. The board shall, upon application by the owner or lessee of the dental radiological equipment, submission of evidence documenting compliance with the inspection standards of the board, and payment of a fee set by the board, issue to the owner or lessee an inspection seal indicating the date by which the dental radiological equipment must pass inspection again. The date on the inspection seal shall be December 31 of the fourth calendar year that occurs after the calendar year in which the inspection occurred. A dentist may not use, or allow a person under the dentist's supervision to use, dental radiological equipment in this state after the date on the most recent inspection seal.

(e) Fees charged under this section may not be higher than the amount necessary to cover the board's cost of registering a control panel or approving the

inspection of dental radiological equipment, as appropriate, plus the cost of issuing the applicable seals.

(f) Notwithstanding AS 08.01.075 and AS 08.36.315, the only penalty applicable to a licensee for violating this section is the imposition by the board in a disciplinary action of a civil fine not to exceed $5,000 for each violation.

(g) In this section, "dental radiological equipment" means equipment for use in the practice of dentistry, consisting of a control panel and associated tube heads, if the equipment emits electronic product radiation, as defined in AS 18.60.545, or uses radionuclides, as defined in AS 18.60.545.

* **Sec. 2.** AS 18.05 is amended by adding a new section to read:

Sec. 18.05.065. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 3.** AS 18.60.525 is amended by adding a new subsection to read:

(e) AS 18.60.475 - 18.60.545 do not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 4.** AS 44.29 is amended by adding a new section to read:

Sec. 44.29.027. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 5.** AS 44.46 is amended by adding a new section to read:

Sec. 44.46.029. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 6.** AS 46.03 is amended by adding a new section to read:

Sec. 46.03.022. Dental radiological equipment. This title does not authorize

the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 7.** TRANSITIONAL PROVISIONS. (a) All litigation, hearings, investigations, and other proceedings pending under a law amended by this Act, or in connection with functions transferred by this Act, continue in effect and may be continued and completed notwithstanding a transfer or amendment provided for in this Act. Certificates, orders, and regulations issued or adopted under authority of a law amended by this Act remain in effect for the term issued or until revoked, vacated, or otherwise modified under the provisions of this Act. All contracts, rights, liabilities, and obligations created by or under a law amended by this Act, and in effect on the day before the effective date of this Act, remain in effect notwithstanding this Act's taking effect. Records of agencies of the state whose functions are transferred under this Act shall be transferred commensurate with the provisions of this Act.

(b) Notwithstanding other provisions of this Act, the Department of Health and Social Services and the Department of Environmental Conservation may continue to regulate dental radiological equipment and record keeping relating to dental radiological equipment, as defined in AS 08.36.075, added by sec. 1 of this Act, to the same extent that the respective departments were authorized to regulate dental radiological equipment and records on the day before the effective date of this Act until the effective date of regulations adopted by the Board of Dental Examiners to implement AS 08.36.075, added by sec. 1 of this Act.

0-LS0825\P
Lauterbach
3/31/98

CS FOR SENATE BILL NO. 160(L&C)

IN THE LEGISLATURE OF THE STATE OF ALASKA

TWENTIETH LEGISLATURE - SECOND SESSION

BY THE SENATE LABOR AND COMMERCE COMMITTEE

Offered:
Referred:

Sponsor(s): SENATOR TAYLOR BY REQUEST

A BILL

FOR AN ACT ENTITLED

"An Act relating to radiological equipment used in the practice of dentistry."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

*** Section 1.** AS 08.36 is amended by adding a new section to read: deleted Jan 28th

Sec. 08.36.075. Dental radiological equipment. (a) Subject to (b) of this section, the board shall establish standards for the registration and inspection of dental [control panels] radiological equipment, including standards for record keeping relating to the control panels and the use of the equipment. The inspection standards adopted by the board must require that an inspection be performed by a person who has

(1) a degree in medical electronics that is based on a four-year program;

(2) a certificate based on a two-year program in medical electronics and two years of apprentice experience in installing and calibrating dental radiological equipment; or

(3) four years of apprentice experience in installing and calibrating dental radiological equipment and a certificate demonstrating completion of an

applicable training program sponsored by a manufacturer of dental radiological equipment.

(b) The board may not adopt a standard under this section that is more stringent than a standard applicable under federal law or regulations or that is more strict than a manufacturer's standard that is applicable to the same aspect of the dental radiological equipment except that, if a federal standard is different from the manufacturer's standard on the same subject, the board shall adopt the stricter of the two standards unless adoption of the other standard would not present a risk of harm to the public or to the operator of the equipment.

(c) A dentist may not use, or allow a person under the dentist's supervision to use, dental radiological equipment in this state unless the owner or lessee of the equipment has registered the equipment's control panel with the board and the control panel displays a seal indicating that it has been registered. The board may charge the owner or lessee of the dental radiological equipment a fee for the registration of each control panel registered under this subsection. For each registered control panel, the board shall issue to the owner or lessee a registration seal that indicates that the registration requirement has been met.

(d) The board shall require that inspection of dental radiological equipment occur once within every five calendar years and require that records concerning the inspection be provided to the board by the owner or lessee of the equipment and kept on file where the equipment is located. The board shall, upon application by the owner or lessee of the dental radiological equipment, submission of evidence documenting compliance with the inspection standards of the board, and payment of a fee set by the board, issue to the owner or lessee an inspection seal indicating the date by which the dental radiological equipment must pass inspection again. The date on the inspection seal shall be December 31 of the fourth calendar year that occurs after the calendar year in which the inspection occurred. A dentist may not use, or allow a person under the dentist's supervision to use, dental radiological equipment in this state after the date on the most recent inspection seal.

rewritten to make plain

(e) Fees charged under this section may not be higher than the amount necessary to cover the board's cost of registering a control panel or approving the

inspection of dental radiological equipment, as appropriate, plus the cost of issuing the applicable seals.

(f) Notwithstanding AS 08.01.075 and AS 08.36.315, the only penalty applicable to a licensee for violating this section is the imposition by the board in a disciplinary action of a civil fine not to exceed $5,000 for each violation.

(g) In this section, "dental radiological equipment" means equipment for use in the practice of dentistry, consisting of a control panel and associated tube heads, if the equipment emits electronic product radiation, as defined in AS 18.60.545, or uses radionuclides, as defined in AS 18.60.545.

* **Sec. 2.** AS 18.05 is amended by adding a new section to read:

Sec. 18.05.065. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 3.** AS 18.60.525 is amended by adding a new subsection to read:

(e) AS 18.60.475 - 18.60.545 do not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 4.** AS 44.29 is amended by adding a new section to read:

Sec. 44.29.027. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 5.** AS 44.46 is amended by adding a new section to read:

Sec. 44.46.029. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 6.** AS 46.03 is amended by adding a new section to read:

Sec. 46.03.022. Dental radiological equipment. This title does not authorize

the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 7.** TRANSITIONAL PROVISIONS. (a) All litigation, hearings, investigations, and other proceedings pending under a law amended by this Act, or in connection with functions transferred by this Act, continue in effect and may be continued and completed notwithstanding a transfer or amendment provided for in this Act. Certificates, orders, and regulations issued or adopted under authority of a law amended by this Act remain in effect for the term issued or until revoked, vacated, or otherwise modified under the provisions of this Act. All contracts, rights, liabilities, and obligations created by or under a law amended by this Act, and in effect on the day before the effective date of this Act, remain in effect notwithstanding this Act's taking effect. Records, equipment, and other property of agencies of the state whose functions are transferred under this Act shall be transferred commensurate with the provisions of this Act.

(b) Notwithstanding other provisions of this Act, the Department of Health and Social Services and the Department of Environmental Conservation may continue to regulate dental radiological equipment and record keeping relating to dental radiological equipment, as defined in AS 08.36.075, added by sec. 1 of this Act, to the same extent that the respective departments were authorized to regulate dental radiological equipment and records on the day before the effective date of this Act until the effective date of regulations adopted by the Board of Dental Examiners to implement AS 08.36.075, added by sec. 1 of this Act.

0-LS0825\L
~ Lauterbach
2/20/98

CS FOR SENATE BILL NO. 160( )

IN THE LEGISLATURE OF THE STATE OF ALASKA

TWENTIETH LEGISLATURE - SECOND SESSION

BY

Offered:
Referred:

Sponsor(s): SENATOR TAYLOR BY REQUEST

A BILL

FOR AN ACT ENTITLED

"An Act relating to radiological equipment used in the practice of dentistry."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

*** Section 1.** AS 08.36.010 is amended by adding a new subsection to read:

(b) Before appointing or reappointing a licensed dentist to the board, the governor shall consider nominations made by the Alaska Dental Society. The Alaska Dental Society may submit up to three nominees for each applicable vacancy on the board and for each applicable seat on the board if the current member's term is scheduled to expire within the next six months.

*** Sec. 2.** AS 08.36 is amended by adding a new section to read:

Sec. 08.36.075. Dental radiological equipment. (a) Subject to (b) of this section, the board shall establish standards for the registration and inspection of control panels for dental radiological equipment, including standards for record keeping relating to the control panels and the use of the equipment.

(b) The board may not adopt a standard under this section that

(1) duplicates a standard applicable under federal law or regulations;

or

(2) is more strict than a manufacturer's standard that is applicable to the same aspect of the control panel.

(c) A dentist may not use dental radiological equipment in this state unless the owner of the equipment has registered the equipment's control panel with the board and the control panel displays a seal indicating that it has been registered. The board may charge the owner of the equipment a fee for the registration of each control panel registered under this subsection. For each registered control panel, the board shall issue to the owner a seal that indicates that the registration requirement has been met for that specific control panel.

(d) The board shall require periodic inspection of a control panel registered under this section every five years and require that records concerning the inspection of the control panel be provided to the board by the owner of the equipment and kept on file where the equipment is located. The board shall, upon application by the owner of the equipment, submission of evidence documenting compliance with the inspection standards of the board, and payment of a fee set by the board, issue to the owner a seal indicating the date on which the equipment's control panel passed inspection. A dentist may not use dental radiological equipment in this state for more than five years after the date on the most recent seal that indicates that the required inspection of its control panel has occurred.

(e) Fees charged under this section may not be higher than the amount necessary to cover the board's cost of registering or approving the inspection of a control panel, as appropriate, plus the cost of issuing the applicable seal.

(f) Notwithstanding AS 08.01.075 and AS 08.36.315, the only penalty applicable to a licensee for violating this section is the imposition by the board in a disciplinary action of a civil fine not to exceed $5,000 for each violation.

(g) In this section, "dental radiological equipment" means equipment for use in the practice of dentistry if the equipment emits electronic product radiation, as defined in AS 18.60.545, or uses radionuclides, as defined in AS 18.60.545.

* **Sec. 3.** AS 18.05 is amended by adding a new section to read:

Sec. 18.05.065. Dental radiological equipment. This chapter does not

authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 4.** AS 18.60.525 is amended by adding a new subsection to read:

(e) AS 18.60.475 - 18.60.545 do not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 5.** AS 44.29 is amended by adding a new section to read:

Sec. 44.29.027. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 6.** AS 44.46 is amended by adding a new section to read:

Sec. 44.46.029. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 7.** AS 46.03 is amended by adding a new section to read:

Sec. 46.03.022. Dental radiological equipment. This title does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 8.** TRANSITIONAL PROVISIONS. (a) All litigation, hearings, investigations, and other proceedings pending under a law amended by this Act, or in connection with functions transferred by this Act, continue in effect and may be continued and completed notwithstanding a transfer or amendment provided for in this Act. Certificates, orders, and regulations issued or adopted under authority of a law amended by this Act remain in effect for the term issued or until revoked, vacated, or otherwise modified under the provisions of this Act. All contracts, rights, liabilities, and obligations created by or under a law amended by this Act, and in effect on the day before the effective date of this Act, remain in effect

notwithstanding this Act's taking effect. Records, equipment, and other property of agencies of the state whose functions are transferred under this Act shall be transferred commensurate with the provisions of this Act.

(b) Notwithstanding other provisions of this Act, the Department of Health and Social Services and the Department of Environmental Conservation may continue to regulate dental radiological equipment and record keeping relating to dental radiological equipment, as defined in AS 08.36.075, added by sec. 2 of this Act, to the same extent that the respective departments were authorized to regulate dental radiological equipment and records on the day before the effective date of this Act until the effective date of regulations adopted by the Board of Dental Examiners to implement AS 08.36.075, added by sec. 2 of this Act.

0-LS0825\P
Lauterbach
3/31/98

Post-it® Fax Note 7671	Date 3-31-98	# of pages ▶ (4)
To CATHERINE REARDON	From J. Knight	
Co./Dept.	Co. (5) L&C	
Phone #	Phone # 465-3814	
Fax #	Fax #	

CS FOR SENATE BILL NO. 160(L&C)

IN THE LEGISLATURE OF THE STATE OF ALASKA

TWENTIETH LEGISLATURE - SECOND SESSION

BY THE SENATE LABOR AND COMMERCE COMMITTEE

Offered:
Referred:

Sponsor(s): SENATOR TAYLOR BY REQUEST

A BILL

FOR AN ACT ENTITLED

"An Act relating to radiological equipment used in the practice of dentistry."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

*** Section 1.** AS 08.36 is amended by adding a new section to read:

Sec. 08.36.075. Dental radiological equipment. (a) Subject to (b) of this section, the board shall establish standards for the registration and inspection of dental radiological equipment, including standards for record keeping relating to the control panels and the use of the equipment. The inspection standards adopted by the board must require that an inspection be performed by a person who has

(1) a degree in medical electronics that is based on a four-year program;

(2) a certificate based on a two-year program in medical electronics and two years of apprentice experience in installing and calibrating dental radiological equipment; or

(3) four years of apprentice experience in installing and calibrating dental radiological equipment and a certificate demonstrating completion of an

applicable training program sponsored by a manufacturer of dental radiological equipment.

(b) The board may not adopt a standard under this section that is more stringent than a standard applicable under federal law or regulations or that is more strict than a manufacturer's standard that is applicable to the same aspect of the dental radiological equipment except that, if a federal standard is different from the manufacturer's standard on the same subject, the board shall adopt the stricter of the two standards unless adoption of the other standard would not present a risk of harm to the public or to the operator of the equipment.

(c) A dentist may not use, or allow a person under the dentist's supervision to use, dental radiological equipment in this state unless the owner or lessee of the equipment has registered the equipment's control panel with the board and the control panel displays a seal indicating that it has been registered. The board may charge the owner or lessee of the dental radiological equipment a fee for the registration of each control panel registered under this subsection. For each registered control panel, the board shall issue to the owner or lessee a registration seal that indicates that the registration requirement has been met.

(d) The board shall require that inspection of dental radiological equipment occur once within every five calendar years and require that records concerning the inspection be provided to the board by the owner or lessee of the equipment and kept on file where the equipment is located. The board shall, upon application by the owner or lessee of the dental radiological equipment, submission of evidence documenting compliance with the inspection standards of the board, and payment of a fee set by the board, issue to the owner or lessee an inspection seal indicating the date by which the dental radiological equipment must pass inspection again. The date on the inspection seal shall be December 31 of the fourth calendar year that occurs after the calendar year in which the inspection occurred. A dentist may not use, or allow a person under the dentist's supervision to use, dental radiological equipment in this state after the date on the most recent inspection seal.

(e) Fees charged under this section may not be higher than the amount necessary to cover the board's cost of registering a control panel or approving the

inspection of dental radiological equipment, as appropriate, plus the cost of issuing the applicable seals.

(f) Notwithstanding AS 08.01.075 and AS 08.36.315, the only penalty applicable to a licensee for violating this section is the imposition by the board in a disciplinary action of a civil fine not to exceed $5,000 for each violation.

(g) In this section, "dental radiological equipment" means equipment for use in the practice of dentistry, consisting of a control panel and associated tube heads, if the equipment emits electronic product radiation, as defined in AS 18.60.545, or uses radionuclides, as defined in AS 18.60.545.

* **Sec. 2.** AS 18.05 is amended by adding a new section to read:

Sec. 18.05.065. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 3.** AS 18.60.525 is amended by adding a new subsection to read:

(e) AS 18.60.475 - 18.60.545 do not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 4.** AS 44.29 is amended by adding a new section to read:

Sec. 44.29.027. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 5.** AS 44.46 is amended by adding a new section to read:

Sec. 44.46.029. Dental radiological equipment. This chapter does not authorize the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 6.** AS 46.03 is amended by adding a new section to read:

Sec. 46.03.022. Dental radiological equipment. This title does not authorize

the department to register, inspect, test, or otherwise regulate dental radiological equipment or records relating to dental radiological equipment regulated by the Board of Dental Examiners under AS 08.36.075.

* **Sec. 7.** TRANSITIONAL PROVISIONS. (a) All litigation, hearings, investigations, and other proceedings pending under a law amended by this Act, or in connection with functions transferred by this Act, continue in effect and may be continued and completed notwithstanding a transfer or amendment provided for in this Act. Certificates, orders, and regulations issued or adopted under authority of a law amended by this Act remain in effect for the term issued or until revoked, vacated, or otherwise modified under the provisions of this Act. All contracts, rights, liabilities, and obligations created by or under a law amended by this Act, and in effect on the day before the effective date of this Act, remain in effect notwithstanding this Act's taking effect. Records, equipment, and other property of agencies of the state whose functions are transferred under this Act shall be transferred commensurate with the provisions of this Act.

(b) Notwithstanding other provisions of this Act, the Department of Health and Social Services and the Department of Environmental Conservation may continue to regulate dental radiological equipment and record keeping relating to dental radiological equipment, as defined in AS 08.36.075, added by sec. 1 of this Act, to the same extent that the respective departments were authorized to regulate dental radiological equipment and records on the day before the effective date of this Act until the effective date of regulations adopted by the Board of Dental Examiners to implement AS 08.36.075, added by sec. 1 of this Act.

Alaska State Legislature
Senate

Official Business

State Capitol
Juneau, AK. 99801-1182

Senate Labor & Commerce Committee

Memo

TO: Terri Lauterbach, Legal Counsel
Legislative Research and Legal Services
via fax: X 2029 three pages (including attachment)

FROM: Annette Kreitzer, Aide to
Senate Labor & Commerce Committee
PH: X 3844

DATE: March 29, 1998

RE: CS SB 160 (L&C) - For 4/1/98

Please prepare a Senate Labor & Commerce Committee substitute using Work Draft LS0825\L by Lauterbach dated 2/20/98 as the base document, and incorporate the following changes:

1) Delete Section 1 related to the Alaska Dental Society making nominations for appointments to the Dental Board; and renumber the following sections.

2) Delete all references to inspecting control panels in Sec. 08.36.075. The intent of this section is that the dental radiological equipment be inspected and the control panel display a seal indicating that it also has been registered. (See attached, rewritten AS 08.36.075.)

3) With respect to the rewritten version and the Work Draft LS0825\L, on page 2, subsection (d) The board shall require periodic inspection...
This subsection needs to be clear that the periodic inspections are done by a radiological technician with the following credentials:

a) four-year degree in Medical Electronics or

b) two-year certificate in Medical Electronics plus two years of apprentice experience installing and calibrating dental radiologic equipment, or

c) four years apprentice experience installing and calibrating dental radiologic equipment plus applicable manufacturers' training and certificate.

This may necessitate a new section laying out these qualifications, but when I read (d), I say The board shall require periodic inspection (BY WHOM???).

4) With respect to the rewritten version and the Work Draft LS0825\L, on pages 1-2, Sec. 08.36.075 (b)(1) The board may not adopt a standard duplicating a federal law... Change this so that the board may not adopt a standard more stringent than a federal law or regulation. (b)(2) Where the federal standard and the manufacturer's standard are different, the board shall adopt the stricter standard, unless there is no threat of harm to the public involved. In other words, if the federal standard is only a paperwork standards - that doesn't carry the same weight as a difference in a recommended dose of radiation.

5) Page 2, lines 4-9 and Page 2, lines 18-20 of Work Draft LS0825\L: A dentist or anyone under the dentist's supervision.

6) Throughout Sec. 08.36.075, the bill refers to the "owner" of the dental radiological equipment. There is no provision for a lessee. This may be the case in some parts of Alaska, where a clinic leases a piece of equipment, but doesn't own it. The Department suggested a sentence on Page 1, Line 13, following "use of the equipment": Only owners or lessees of dental radiological equipment shall be required to register. I am comfortable with just adding the words "or lessee" following "owner" wherever applicable.

7) Page 2, lines 11-12: Is it clearer to say:
The board shall required [PERIODIC] inspection of dental radiological equipment registered under this section once within every five calendar years...

8) Throughout the proposed language (attachment) is the phrase "dental radiological equipment" or some derivative - use the phrase: "dental radiological equipment".

9) Page 2, Lines 11-20 (d): Please add within this paragraph:
An inspection cycle ends on December 31 of the fifth calendar year counting the year the inspection was conducted.

and
The board shall, upon application by the owner or lessee of the equipment, submission of evidence documenting compliance with the inspection standards of the board, and payment of a fee set by the board, issue to the owner or lessee a seal indicating the date on which the dental radiological equipment's [PASSED] approved inspection period will expire. A dentist, or anyone under the dentist's supervision, may not use dental radiological equipment in this state [FOR MORE THAN FIVE YEARS AFTER THE DATE ON THE MOST RECENT SEAL THAT INDICATES THAT THE REQUIRED] if the approved inspection period listed on the seal has [OCCURRED]expired.

Please call me if you have questions.

Sec.08.36.075. Dental radiological equipment. (a) Subject to (b) of this section, the board shall establish standards for the registration and inspection of dental radiological equipment, including standards for record keeping relating to the use of the equipment.

(b) The board may not adopt a standard under this section that

(1) duplicates a standard applicable under federal law or regulations; or

(2) is more strict than a manufacturer's standard that is applicable to the same aspect of the radiological equipment.

(c) A dentist may not use dental radiological equipment in this state unless the owner of the equipment has registered the equipment with the board and the control panel for said equipment displays a seal indicating that it has been registered. The board may charge the owner of the equipment a fee for the registration of each control panel registered under this subsection. For each registered control panel, the board shall issue to the owner a seal that indicates that the registration requirement has been met.

(d) The board shall require periodic inspection of radiological equipment registered under this section every five years and require that records concerning the inspection of said equipment be provided to the board by the owner of the equipment and kept on file where the equipment is located. The board shall, upon application by the owner of the equipment, require submission of evidence documenting compliance with the inspection standard of the board, and payment of a fee set by the board, issue to the owner a seal indicating the date on which the dental radiological equipment passed inspection. A dentist may not use dental radiological equipment in this state for more than five years after the date on the most recent seal.

(e) Fees charged under this section may not be higher than the amount necessary to cover the board's cost of registering or approving the inspection of radiologic equipment, as appropriate, plus the cost of issuing the applicable seal.

(f) Notwithstanding AS 08.01.075 and AS 08.36.315, the only penalty applicable to a licensee for violating this section is the imposition by the board in a disciplinary action of a civil fine not to exceed $5,000 for each violation.

(g) In this section, "dental radiological equipment" means equipment for use in the practice of dentistry consisting of a control panel and associated tube heads, if the equipment emits electronic product radiation, as defined in AS 18.60.545, or uses radionuclides, as defined in AS 18.60.545.

Educational criteria for technicians hired to inspect and calibrate dental radiological equipment shall consist of one of the following:

1. A four year degree in Medical Electronics

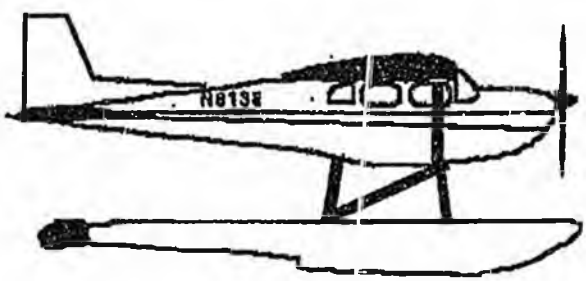
2. A two year certificate in Medical Electronics, plus two years of experience installing and calibrating dental radiologic equipment

3. Four years experience installing and calibrating dental radiologic equipment plus applicable manufacturers's training and certificate.

TIM WOLLER DDS 3529 College Rd #205
Fairbanks, Ak 99709

FAX

907-479-5786



DESTINATION Mel at Sen. Robin Taylors office

FAX NUMBER 465-3922

DATE 3/25/98 Rewording for SB160 Educational Criteria for dental x-ray inspectors

PLS CALL MEL

Notes on Work Draft dated: 2/20/98 CSSB 160

Page 1

Line 13 ...relating to the control panels and the use of the equipment. Only owners or lessors of radiological equipment shall be required to register.

Note: Lessors should be included in the terminology as some people may simply lease equipment (i.e., never "own" it). Who would we really require to register the equipment? The company back East who shipped it to Alaska and set it up or the person who is paying the monthly lease payments?

Line 15 CONCERN: The board would want likely want to adopt the federal standards. This does not allow the board to duplicate federal law or regulations.

Page 2

Line 2 CONCERN: This prohibits stricter standards than the "manufacturers" standard. What if the manufacturer's standard is lower than the federal standard?

Lines 4 through 9: (c) A dentist or anyone under the dentist's supervision, may not use dental radiological equipment in this state unless the owner or lessor of the equipment has registered the equipment's control panel with the board and the control panel displays a seal indicating that it has been registered. The board may charge the owner or lessor of the equipment a fee for the registration of each control panel registered under this subsection. For each registered control panel, the board shall issue to the owner or lessor a seal that indicates that the registration requirement has been met...

Line 11 - 20 (d) The board shall require [periodic] inspection of a control panel registered under this section once within every five calendar years and require that records concerning the inspection of the control panel be provided to the board by the owner or lessor of the equipment and kept on file where the equipment is located. An inspection cycle will end on December 31 of the fifth calendar year counting the year the inspection was conducted. The board shall, upon application by the owner or lessor of the equipment, submission of evidence documenting compliance with the inspection standards of the board, and payment of a fee set by the board, issue to the owner or lessor a seal indicating the date on which the equipment's control panel's [passed] approved inspection period will expire. A dentist, or anyone under the dentist's supervision, may not use dental radiological equipment in this state [for more than five years after the date on the most recent seal that indicates that the required] if the approved inspection period listed on [of] it's control panel has [occurred] expired.

NOTE: The above is intended to set up a five year inspection cycle with all certifications ending at the same time for a calendar year. This will allow the board to notify dentist of equipment dates of certification throughout the state. Will assist traveling dentists.

DCED

Line 25 Concern that offenses should be allowed to be used as unprofessional conduct. Need to discuss further. Maybe a "first" offense could be agreed to not warrant license action, but subsequent violations should be considered unprofessional conduct. Is it agreed that a violation by an employee (someone under the dentists supervision) constitutes a violation for the dentist?

Other Concerns

- Standards for inspectors. Maryland "licenses" inspectors who are allowed to inspect equipment in their state. Extensive education is required, which manufacturer's representatives may not have. Provision should be made to revoke certification of equipment if fraudulent documents are submitted.

- Costs which will be incorporated into the FEE for owners/lessors will include:

Staff Time
- -development of regulations
- -time spent in registration of equipment
- -time spent answering questions from owners/lessors
- -time spent pulling/mailing rosters and enforcement notices
- -time spent investigating and prosecuting violations

Copying/Printing
- -printing stickers
- -Printing rosters
- -printing registrations

Postage
- Mailing rosters and stickers

Phones
- Calls directly related to the owner/lessor

- How would dentists licensed under AS 08.36, but who work for PHS and/or on a federal facility be affected? If the federal facility does not register their equipment under this bill--could the dentists be considered in violation?

March 18, 1998

TO: SENATE LABOR & COMMERCE COMMITTEE
Senator Loren Leman, Chairman

Sirs:

Please copy and distribute to each listed member of committee for their review.

Thank you.

Fred

Floyd F. (Fred) Bouse, DDS

FLOYD F. "FRED" BOUSE, DDS
Family Dentistry

March 16, 1998

TO: SENATE LABOR & COMMERCE COMMITTEE
Senator Loren Leman, Chairman

Also: Senator Lyman Hoffman, Senator Tim Kelly, Senator Jerry Mackie, Senator Mike Miller, Senator Robin Taylor

Dear Sirs,

Enclosed is a copy of a letter sent to Senator Bert Sharp and others on March 5, regarding the issues surrounding SB 160.

I have previously written letters of concern and made phone calls to Dept. of Health & Social Services, protesting lack of services and encouraging a more rational approach to effective maintenance of dental office radiographic equipment.

On January 27, 1998, that same department sent a letter to me and others (copy enclosed) in which I was accused of "continuously" overexposing my patients. This slanderous statement was made in spite of the fact that no department representative has been in my office in at least seven years (please see middle paragraph of letter from Health & Social Services to me). This kind of knee-jerk reaction, by people in responsible position, has no place in the professional health-care system in our great state - or any other state. It is more a <u>defensive over-reaction</u> to my criticism of the department's ineffectiveness and excessive cost.

How would you personally feel about my office, i.e. my personal radiological skills, the training level of my staff, the technical state of my radiographic equipment, if you had read this letter from Health & Social Services (dated January 27, 1998)? Let me suggest that not only would you not want my dental services, but rather you would <u>flee</u> in order to avoid being "over-exposed".

This accusatory letter is now a matter of public document, having been disseminated by K. Coleman and staff. Such a public condemnation of my professional acumen should be backed by a <u>thorough</u> investigation,, not simply a follow-up check, seven years after the fact.

So, then, we have either a woefully inadequate department, who knows of a serious public health threat ("...continously..over exposed") and fails to correct the problem <u>or</u> we have a department that egregiously over-reacts to situations and writes accusatory letters with language inserted that is far beyond the realm of studied and controlled professionalism. I am embarrassed and I am hurt personally. There could even be financial, economic loss suffered to my family and me, due to

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this situation - all based on questionable data, no more current that at least seven years.

We need change in this regard of monitoring/certifying radiographic equipment in the dental office. These folks at H&SS are making issue of problems that are irrelevant to good health care; we dental surgeons are paying for inspections we don't need and don't get. The recent letter from H&SS is a perfect example of an under-informed, over-reacting, politically posturing staff.

We in the dental profession are dedicated to maintenance of our facilities, and especially our radiographic equipment, in first-rate, state-of-the-art condition. Let me encourage you to push through on SB160. This legislation address these issues and makes possible a far more responsive management of dental practice equipment. Health & Social Services will be able to focus better in other areas of (real) concern, the cost to the state will be greatly reduced and the health needs of the people of our state will be better served.

We deeply appreciate the efforts that have gone into this effort. If I personally may be of any assistance in this matter, please do not hesitate to call.

Yours in Service,

Fred

Floyd F. (Fred) Bouse, DDS

FFB/sb

STATE OF ALASKA

TONY KNOWLES, GOVERNOR

DEPT. OF HEALTH AND SOCIAL SERVICES

DIVISION OF PUBLIC HEALTH

STATE PUBLIC HEALTH LABORATORIES
OFFICE OF RADIOLOGICAL HEALTH
P.O. BOX 110613
JUNEAU, ALASKA 99811-0613
PHONE: (907) 465-3019
FAX: (907) 465-2088

January 27, 1998

Floyd F. Bouse, DDS
Gentle Dental Care
Geist Professional Building
3745 Geist Road
Fairbanks, Alaska 99709

Dear Dr. Bouse,

Thank you for taking the time to write and express your opinions regarding the frequency of dental x-ray equipment on site inspections. We share your concerns. Clyde Pearce, a full-time x-ray inspector stationed in Anchorage, was hired in May 1997. With the addition of Mr. Pearce, we anticipate a three-year cycle to inspect all facilities with x-ray equipment in the state.

Mr. Pearce will be inspecting your facility on February 23 at 9 AM and will evaluate whether the previous safety issues have been corrected. The reports from previous on site inspections of your facility are enclosed. The inspection reports reflect that patients in your office have continually been over exposed. The inspection reports are yours to distribute to the individuals you copied in your letter should you so desire. It is the responsibility of the owner of the x-ray equipment to take the necessary measures to ensure their equipment is operating safely. A copy of the regulations is included.

The Commissioner of the Department of Health and Social Services was directed to establish reasonable fees for service in 1986 when the legislature passed AS 44.29.022. Enclosed is the 1993 Proposed Fee Schedule Documentation, which provides an explanation of the current fee schedule.

Please feel free to contact me if you have further questions.

Sincerely,

K.A. Coleman
Radiological Health Specialist

Alaska State Legislature

Chairman,
Judiciary Committee

Member,
Resources Committee
Rules Committee
Committee on Committees

State Capitol
Juneau, Alaska 99801-1182
(907) 465-3873
Fax: (907) 465-3922

352 Front Street
Ketchikan, Alaska 99901
(907) 225-8088
Fax: (907) 225-0713

Senator Robin L. Taylor
Senate Majority Leader

SPONSOR STATEMENT

SENATE BILL 160

Senate Bill 160 changes the procedures for inspecting and registering dental radiological equipment. Current procedures are erratic and inutile. On-site inspections by the Department of Health and Social Services are unnecessary because the incidence of x-ray overexposure has been so insignificant as to be non-existent.

Inspections and needed adjustments are routinely performed by trained dental supply company technicians who are far more qualified to perform such inspections than representatives from the Department.

SB 160 will place the registration of dental radiological equipment with the Board of Dentistry. The owner of the equipment will be responsible for providing documentation to the Board that the equipment is registered and has been inspected within the past five years. The Board will establish inspection criteria.

Under SB 160, if a dentist uses unregistered or uninspected equipment, they will be subject to a civil penalty in the form of a fine, levied by the Board, not to exceed $5000 for each offense.

Gentle Dental Care

FLOYD F. "FRED" BOUSE, DDS
Family Dentistry

Post-it® Fax Note 7671	Date 5/5/98	# of pages ▶ 1
To Senator R. Taylor	From Dr Fred Bouse	
Co./Dept.	Co.	
Phone #	Phone #	
Fax # 907-465-3923	Fax # 907-474-8488	

March 5, 1998.

Senator Robin L. Taylor
State Capitol - Room 516
Juneau, AK

Dear Sirs,

We in the dental profession very much appreciate your efforts regarding SB160.

I personally wrote letters of protest about this matter several years ago and again recently. The letters were sent to the Department of Health and Social Services in Juneau.

The last time my office was inspected was seven years ago or so - fees paid to the Department of Health & Social Services have increased to 250% of original fees, yet helpful inspection of my facility has been sporatic-to-non-existent. Only after a recent letter I wrote, in which I protested a lack of services (from Health and Social Services Radiology Dept.) did I have my radiological equipment examined by a state employee. I personally desire and invite intelligent, helpful involvement of the appropriate parties in the maintenance of my equipment in first-rate, state-of-the-art condition.

The State of Alaska has been woefully negligent in its duty to the dental profession regarding radiological inspections: negligent not because we need inspections, but because we were promised inspections, we paid for inspections and then never or hardly ever get what we are paying for.

A much more effective and responsive solution to this matter is addressed by SB160. Let me encourage you to proceed and prevail in this matter.

Thank you for taking time to read my note.

Yours in service,

Floyd F. Bouse, DDS

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LEGISLATIVE INFORMATION OFFICE
119 N. CUSHMAN, SUITE 101
FAIRBANKS, AK 99701
452-4448

AK. burned
Dist. 3-6-98

DATE: 3/5/98

Please accept the enclosed original(s) of written testimony for the

Senate L+C (SB 160) teleconference scheduled on

3/5/98. A copy of this testimony was transmitted to your committee via fax.

Thank you,

Traci Tilton

Helmbrecht Dental
MICHAEL J. HELMBRECHT, D.D.S.

421 Third Street Fairbanks, Alaska 99701 (907) 456-1237 FAX (907) 452-4778

March 5, 1998

TO WHOM IT MAY CONCERN:

The following is a copy of a letter sent to Senator Robin Taylor in rebuttal to the Department of Health and Social Services attempt to justify state sponsored x-ray inspections.

March 26, 1997

Senator Robin Taylor
State Capitol
Juneau, Alaska 99801-1182

Dear Senator Taylor,

I have received a copy of the letter sent to your office by Dr. Peter Nakamura, commissioner of the Department of Health and Social Services. I am grateful for this opportunity to correct his misleading claims.

Alaska's current system is outdated and technologically incapable of meaningful inspection. We can modernize x-ray inspection techniques to reflect the current technology used in x-ray equipment and film processing while maintaining the same high standards for public safety that the dentists in this state have always had. At the same time we can cut the unneeded expense and bureaucracy that has been a burr in the saddle of dentistry since inspections began in 1988.

I will explain what is currently required but first I must dissect each of Dr. Nakamura's paragraphs to correct his erroneous claims.

Paragraph #1

The Department's first paragraph claims that Alaska's x-ray inspection fees are commensurate with other states in the Northwest. Each figure the Department sites is wrong and misleading..

The correct breakdown is provided:

1) ALASKA:

The current fee in Alaska is $50.00 per x-ray source per year. To compare accurately, let's see what our office with eleven x-ray sources would pay in each state.

Currently we pay $550.00 per year to Alaska

2) WASHINGTON:

The Department reported the fee accurately for Washington, however, you were told it was an annual fee when in fact it is a bi-annual fee. This in effect cuts the cost in half.

Cost for our office: $255.00 per year to Washington

3) OREGON:

The Department reports an $87.00 per control panel bi-annual fee. Of course the layman would not distinguish between "control panel" and "x-ray source". In actuality one control panel can control up to four x-ray sources. Our office has three control panels. Most dental offices have one control panel.

Cost for our office: $130.00 per year to Oregon

4) MONTANA:

The Department reports a $100 per tube per year fee for Montana. The truth is that Montana has no routine inspection nor do they have an annual fee. They will inspect a newly installed x-ray head before it is put in service. The fee for this service is a one-time fee of $100.00.

Cost for our office: $0.00 per year to Montana

I'd like to know where the Department is getting it's data.

Paragraph #2

This paragraph from the Department's letter basically deals with two different topics. The first is the Inspector's educational qualifications. The Department states that the Inspector exceeds the qualifications necessary for her job, but the Department falls short of giving us the Inspector's qualifications. Recruitment Bulletin #122-94 for the State of Alaska lists minimum educational qualifications for a Radiological Health Specialist as: Bachelor's degree or the equivalent in radiological health, health physics, physics, chemistry, environmental science, or a closely related field. The state would not provide us with the Inspector's curriculum vitae, but we are reasonably sure the Inspector holds a degree in "environmental science". In checking with several universities, we found that this is a liberal arts degree with a curriculum emphasis in humanities. It should be noted that the Inspector's predecessor was a radiological physicist. It certainly would be preferable to have an inspector who has a thorough scientific background in radiology, not one who has been educated in ravages of pollution and mans desecration of the earth. Its like having the IRS prepare your taxes when the interpretation of regulations becomes a point of contention. It would be necessary to make changes in the minimum qualifications for the position of Radiological Health Specialist if we are to maintain state-sponsored x-ray inspections.

The second topic in paragraph #2 deals with the Inspector's presentation to the Alaska Dental Society meeting in August. The minutes reflect the current planned expansion of her office to include another full-time inspector for the Anchorage area. Also, the Inspector reported that there hasn't been a consistent pattern of inspection for the last six years. Instead of helping build another bureaucratic dynasty, the citizens of Alaska deserve a safer, more predictable, and less costly system of x-ray inspection.

Paragraph #3

The Department's third paragraph deals with an x-ray inspection of our office in 1993. I mistakenly reported no inspection for at least ten years in an earlier letter. In fact an inspector visited while we were out of town. Our biomedical equipment technician, Dan Anderson, handled the reported "items of non-compliance" as stated in the September 10, 1993 report. Mr. Anderson couldn't find any "unattached chords" or "drifting tube heads" as the report indicated. No corrective measures could be taken. The matter was never brought to my attention and thus the inaccurate report in my first letter for which I apologize. It should be noted that the inspection described above cost my patients $2,750.00 if we assume one inspection every five years.

Paragraph #4

This paragraph is misleading because it doesn't define "overexposure". X-ray dose equivalents are measured in rems. Currently the federal government standards allow for an individual to receive 5 rems per year with no harmful effects. Most "overexposures" of x-ray film is measured in mrem (millirems). If one millirem is used to expose a film more than is necessary, then the film is "overexposed". However, it would take more than 5,000 of these millirems per year just to receive the dose equivalent allowed by the federal government. In fact, the amount of x-radiation the average person receives from dental x-rays is one-tenth the amount of radiation he receives from consumer products within the home. According to the head design engineer at Gendex (the leading manufacturer of dental x-ray equipment) the types of x-ray sources used in dental offices are incapable of emitting harmful doses of radiation. This incapability is required to meet the strict performance standards set by the FDA.

Also materially misleading the Department includes dental x-rays with medical x-rays. The graph he provided speaks only to medical x-rays. It should be noted that x-ray dosage for diagnosis is tiny compared to that used for therapeutics (eg: treating leukemia). In dentistry, we only use x-rays for diagnosis (very small doses).(see figure 1.) Also, the study from which the Department took their pie chart specifically states that dental x-ray dosages are so minute that they are not included in the statistic of "Medical X-rays".

The Department goes on to state that the over exposure potential in Alaska is "extreme" since we lack regulation requiring dentists to post proper x-ray technique guidelines in our offices. This is incorrect. Today's x-ray equipment cannot produce harmful doses. Proper technique in taking x-rays is the only way to acheive a good result so it is in our best interest as well as the patients to follow proper procedure. To date, not one instance of any adverse reaction to dental x-rays has been reported in the United States before or after x-ray inspection began. In fact if there was a risk it would be to the dental office personnel who are around dental x-rays everyday. The National Council on Radiation Protection and Measurements (NSRP) currently recommends a maximum permissible dose equivalent from occupational sources of 5 rem per year as described earlier. When 231 dental personnel in 72 private offices were studied, a mean one month exposure of .01rem (range of .005 to .06 rem) was reported in the study. This means it would take approximately 83.3 to 1000 months to exceed the current annual (12 month) federal standard of 5 rems if you worked in a dental office. It should be noted that this study was done before Alaska even had a dental inspection program. I remain curious as to the problem that the bureaucracy is trying to fix.

There is ample evidence of adverse effects of radiation in sufficient doses. However, there is no proof of such effects from doses employed in dental practice! Recent analysis suggest that cancer risk to a patient from a dental radiographic examination is on the order of one in a million; the genetic risk is substantially less, about one in a billion. So lets look at other things people do in their daily life that have an order of magnitude of risk similar to a whole series of dental x-rays.

Table 8 ■ Situations in which a person has a one in a million risk of dying.*

Risk situation	Cause of fatality
Being a man, age 00, for 20 minutes	Cardiovascular disease, cancer
Living in New York for two days	Air pollution
Living in Denver for two months	Cosmic radiation
Living in a stone building for two months	Natural radioactivity
Drinking water in Miami for one year	Carcinogens
Living near a polyvinyl chloride plant for ten years	Carcinogens
Riding in a canoe for six minutes	Accident
Riding a bicycle for ten miles	Accident
Riding in a car for 300 miles	Accident
Traveling by airplane for 1,000 miles	Accident
Traveling by airplane for 8,000 miles	Cosmic radiation
Working in a coal mine for one hour	Black lung
Working in a coal mine for three hours	Accident
Working in a typical factory for ten days	Accident
Smoking cigarettes, 1.4	Cardiovascular disease, cancer
Drinking wine, 500 cc	Cirrhosis
Drinking diet soda, 30 cans	Carcinogens

*Data from Parkin[9] and Wilson [1]

Paragraph #5

Here the Department erroneously describes the maintenance capabilities of technicians typically hired to work on dental equipment. Dan Anderson is the biomedical equipment technician I referred to earlier. He uses a $3,000.00 meter capable of 2% resolution on kV measurements that he uses on our x-ray equipment. According to Dan, he doesn't know of any equipment technician who doesn't have instrumentation for measuring kVP as the Department states. Fred Lane from Burkhart Dental Supply in Anchorage agreed with Dan Anderson's statements.

Also, the Department leads one to believe that a dentist would intentionally alter their x-ray equipment to perform differently than the stringent federal requirements. This simply does not happen. There is not one case to support this claim. A dentist would have no reason to alter his x-ray equipment nor would most dentists be technically capable of altering x-ray equipment.

To address quality assurance for x-ray film processing, these days its all automatic with state-of-the-art processors that maintain proper temperature and replenish solutions automatically. These processors on occasion require some service in which case dentists typically rely on a biomedical equipment technician, never an environmental scientist.

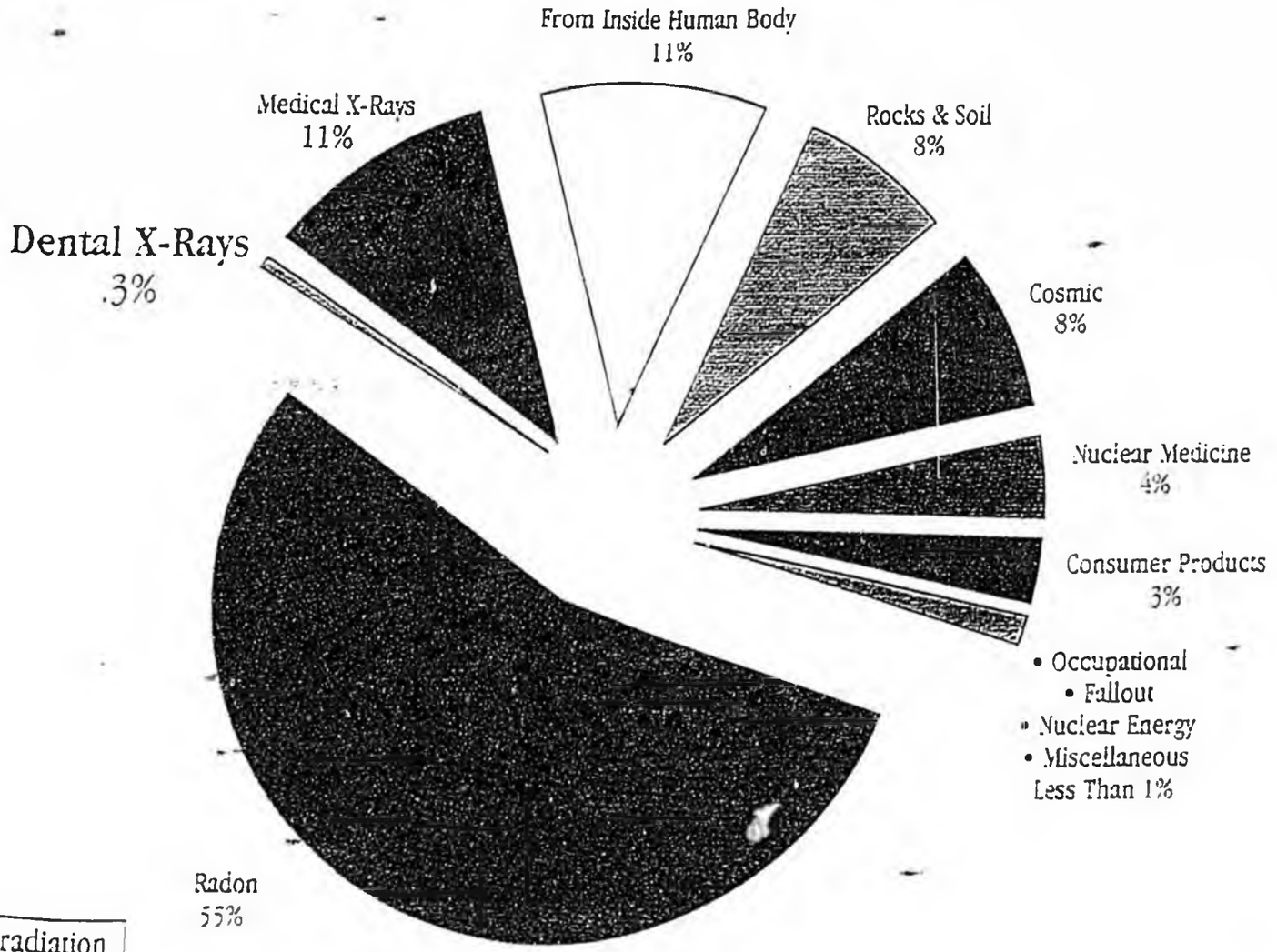
Paragraph 6

The following conclusion of the Department's letter attempts to justify bureaucratic fees for x-ray inspection.

> "Presuming that one million x-ray procedures are performed each year in Alaska and as a result of state inspection each exposure is reduced by 10 millirem (.01 rem): then 10,000 rem are saved each year, the equivalent of one theoretical life. The question becomes how much is it worth to save a life? Fifty dollars per tube soon becomes a very insignificant investment."

Certainly you can understand dentistry's frustration when we are dealing with this type of reasoning. This incorrectly assumes that all dental x-ray procedures would be overexposed and that state inspections would somehow reduce this intentional overexposure. Next the Department incorrectly assumes that all the alleged harmful effects to each person can somehow be added together to save a "theoretical life". Basically what the Department is saying is that if 10,000 mosquito bites could kill you, and the average person receives four mosquito bites on an average evening in Alaska, then we should have a bureaucrat fly around the state picking one mosquito off the 10,000 different Alaskans to somehow save one "theoretical life". Also the fifty dollar cost the Department refers to translates into $2,750.00 per inspection for our office (assuming one inspection every five years), or $2,250,000.00 for the dental patients in Alaska to pay during my practicing career.

Sources of Radiation Dose



Estimated annual radiation dose of 360 Millirem for an average person.

Source: National Council on Radiation Protection and Measurements

CONCLUSION

Our current system of dental x-ray inspection is broken. It is no longer cost effective or in the publics best interest. There is no need for government inspections of dental x-ray machines since the amount of radiation is so minute there is no chance of harm.

We have basically two problems from the state level that can easily be solved. The first problem is a department which by there own admission hasn't had personnel to do consistent inspections in over six years. Since dental x-ray units comprise over 50% of the units that the department inspects, but emit only .3% of the radiation that Alaskans receive (see figure 1) we can transfer authority to regulate these units to the dental board of examiners just as we do with continuing education and CPR training. That would free the department to inspect only those x-ray machines that are capable of harmful doses of radiation eg. industrial, hospital, mechanical, chiropractic, and veterinary. With a 50% drop in their case load, the department should once again have enough manpower to do their inspections. Since the board of dental examiners is comprised of dentists and laymen who work in the publics interest, the publics interests would be served. The dental board would have the power to regulate dental x-ray machines. This would save the state from having to fly an inspector around to dental offices. Also, this would stop the erroneous allegations of "non compliance" which have been detrimental to the profession of dentistry in that condemnation of an x-ray unit not only disrupts patient care, but is embarrassing to the dentists and instills irrational fears in patients as well as office personnel. The cost of addressing the erroneous allegations of non-compliance can be even more expensive than the inspection itself. Here I will share two cases to make my point.

CASE #1

An inspection was done at a remote dental facility in which the inspector found that the aluminum filter on the x-ray unit was malfunctioning. Since the dentist required this x-ray unit to perform his procedures, he immediately contacted a biomedical equipment technician who changed his busy schedule to fly to the dental facility with all the necessary parts and equipment. Upon his inspection, he found the aluminum filter to be functioning fine (aluminum foil does not malfunction). The technician found himself in an embarrassing and ethically compromised position. Who pays for his time and travel?

CASE #2

The state inspector required every Gendex model 770 x-ray unit in Anchorage to be red tagged because under state law tube lengths has to be at least 8 inches. Since the units in question have only 4 inches of tube protruding from the unit, the inspector shut them down apparently unaware that x-ray tubes extend from the back of the unit to the tip of the cone. This blunder caused alot of time and expense by dentists, technicians, and the manufacturer.

I thank you for taking your time with this important issue. Lets not let big government stand in the way of a profession which has an unblemished history of public safety using x-radiation.

Sincerely,

Mike Helmbrecht DDS

Michael J. Helmbrecht, DDS

Gentle Dental Care

FLOYD F. "FRED" BOUSE, DDS
Family Dentistry

March 5, 1998

Senator Bert Sharp
State Capitol - Room 516
Juneau, AK

Dear Sirs,

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I personally wrote letters of protest about this matter several years ago and again recently. The letters were sent to the Department of Health and Social Services in Juneau.

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A much more effective and responsive solution to this matter is addressed by SB160. Let me encourage you to proceed and prevail in this matter.

Thank you for taking time to read my note.

Yours in service,

Fred

Floyd F. Bouse, DDS

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David L. Nielson, D.D.S.
Julie M. Robinson, D.D.S.

GENERAL DENTISTRY

880 N STREET, SUITE 301
ANCHORAGE, ALASKA 99501
TELEPHONE 276-7787
279-8274

March 16, 1998

Senate Labor and Commerce
Senator Loren Leman Chair
State Capitol
Juneau, Alaska 99801

Dear Senator Leman:

My name is Dr. David Nielson, and I have been practicing dentistry in Anchorage since 1986. Each year we have faithfully paid our x-ray head fees pretty much without question, as I would venture to guess do most dentists. However, until recently nobody from the state has expressed the least bit of interest in our x-ray equipment, let alone visit our office for an inspection. Then, in 1997 a state representative came to address our state dental society's executive council, of which I am a member. You see, the dental profession was starting to question the rational for the high fees.

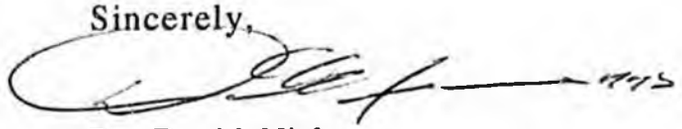
What happened next was such a coincidence. For the first time in over ten years, and less than a month after our meeting, the very person who addressed our committee came to our office for an inspection. In the end, she found nothing wrong and left us with some helpful hints on how to improve our contrast or something. When all was said and done, I had no problem with the whole affair other than the timing seemed suspect.

Approximately two months ago, however, something happened that I do have a problem with. While I was away at a lunch meeting, a radiation safety officer from the state stopped by the office for a visit/inspection. When I returned, I could tell most of the staff was upset about something, particularly my assistant. When I asked her what the trouble was, she could hardly speak without getting choked up. Apparently, this official had stopped by with some kind of measuring devise that he claimed would pick up scatter radiation from x-ray heads. After going from room to room with my assistant he concluded that "everybody in the office was getting some scatter radiation." He also told my assistant that if she were his wife or daughter, he would be concerned.

My assistant at the time was two months pregnant, and I, as an obviously unconcerned boss, was speechless. His claim sounded preposterous to me, but not being a radiation expert, or even having a chance to ask him questions, put me at a disadvantage. Two quick phone calls to the supplier who designed our office and the manufacturer of our x-ray equipment helped calm everyone down, and reassure them of their safety. I was able to reach the official later by phone. He claimed there were no violations whatsoever, but suggested that anyone taking an x-ray stand as far away from the source as possible. He also said he would send a report, which he has not done.

Sense this episode, we have gained more information about how truly safe dental x-rays are, and my staff finally feel confident they are not in danger. However, the poor tactics and miss information given to them by this state official in my absence, caused a great deal of unwarranted grief. Because of events like this one, I must seriously question the current system. Dentists are paying a very high price with no perceived benefit to the public or the employees. The current system is definitely broken.

Sincerely,



Dr. David Nielson

Alaska State Legislature
Senate

Official Business

State Capitol
Juneau, AK. 99801-1182

Senate Labor & Commerce Committee

Memo

TO: Senator Mackie, Vice Chairman
Senator Kelly
Senator Miller
Senator Hoffman

FROM: Annette Kreitzer, Aide to
Senate Labor & Commerce Committee

DATE: March 6, 1998

RE: SB 160: Dental Radiological Equipment

Please add the attached materials to your SB 160 folders. This material was faxed from the Fairbanks LIO following the hearing yesterday.

Alaska State Legislature

Please enter into the record my testimony to the S LABOR + Commerce.
committee name

committee on SB 160 **bill # / subject**, **dated** 3/5/98.

My name is Dan Pitts. I live in Soldotna Alaska and have practiced dentistry there for twenty years. I am representing the Alaska Dental Society and am speaking in favor of this bill. We wholeheartedly agree with the ~~[redacted]~~ sponsor's statement. Overexposure is nonexistent, inspections are haphazard, and never scheduled. Inspector's just show up and expect patients to be rescheduled or delayed. Inspection and corrections should be regulated through the board of dentistry who is entrusted to protect the public. The fee's paid should be changed on basis of administrative costs (self funded)

Signed: Dan O Pitts DDS
Testifier

Representing (Optional)
155 Smith Way Soldotna Alaska
Address
907-262-4989
Phone number

Floyd F. (Fred) Bause, D.D.S.
A PROFESSIONAL CORPORATION
GEIST PROFESSIONAL BUILDING
3745 GEIST RD., FAIRBANKS, ALASKA 99701
(907) 479-2208

February 3, 1987

Dear Sirs,

On January 26 I received a registered letter from the Department of Health and Social Services. A copy of that letter is enclosed for your information.

I was truly annoyed and troubled about now having another additional form of taxation being placed upon the medical-dental community. But I was also very curious about the possible need for additional inspections or quality assurance-type programs for radiographic equipment here in Alaska. My thought was that if there has been a significant problem with office radiographic equipment in our state, then additional and more frequent inspections would be a good idea.

So I placed a call to the Department of Health and Social Services and asked for Mrs. Ward who is signed on the letter previously received. Please allow my sharing with you some of my questions asked of her and then her answers:

1) Was there legislative input with hearings or was this something that originated in Mrs. Ward's own office?
2) If the idea originated in the Health and Social Services' office, what individual person was responsible for making the final recommendation, and what was the reason the "recommend" decision was made?
3) How much of an increase in periodic safety inspection is there to be and what were the statistical figures on how many dental or medical facilities in Alaska were indeed having problems with their radiograph equipment.
4) Was there some sort of sunset provision to this new tax so that, if after increased inspection there was found to

be no significant problems, the program would be deferred and the tax discontinued?

Mrs Ward stated that there was legislative authorization for this tax (a bill was passed) though she did not know the name(s) of the sponsors. Then she stated that the idea for charging a fee to users of radiographic equipment actually came from her office. She went on to say that she personally suggested the idea.

When I asked for the specific reason for creating this new tax, she stated that it was entirely to increase revenues within the Health and Social Services department to pay for government operation.

As to the need for and future prospects for increased inspection of radiographic equipment, she informed me that there was never a perceived need nor was there any plan for an increase in public service, ie. inspections of equipment. When I asked for figures and statistics from within the Health and Social Services department which would indicate a need for more inspection, she said she knew of none, but I could correspond with the fellow who does such work, a Mr. Heidersdorf.

As for the wisdom of terminating such a tax if and when it was no longer needed - a sunset provision as it were: Mrs Ward said that there is no provision to give relief from the new tax. That is, we are stuck with this new expense and there is no resolution to it, other than legislative action.

I complained to Mrs Ward that when a new cost like this is thrust upon businesses in the state, those costs must be borne by the public, in the form of either increased fees to our patients/clients or decreased net income for the practioner or decrease in wages or salary for our staff and I told her that none of those was wise in this time of economic difficulty that all of us here in Alaska are facing. She countered by saying that she didn't think "...a hundred dollars or so would be significant to a doctor's practice." Can you imagine the pompous, presumptuous and insensitive nature of that statement!' What this state employee said in effect is that "you doctors have lots of money anyway and this cost will not be a problem for you." I'm telling

you my feet are hopping up and down mad as I write this to you! These people in Juneau are supposed to be busy as a bee down there, devising ways to save money and cut operating costs for the people of Alaska. If ever the people of Alaska needed relief from expenses and costs it is now. These people should be devising ways of taking pressure off of business, not piling more pressures on. What was said to me on the phone was very, very careless. It was pompous to say that a bureaucrat tucked away in some office has the knowledge and wisdom to precipitate a new fee on the people of Alaska. It was presumptuous to say in effect that "you can afford it, Doc." It was insensitive to the pressures we in the health-care professions face in trying to keep health-care costs from escalating.

Let me tell you what I suggested to Mrs Ward was the real reason for this new fee: This whole idea is a way for people who sit in this or that seat of our state governmental bureaucracy to preserve their own personal paycheck (and don't worry, the doctors can pay, they 'got lots of money...)! Mrs Ward finally said to me near the end of our conversation that the real reason for this fee was (not better service to the public but rather) to simply raise funds to preserve and support the operating budget for her office. Now we have the facts. We are talking here about state agencies hustling to squeeze money wherever they can, out of whomever they can, hoping for few if any cries of protest. And supposedly in Mrs Ward's mind, health-care people of our state are an easy mark to start with.

Let us carry this idea of "twenty dollars per tube head" a little further: Let's charge commercial fishermen twenty dollars per net set, or per crab pot or per outboard motor; let's charge building contractors twenty dollars per every power saw they own; heck, let's charge legislators $20 per every legislative assistant they think they need. Now we'll get some action, you can bet - as long as they have to pay out of their own pocket!

Pursuing issues like this can be very time-consuming and frankly most people are just too busy to follow up on this problem. I have spoken to several other of my colleagues and at this point

our feelings are unanimous: If there was a real or even perceived danger to our patients that required more frequent inspection of our equipment, we would not only support an inspection program but we would indeed lead the way with the professional assistance of Mr Haidersdorf.

Sadly, the entire purpose of this scheme is to preserve the salary levels and paychecks of the folks who currently have jobs within the Department of Health and Social Services.

I am petitioning you sir/ma'am to lend us in the health-care professions your support in assuring that kind of bureaucratic insensitivity is not only publicly declared intolerable but you will then take appropriate action to correct the problem. Please respond quickly and with [illegible] to my letter.

I shall be mailing copies of this letter and plea to other of my colleagues, to local state legislators and representatives and to other concerned parties.

Yours in service with kind regards,

DR B

Floyd F Bouse, DDS

FFB/sb

cc: Rep. Mike Davis
Rep. Niilo Koponen
Rep. Steve Frank
Rep. Mike W. Miller
Rep. John Ringstad
Sen. Don Bennett
Sen. Bettye M. Fahrenkamp
Sen. Frank Murkowski
Sen. Ted Stevens
Congressman Don Young
Dave Rasley, Local 302
Dr Bill Schlanske
Dr Mike McKrill
Dr George Shaffer
Dr Bill Guy
Dr Warren Huss
Dr George Hansen
Drs Mike & Diane Heilbrecht
Drs Joe Cumming and Diane Mistler
Dr Eric Buntow
Dr Lou Thornley
Dr Bob Veazie

Floyd F. (Fred) Bouse, D.D.S.
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February 4, 1987

Dear Colleagues and Friends,

I spoke with Martha Dearborn today, February 4, 1987, and she informed me that there had indeed been input to Health and Social Services, about this new fee, from the Alaska Dental Society. But only a minor and anemic (my words) complaint was made-something about administrative costs for this program in all probability exceeding the moneys "extracted" from us dental surgeons.

I sincerely hope that some curative measures can be taken by the dental community as a whole, and I am writing to urge you to share my letter and conversaton with Mrs. Ward with your constituents.

This whole darned affair is bureaucratic fish spearing at its worst, (you are the fish, fella) and I'm really disappointed to think that the Alaska Dental Society representatives didn't stand up and bellow like a wounded bear!

I shall send a copy of all this to non-Alaska Dental Society members here in Fairbanks and I hope you would be so helpful in your area.

With Best Regards,

Fred

Floyd F. Bouse, DDS

FFB/sb

Gentle Dental Care

FLOYD F. "FRED" BOUSE, DDS
Family Dentistry

December 30, 1997

Kate Coleman
STATE OF ALASKA
Dept. of Health and Social Services
PO Box 110613
Juneau, AK 99811-0613

What a farce you people are! All these fees, all this paperwork - and for what? Safety? Our equipment could be in any state of disrepair or perfection and you wouldn't know - or care. If you cared, you would be here, to certify safety, ***in person***.

This kind of beaurocratic, self-preserving trough-feeding is embarrassing and counterproductive for the good people of our state.

What a waste of hard-earned money!

Sincerely,

Dr B

Floyd F. Bouse, DDS

FFB/sb

cc: Dr. Art Hansen, President, NCDDS
Dr. Tim Woller, President, Alaska State Dental Society
Senators, Gary Wilken, Bert Sharp, Mike Miller, Georgianna Lincoln
Representatives John Davies, Tom Brice, Pete Kelly, Al Vezey, Gene Therriault, Jeannette James, Irene Nicholia, Gene Kubina
Governor Tony Knowles

Geist
Professional
Building
3745 Geist Road
Fairbanks, Alaska
99709
(907) 479-2208

We make miles of smiles for you.

Enclosures

CC: without enclosures
Dr. Art Hansen, President, NCDDS
Dr. Tim Woller, President, Alaska State Dental Society
Senators Gary Wilken, Bert Sharp, Mike Miller, Georgianna Lincoln
Representatives John Davies, Tom Brice, Pete Kelly, Al Vezey, Gene Therriault, Jeannette James, Irene Nicholia, Gene Kubina
Governor Tony Knowles

Dr. Peter Nakamura, Director Public Health, DHSS
Elmer Lindstrom, Legislative Liaision, DHSS

X-RAY REGISTRATION APPLICATION

Mailing Address:

FACILITY NAME
CONTACT PERSON
ADDRESS
CITY, STATE, ZIP

Same

Mail To:
RADIOLOGICAL HEALTH PROGRAM
DIVISION OF PUBLIC HEALTH
P.O. BOX 110613
JUNEAU, AK 99811-0613

Check Appropriate Box/es

- ☐ New Facility
- ☐ Mailing Address Change
- ☐ Site Address Change
- ☐ Tube Count Corrections

Site Address:

FACILITY NAME: Geist Professional BLDG.
CONTACT PERSON: Floyd F. Bouse
ADDRESS: 3745 Geist Rd
CITY, STATE, ZIP: Fairbanks, AK 99709

Telephone:

USER INFORMATION

Individual Responsible for Radiation Protection: Your Surgeon

Classification of Individual in Charge of Source

- ☑ Radiologist
- ☐ Chiropractor
- ☐ Veterinarian
- ☐ Registered X-Ray Tech.
- ☐ Industrial Radiography
- ☐ General Practitioner
- ☐ Dentist
- ☐ Podiatrist
- ☐ Non-Registered X-Ray Tech.
- ☐ Other (Specify)

Source Type *(Specify number of tubes per type)*

Medical	Dental	Other
___ Fluoroscopic	K Conventional	___ Industrial Radiography
___ Stationary Radiographic	K Panoramic	___ Diffraction Apparatus
___ Portable/Mobile Rad.	___ Cephalometric	___ Electron Microscope
___ Photofluorographic		___ Cabinet
___ Therapy		___ Other (Specify)
___ Accelerator		
___ Special Procedures		

CERTIFICATION

This is to certify that, to the best of my knowledge and belief, all information contained herein, including any supplements attached hereto, is true and correct.

Print Authorized Name: FLOYD F. BOUSE, DDS Date: 28 Dec 97

Authorized Signature: F Bouse DDS

Title: Doctor Dental Surgery

STATE OF ALASKA

DEPT. OF HEALTH AND SOCIAL SERVICES

DIVISION OF PUBLIC HEALTH

TONY KNOWLES, GOVERNOR

STATE PUBLIC HEALTH LABORATORIES
OFFICE OF RADIOLOGICAL HEALTH
P.O. BOX 110613
JUNEAU, ALASKA 99811-0613
PHONE: (907) 465-3019
FAX: (907) 465-2088

January 27, 1998

Floyd F. Bouse, DDS
Gentle Dental Care
Geist Professional Building
3745 Geist Road
Fairbanks, Alaska 99709

Dear Dr. Bouse,

Thank you for taking the time to write and express your opinions regarding the frequency of dental x-ray equipment on site inspections. We share your concerns. Clyde Pearce, a full-time x-ray inspector stationed in Anchorage, was hired in May 1997. With the addition of Mr. Pearce, we anticipate a three-year cycle to inspect all facilities with x-ray equipment in the state.

Mr. Pearce will be inspecting your facility on February 23 at 9 AM and will evaluate whether the previous safety issues have been corrected. The reports from previous on site inspections of your facility are enclosed. The inspection reports reflect that patients in your office have continually been over exposed. The inspection reports are yours to distribute to the individuals you copied in your letter should you so desire. It is the responsibility of the owner of the x-ray equipment to take the necessary measures to ensure their equipment is operating safely. A copy of the regulations is included.

The Commissioner of the Department of Health and Social Services was directed to establish reasonable fees for service in 1986 when the legislature passed AS 44.29.022. Enclosed is the 1993 Proposed Fee Schedule Documentation, which provides an explanation of the current fee schedule.

Please feel free to contact me if you have further questions.

Sincerely,

K.A. Coleman
Radiological Health Specialist

03/05/98 LEGISLATIVE TELECONFERENCE NETWORK SYSTEM LTN1150
14:11:21 PARTICIPANT LIST (TESTIFIERS ONLY) BY:JNU
TCN:80374 SCHEDULED FOR:03/05/98 13:30 TO 15:00 FOR:FBX
PUBLIC HEARING SENATE LABOR & COMMERCE

LOCATION:FAIRBANKS

HB 199	MR.	RICHARD	HOMPESCH		TESTIFY
SB 160		MIKE	HELMBRECHT	DDS	TESTIFY
SB 160		DAVID	EICHLER	DMD	TESTIFY
SB 160		DAN	ANDERSON	BIOMED EQUIP	TESTIFY
HB 135		ART	HANSEN (SB160)	DDS	TESTIFY
HB 135		TIM	WOLLER (SB160)	DDS	TESTIFY

03/05/98 LEGISLATIVE TELECONFERENCE NETWORK SYSTEM LTN1150
13:32:52 PARTICIPANT LIST (ALL PARTICIPANTS) BY:KEN
TCN:80374 SCHEDULED FOR:03/05/98 13:30 TO 15:00 FOR:KEN
PUBLIC HEARING SENATE LABOR & COMMERCE

LOCATION:KENAI LIO

SB 160	DR.	DAN	PITTS_(HB 135 ALSO)	AKDENTAL SOCIETY	TESTIFY

Calvin Fair

Soldotna - 20yrs

03/05/98 14:24:02 LEGISLATIVE TELECONFERENCE NETWORK SYSTEM LTN1120
MESSAGE FROM: LIOCMBB IN KENAI LIO JNU

RE TCN: 80374 SCHEDULED FOR:03/05/98 13:30 TO 15:00
SPONSOR: SENATE LABOR & COMMERCE PURPOSE: PUBLIC HEARING

MESSAGE TEXT: DR. PITTS HAD TO LEAVE SO WILL SEND
WRITTEN T ON SB 160

03/05/98 14:47:16 LEGISLATIVE TELECONFERENCE NETWORK SYSTEM LTN1120
MESSAGE FROM: LIOCJEN IN ANCHORAGE JNU

RE TCN: 80374 SCHEDULED FOR:03/05/98 13:30 TO 15:00
SPONSOR: SENATE LABOR & COMMERCE PURPOSE: PUBLIC HEARING

MESSAGE TEXT: WILL CMTE GET TO SB 212 THIS AFTERNOON?

They have 2 people for that bill

COMMITTEE:
SENATE LABOR & COMMERCE

DATE: March 5

Subject of meeting:
SB 160 - DENTAL RADIOLOGICAL EQUIPMENT

SIGN-IN

PLEASE PRINT! NAME	ADDRESS (MAILING) & (ZIP)	PHONE	REPRESENTING	DO YOU WANT TO TESTIFY?
C Nakamura	Juneau - DHSS	465 3070	DHSS	Y
Barbara Reardon	Occupational Licensing DCED	465-2538	DCED	Yes
SID HEIDERSDORF	Box 020655, JUNEAU	789-9858	SELF	YES

Article 4
Continuing Education

Post-it® Fax Note 7671	Date 3-10	# of pages ▶ 18
To M. HELMBRECHT	From J. MALONE	
Co./Dept. ALASKA	Co. ADA 1-800-	
Phone #	Phone # 621-8099	
Fax # 907 452 4775	Fax # 3124402536	

X-Radiation: Potential Risks and Dose-Reduction Mechanisms

Kenneth Abramovitch, DDS, MS
Associate Professor

Lisa P. Thomas, RDH, DDS
Clinical Assistant Professor

Section of Radiology
Department of Oral Diagnostic Sciences
Dental Branch
University of Texas Health Science Center at Houston
Houston, Texas

Learning Objectives

After reading this article the reader should be able to:

- define and list the maximum permissible dose for occupationally and nonoccupationally exposed individuals.
- list four sources of naturally occurring background radiation.
- discuss the dose and risk considerations for each critical organ with regard to dental x-radiation exposures.
- list methods available to reduce dental x-radiation to the patient.
- describe how collimation affects patient exposure to dental x-radiation.

Table 1—Annual Maximum Permissible Radiation Doses[1]

Occupationally exposed (includes dental workers who take x-rays)	5,000 mRem (50 mSv)
Nonoccupationally exposed (the general public)	500 mRem (5 mSv)

Nearly a century after its discovery in 1895, x-radiation remains a controversial diagnostic modality. It has been associated with several risks and side effects, some of which are difficult to substantiate. Despite the controversy, radiography is a reliable and convenient diagnostic aid for the dental profession. This article will discuss relative risks associated with dental x-rays and the mechanisms available to reduce those risks.

Radiobiologic Risks

Biologic Risks and the Maximum Permissible Dose

X-radiation is an ionizing form of electromagnetic radiation. When absorbed in human tissues, energy levels of this magnitude alter the electrostatic charges and molecular bonding of complex structural and regulatory proteins. Such changes can affect the basic conformation of cytoplasmic and nuclear organelles. These alterations increase the risk of permanent, demonstrable damage to the tissues by slowing, accelerating, altering, or stopping their normal biologic function.

Because of these risks, the International Commission of Radiological Protection (ICRP) has defined a safety limit for tissue exposure to ionizing radiation below which the risks are considered minimal. The safety limit is referred to as the maximum permissible dose (MPD). More specifically, this dose can be summarized as the amount of radiation received chronically or acutely over a lifetime, which, in light of present knowledge, is not expected to cause appreciable body injury.[1] The annual MPD values are listed in Table 1.

The MPDs for individuals working with radiation (ie, occupational exposure, which includes dental personnel) is 10 times higher than

for the general population (ie, nonoccupational exposure). Occupationally exposed personnel are assumed to be willing to accept a higher risk of radiation exposure for the lifestyle attained by their employment. Yet, if all radiation workers were to realize this tenfold increase in radiation exposure, it is not expected to affect the mutation rate of the whole population for any pathologic entity.

The ICRP has a lower MPD for occupationally exposed women who are pregnant. They have the same MPD as the lay population. This is to protect the fetus, which should not be considered occupationally exposed.

The ICRP has recently suggested lowering the MPD values to 200 mRem(2mSv)/y.[2] This limit is presently being reviewed by several organizations.

Environmental and Diagnostic Radiation

MPD values were established because people are regularly exposed to naturally occurring environmental sources of ionizing radiation (Table 2). Consequently, biologic systems are constantly exposed to these sources of radiation, which must be considered within the range of tolerance. Radon and its decay products are the major sources of naturally occurring background radiation. Note: the average whole-body exposure limits are below the MPD values for occupational and nonoccupational individuals.

Medical and dental diagnostic x-radiation exposures can also contribute to the annual whole-body exposures. However, these values are not considered in MPD calculations because diagnostic x-rays are assumed to be beneficial to the life span of an individual. Note the relatively low dose equivalent for diagnostic radiation compared to the naturally occurring sources of background radiation. The sum of all of these procedures remains below MPD values.

Table 2—Average Individual Annual Effective Dose Rate of Ionizing Radiations[1]

	mRem	mSv
Natural		
Radon	200	2.0
Cosmic	27	0.27
Terrestrial	28	0.28
Internal	39	0.39
Artificial		
Medical		
X-ray diagnosis	39	0.39
Nuclear medicine	14	0.14
Consumer products	10	0.1

Table 3—Critical Organs and Their Potential Risks

Organ	Risk
Skin	Carcinoma
Bone	Leukemia
Gonads	Mutation
Eye lens	Cataracts
Thyroid gland	Carcinoma
Embryo/Fetus	Congenital defects

Critical Organs

Critical organs affected by dental x-radiation are defined as the tissues that, by virtue of their radiosensitivity or proximity to the dental beam, are possibly vulnerable to pathologic or life-threatening sequelae.[3] These critical organs and their potential risks are listed

in Table 3. The dose and risk considerations for each of the critical organs are discussed separately.

Skin

Dental exposures for a full mouth series of x-rays vary considerably, depending on the technique used. The type of film speed, kilovoltage, filtration, collimation, etc, all affect the amount of exposure. Several dosimetry studies have shown that a trend for decreasing exposures is evident.[4] According to current ICRP data, a full mouth x-ray series using 70 kV, D-speed film, and round collimation yields an average effective dose of 840 mRems (8.4 mSv).[5] A full mouth x-ray series procedure taken with D-speed film, round collimation, 80 to 90 kV, and a 16-inch long-cone focal distance, has a maximum cumulative skin dose at any one site of approximately 1,250 mRem (12.5 mSv).[6] The approximate skin dose from the intraoral exposure of one diagnostic-quality radiographic image with D-speed film is 200 mRems (2 mSv).[6] Increased risk to the earliest type of skin cancer is not evident below dose levels of 25,000 mRems (250 mSv).[6] Keeping the proper risk perspective (according to these numbers), carcinoma induction from dental radiographic exposures that are approximately 1% to 5% of acute threshold doses seems very low.

Bone Marrow

Leukemia induction is the major risk associated with x-ray exposures of bone marrow. Approximately 5% of the body's bone marrow gets exposed from dental radiographic procedures. The bone marrow dosage ranges from 1 to 3 mRems (.01 to .03 mSv) for 1 exposure and 9 to 14 mRems (.09 to .14 mSv) for a full mouth x-ray series.[6] Whole-body exposures of 5,000 mRems (50 mSv) are reported to increase the risk of leukemia induction. Linus[7] showed no significant increase in leukemia risk from long-term (chronic) fractionated doses of up to 30,000 mRems (300 mSv).

Table 4—Quality-Assurance Measures

- x-ray equipment testing and maintenance
- good radiographic technique (ie, film placement, reversed film, etc)
- using film holders
- proper exposure parameters
- proper film handling before and after exposure
- proper time/temperature film processing
- darkroom maintenance to prevent film fogging (ie, checking for light leaks, storing film at proper temperature, etc)

Gonads

Dental x-ray exposure to genetic tissues in the gonads results primarily from secondary scatter radiation off the skull. The gonadal scatter exposure from a standard full mouth x-ray series is about 0.5 mRems (0.005 mSv).[6] This dose can be reduced by 95% by using a lead apron. The average daily gonadal radiation exposure from natural background radiation is 0.15 to 0.3 mRems (.0015 to .003 mSv).[8] The full mouth x-ray series gonad exposure with lead apron protection is about seven times less than the average daily gonadal exposure of the US population from background radiation. At higher elevations (ie, Denver, Colo), these doses double because of the earth's proximity to the cosmic sources of background radiation.[8] Radiation doses of this low magnitude have very little effect on the genetically significant dose of the US population, ie, the dose of radiation required to affect genetic mutation rates.

Eye Lens

Cataract formation is very debilitating and can eventually cause blindness. Exposures of greater than 200,000 mRems (2,000 mSv) are required to induce cataract formation.[4] The standard full mouth x-ray series yields a lens dosage of 60 mRems (0.6 mSv). Again, it seems highly unlikely that dental exposures, which are 0.0003% of the threshold, contribute to this problem. They do contribute to a cumulative dose for cataract formation. However, fractionating the dose to this degree decreases the harmful effect.[9]

Thyroid

Radiation doses of 5,000 to 7,000 mRems (50 to 70 mSv) are required for thyroid carcinoma induction.[4] The thyroid exposure during a standard full mouth x-ray series is about 23 mRems (0.23 mSv). Again, carcinoma induction from a dental x-ray beam is very unlikely. It is also significant to note that of all the neoplasias affecting humans, thyroid cancer has only a 10% incidence of mortality.[10]

Harmful effects to the thyroid gland in children may be more significant because growing children have more active metabolic rates. The use of the lead thyroid collar diminishes the exposure to a negligible amount.

Embryo/Fetus

Dental x-ray exposure of pregnant patients is not recommended except in an acute emergency where the benefit of the diagnostic information far exceeds the radiation risk to the fetus. The National Council of Radiation Protection and Measurements (NCRP) has reported that the production of congenital defects is negligible from gonadal exposures of 5,000 mRems

(50 mSv) or less.[11] Danforth and Gibbs'[12] calculation of relative risks has shown that the chances of having a first-generation defect from a dental x-ray examination is 9 in 1 billion (ie, 0.000,000, 9% or 9.0×10^{-7}%).

The ALARA Principle

It is evident from the preceding discussion that risks of long-term biologic damage from dental x-ray exposures are extremely low.

However, it remains very difficult to scientifically document the long-term (30 to 50 years) cumulative effects of low-dose chronic exposure. Recently, it was reported that dental x-ray exposures may be causing higher incidences of salivary gland and brain tumors.[13,14] This risk estimate was based on several assumptions and estimations of the number of dental radiation exposures and the type of equipment used on the patients in their past dental treatment, all of which are difficult to prove. Consequently, a direct cause-effect relationship between previous dental radiation exposure and future cancer could not be made.

Regardless of the accuracy of these risk associations, radiobiologic damage does occur from exposure to x-radiation, so the ALARA (as low as reasonably achievable) principle[15] should be followed. This principle recognizes that knowledge of the cumulative long-term effects of exposure to low levels of diagnostic radiation may be minimal, but it still remains a risk entity. Scientific data is not available that can demonstrate a threshold radiation dose below which no harmful effect will ever occur. It is therefore prudent that we adhere to the ALARA principle, whereby all diagnostic radiographic procedures use the maximum amount of dose *reduction* possible. This would minimize the potential risks and any adverse sequelae to diagnostic radiation.

Various techniques are available to reduce radiation exposure from dental radiography. Incorporating these techniques into dental practice will have a profound effect on patient dose reduction.

Techniques for Reducing Radiation Exposure

The NCRP is a private organization composed of experts in various aspects of radiation. They operate under a congressional charter as an advisory group that makes recommendations governing the use of x-radiation. It is the responsibility of each individual state to make its own rules and regulations regarding radiation exposure based on these recommendations. The Texas Radiation Control Act, enforced by the Texas Department of Health, is based on many of the NCRP recommendations. Some of these regulations will be alluded to in the following discussion.

Beam Collimation

Based on an NCRP recommendation, it is mandated in most states that the dental x-ray beam be no larger than 7.0 cm in diameter (2.75 inches) at the patient's skin surface. Most dental units are sold with a 2.75-inch, lead-lined cylindrical cone (ie, BID or beam indicating device) collimation. However, smaller rectangular-shaped collimators are also available that further restrict the size of the beam. This kind of enhanced collimation can reduce the scatter radiation by 45% to 95%, depending on the site in question.[6] Scatter radiation is so dramatically diminished that the gonadal scatter from a 20-exposure full mouth x-ray series with rectangular collimation is the same as the scatter from 4 bitewing exposures with the size 2.75-inch-diameter, round collimation.[6] An earlier study[16] showed that rectangular collimation reduced the bone marrow dose by 60%.

Wood et al[17] went so far as to recommend that the scatter to the gonads is so minimal with rectangular collimation that a lead apron is not needed when rectangular collimators are used. Using the smaller-size beam from rectangular collimation may be more technically demanding, but Parks[18] concluded that radiography with rectangular collimation is no more difficult a technical skill for novice dental hygiene students to learn than dental radiography with round collimation.

Film Speed

E-speed film is the fastest, most sensitive, commercially available film speed. This film speed reduces dental radiation exposures by up to 50% when compared with D-speed film.[19] These are the only two film speeds available commercially for intraoral radiography. Exposure parameters for diagnostic dental films deliver a skin entrance dosage of 100 to 200 mRems (1 to 2 mSv).[4] The suggested exposure limit set by National Evaluation of X-Ray Trends (NEXT) is 400 mRems (4 mSv), which is a very lenient limit. Although images on E-speed film have less contrast than regular D-speed film images, there is no loss of diagnostic detail for caries and periodontal evaluations and endodontic procedures.[20-22]

The American Academy of Oral and Maxillofacial Radiology strongly recommends that the dental profession use E-speed instead of the slower D-speed film. E-speed film reduces exposure to both the patient and operator by reducing the number of retakes necessary as a result of patient or machine movement.[23]

Constant Potential X-Ray Generators

In the last 10 years, several new dental units have become available that produce x-radiation with a steadier stream of higher kilovoltage x-ray photons. Because the x-ray beam from this machine has a greater proportion of high-energy photons, shorter exposure cycles can be used. In addition, fewer of the lower kilovoltage (ie, lower energy) x-ray photons are produced. The lower energy x-ray photons are those in the beam that are too low in energy to contribute to the x-ray image, but are of sufficient energy to contribute to the patient's radiation dose. Constant potential dental x-ray machines can reduce radiation dose by up to 30%. Intrex®[a], Castle® HDX®[b], and Heliodent®[c] MD are examples of commercially available machines with this capacity. The only drawback to these units is that they are more expensive, costing approximately twice the amount of a regular dental unit. Fortunately, the price is not a major deterrent for many dental offices.

High-Energy Beams

Commercially available dental units range in their kilovoltage capacity from 60 to 100 kV. Machines with higher range kilovoltage potentials, ie, 80 to 90 kilovoltage, have larger generators with clinically larger tube heads. These larger units also have a higher purchase price. However, higher kilovoltage beams with the appropriate filtration and increased focal distances (16 inches) reduce the radiation exposure to the patient.[24] Higher kilovoltage beams produce long scale contrast images with many shades of gray that demonstrate more information on tissue density. This is extremely helpful for the early detection of caries and crestal bone changes in periodontal disease. Higher kilovoltage beams are also better for producing images for skull cephalometry.

Filtration

Filtration removes low-energy x-ray photons from the x-ray beam. The low energy photons do not contribute to the image but still affect the radiation dose. Radiographic units are manufactured with built-in filtration, which is dependent on the tube voltage. The greater the tube voltage the more the filtration. Adding extra filters made with rare earth metals to the x-ray unit has been shown to reduce radiation from 25% to 71%.[25] Added filtration with niobium decreases radiation exposure by up to 47%.[26] In each study, diagnostic images were produced with minimal loss of image information. However, the benefits of added filtration have yet to be determined because use of added filtration also increases the exposure time, and hence, the tube load.

Lead Aprons

Lead aprons are generally required for all patients exposed to dental radiation. For example, it is a regulation of the Texas State Board of Dental Examiners (Chapter 113.2) that all patients wear a lead apron during direct exposure to dental radiation. Scatter radiation to the thoracic, abdominal, and gonadal areas is reduced by up to 94% with a lead apron.[27] The apron also has a positive psychological or comforting effect on the patient.

Thyroid collars similarly reduce radiation exposure to the thyroid gland. These collars are highly recommended, provided they do not interfere with the image. This precludes their use during panoramic exposures. Thyroid collars reduce dental x-ray exposure to the thyroid gland up to 94%.[28,29]

Quality Assurance

A quality-assurance program is also needed to reduce radiation ex-

[a] KEYSTONE X-RAY, Inc, Dental Div. Neptune, NJ 07753
[b] MDT Diagnostic Co, North Charleston, SC 29411
[c] Pelton & Crane, A Siemens Co. Charlotte, NC 28224

Feature

X Rays: What is the Risk?

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Introduction

If it hasn't happened already, it will. It's simply a matter of time before one of your patients will ask: "How much radiation is involved with these x rays?" or "Aren't these x rays harmful?" or, "Are you using the latest methods to reduce my exposure to x rays?" Dentists and their office personnel are continually asked questions pertaining to the use of x rays. Your response, or that of your staff, may have a profound effect on your practice. To respond with a clear and concise answer will serve to increase their confidence in you as a practitioner. On the other hand, to simply ignore these questions, or treat them lightly, may create the impression of a lack of concern for their overall well being. This may not only result in a loss of the patient's confidence in your ability, but also the loss of a patient.

There is no question that ionizing radiation in general, and x rays in particular, have a potential harmful effect on humans. It is known beyond a shadow of doubt that if exposed to sufficient quantities of radiation, humans will experience an increased risk of nonfatal and fatal cancer, hereditary disease, or loss of life expectancy. It is the purpose of this article to provide you with the information to put these risks into perspective, allowing you to use x rays when needed for diagnosis.

Frederiksen

Radiation in our Environment

No matter who we are or where we live, we are subjected to quantities of radiation exposure from a variety of sources. Because not all of these sources are responsible for exposure of the whole body, the quantities of radiation they deliver are expressed in terms of effective dose. This unit, effective dose, is calculated from both whole- and partial-body exposures. It is the dose that may be expected to result in the same total risk of harm as that from a uniform whole-body exposure of the same magnitude. Effective dose is then a useful term that allows comparisons to be made between sources of radiation exposure which expose only portions of the body, such as radiographic techniques, and whole-body exposures, including those resulting from natural or background radiation. The unit of effective dose is the sievert (Sv). A millisievert (mSv) is one thousandth of a sievert.

Estimates of the radiation exposure of all persons living in the Unites States resulting from all sources have been made. By totaling these individual exposures and then dividing by the population, an average dose has been determined (1) (Table 1). In this manner, it has been estimated that an average individual living in an average location in the United States receives an effective dose of 3.6 mSv of radiation every year. Of this total, over 80 per cent (3.0 mSv) is the result of natural or background radiation. This means that every day of a person's life, they receive 0.008 mSv of radiation exposure from natural sources or sources over which they have no control. We are all concerned with the human contribution to radiation exposure; however, it is estimated that in total, this amounts to only 0.6 mSv. Including everything from the medical uses of radiation to consumer products (including some smoke alarms, airport inspection systems, and dental porcelain) to nuclear reactors, this category subjects an average individual to less than one third the radiation delivered by naturally occurring radon (2.0 mSv).

Dental x-ray examinations are estimated to be responsible for an average annual effective dose of less than 0.01 mSv (2). This figure, equal to only 2.5 percent that of medical x-ray diagnosis and 0.3 percent of the total average annual effective dose, is surprising when it is considered that dentists own over half of the x-ray machines in this country and perform an estimated 105 million examina-

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tions per year using 380 million pieces of film. In spite of these figures, the use of x rays in dentistry is not considered as a source of exposure and for that reason not listed in Table 1. The exclusion of dental x rays as a source may have resulted in part from the introduction of the term "negligible individual dose" (3). Formulated by the National Council on Radiation Protection and Measurements, a private, nonprofit organization whose findings are made into law by most states, the negligible individual dose is that quantity of radiation that can be dismissed. Currently, this dose is established at 0.01 mSv per year, a quantity equal to that of the estimated average annual effective dose resulting from dental x-ray examinations.

Exposure From Dental X Rays

Occupational Exposure. Within twenty-five years of Roentgen's discovery of x rays, it had been estimated that over 100 early pioneers in radiology had died of cancer caused by their exposure to radiation (2). This finding, among others, has resulted in the establishment of limits on the amount of radiation a person may be exposed to in the course of their occupation. The Texas Regulations for the Control of Radiation state that each registrant shall control the occupational dose to individual adults such that it will not exceed an annual effective dose of 0.05 Sv (4). This limit has been set in an attempt to ensure that the lifetime fatal cancer risk as a result of exposure to x rays will be similar to the risk of accidental death in "safe" industries where there is no exposure to radiation. Because even this dose carries with it some risk, all individuals are further urged to follow the principles of ALARA (As Low As Reasonably Achievable) which recognize that no matter how small the dose, there may be some risk of effect. The fact that the dental profession follows these principles may be illustrated by the fact that most recent data show that the annual effective dose of those occupationally exposed in the operation of dental x-ray equipment was 0.2 mSv (2). This figure is only 1/250 the allowable limit. This finding is perhaps one of the reasons that the State of Texas no longer requires radiation monitoring of dental employees.

Patient Dose. The dose delivered to the patient as a result of an x-ray examination is dependent in part on the specific area exposed, the size of the area exposed, and on the type of image receptor used. The latter may be either intraoral direct-exposure film, extraoral screen-type film, or some form of solid state detector as used in digital radiography, including computed tomography. Table 2 (5,6,7,8) lists the effective dose patients may receive by undergoing both some common and more specialized dental and medical radiographic examinations. By comparison of figures in the table, a lower GI series (barium enema) can be seen to deliver 27 times more radiation to the patient than a full-mouth series of oral radiographs and a radiograph of the chest about three times more than a panoramic film.

Risk

Risk is the chance or possibility of loss or injury. The probability of loss or injury may be considered in both relative and absolute terms. Relative risk can be illustrated by comparing doses received as a result of exposure to x rays for diagnostic purposes with natural or background radiation. Table 2 lists the days of equivalent natural exposure. It can be seen from these data that a panoramic radiograph delivers a dose to the patient equal to 3.3 days of natural radiation exposure, a bitewing examination 4.8 days, and a full-mouth survey 18.8 days. Additionally, by comparison, radon in our environment (2.00 mSv, Table 1) is responsible for an annual exposure of over 13 times that of a full-mouth survey of intraoral films. These figures can also be used to make comparisons between persons living in various locations of the U.S. For example, it has been estimated that the effective dose from cosmic radiation in Denver, Colorado, is 0.24 mSv higher than the U.S. average (2). This is because of Denver's higher elevation. This would mean that a patient living in an average location of the U.S. who had almost four panoramic and bitewing examinations every year (total effective dose for these examinations is 0.064 mSv, Table 2) would incur the same risk of potential harm from radiation as a patient living in Denver who was not exposed by these examinations.

In absolute terms, risk can be described by calculation of detriment. Detriment is a term used to represent a combination of the probability of occurrence of an unfavorable health effect resulting from radiation exposure and a judgment as to the severity of the effect (9). Thus, radiation detriment can be expressed as the total harm that would eventually be experienced by an exposed population of individuals and their descendants as a result of radiation exposure. This includes the probability of fatal cancer, the weighted probability of nonfatal cancer, the weighted probability of hereditary effects, and the relative length of life

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lost. Detriment can be calculated on the basis of the probability of incidents per million of exposed population, the population at risk (Table 2). For some of the more common examinations, this probability ranges from less than 0.1 per million for a single-film tomogram that may be made for oral implant diagnostics, to 11 per million for a full-mouth survey, to 296 per million for a lower GI series.

Calculation of risk per million from the use of x rays allows for comparison with risks patients are subjected to in the course of their everyday lives. Table 3 lists some of these risks compiled from various newspaper and news magazine articles over the years. These data, expressed as the probability of either death or developing cancer, show that patients have about the same risk of choking to death (13 per million) as expressing some detriment from having a full-mouth survey (11 per million) made during the course of an oral examination. In all fairness, however, diagnostic x rays involve a risk generally much higher than that of being killed by falling airplane parts or in a shark attack.

Minimizing the Risk to Patients and Personnel

Although the risk from exposure to x rays may be compatible with everyday life, according to the principles of ALARA we should always try to employ techniques, equipment, and materials that will allow us to produce radiographs with the least amount of radiation. As an added benefit, everything we do to reduce patient exposure will reduce the possibility of exposure of ourselves and our personnel.

The following is a summary of methods of exposure reduction that can be used in oral radiography (2). Patient selection is probably the single most effective way in which exposure can be reduced (See *Guidelines*, this issue). If the decision is made that radiographs are not necessary, this represents a 100 percent reduction in patient exposure. An almost 50 percent reduction in patient exposure can be realized by using E-speed film rather than D-speed film. The use of digital intraoral imaging techniques also requires less radiation. Digital imaging has been found to require only 40 percent the radiation of E-speed film and 23 percent that of D-speed film (10). Rare-earth intensifying screens, such as Lanex® (Eastman Kodak Co., Rochester, NY), which may be used in extraoral radiography, are up to eight times more sensitive to x rays than conventional screens, resulting in a significant reduction in patient exposure. Long-cone instead of short-cone techniques for intraoral radiography may result in a 32 percent reduction in exposed tissue volume. Rectangular collimation will reduce the area of the patient's skin surface exposed by 60 percent over that of round collimation. Leaded aprons and collars can reduce the amount of scatter radiation to the patient's abdomen by 98 percent and to the thyroid gland by 92 percent. And finally, good darkroom techniques, including time-temperature processing, may contribute to exposure reduction. Six percent of dental radiographs may not be readable because of poor darkroom techniques. Radiographs that must be remade because of inadequate exposure or processing techniques result in a doubling of patient exposure.

Finally, to ensure that a dental office consistently produces high quality radiographs with a minimum of patient exposure, the American Dental Association recommends the establishment of a quality assurance program in each dental office (11). Such programs include inspection of the x-ray unit, darkroom, and ancillary equipment such as leaded aprons at suitable intervals and the establishment of written procedures for safe operation, exposure and processing techniques, and maintenance. Many of these items are required by the Texas Regulations for the Control of Radiation (4) (See *Message*, this issue).

The practice of dentistry requires lifelong learning. Every practitioner should keep in mind that developing and maintaining skills and acquiring knowledge is a continuous process. Every effort should be made to be aware of improvements in techniques in radiology and every field of dentistry so that patients may receive quality care.

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Table 1.

Average Annual Effective Dose of Ionizing Radiations to a Person in the United States

Source			Effective Dose (mSV)	
Natural				
	External			
		Cosmic	0.27	
		Terrestrial	0.28	
	Internal			
		Radon	2.00	
		Other	0.40	
	Total			3.00
Man-Made				
	Medical			
		X-ray diagnosis	0.39	
		Nuclear medicine	0.14	
	Consumer products		0.10	
	Other			
		Occupational	<0.01	
		Nuclear fuel cycle	<0.01	
		Fallout	<0.01	
		Miscellaneous	<0.01	
	Total			0.60
Total= Natural plus Man-Made				3.60

Dental not listed

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Table 2.

Effective Dose by Radiographic Technique

Technique	Effective Dose (mSv)	Days Equivalent Natural Exposure	Probability (per million)
Dental			
Intraoral			
Periapical (15 films)	0.111	13.9	8.1
Bitewing (4 films)	0.038	4.8	2.8
Full-mouth survey (19 films)	0.150	18.8	11.0
Extraoral			
Panoramic	0.026	3.3	1.9
Film tomography *	<0.001-0.030	<0.1-3.8	<0.1-2.2
Computed tomography			
Maxilla	0.104	13.0	7.6
Mandible	0.761	95.1	55.6
Medical			
Lower GI series	4.060	507.5	296.4
Upper GI series	2.440	305.0	178.1
Chest	0.080	10.0	5.8

* Scanora® Integrated Imaging system (Orion/Soredex, Helsinki, Finland). The effective dose is dependent on the region of the jaws exposed and the collimation option used, i.e., round or rectangular.

Table 3.

How Safe ?

End Result And Cause	Probability of Occurrence (per million)
Cancer	
Exposure to termicide (Chlordane)	100-300
Herbicides and fungicides on fruits and vegetables	278
Death	
Choking	13.0
Boating accident	4.6
Tornado	2.2
Bathtub accident	0.6
Struck by lightning	0.5
Overseas terrorist attack	0.1
Falling airplane parts	0.1
Shark attack	0.003

Oral Radiology

Risks From Dental Radiation in 1995

Robert P. Langlais DDS, MS and Olaf E. Langland DDS, MS

When an individual is exposed to ionizing radiation from a dental X-ray machine, the postulated risk from this procedure is the induction of damage to either the somatic or genetic tissues of the exposed person. Somatic tissues include all tissues of the body except the sperm and ovum, which are genetic tissues responsible for transmitting specific traits from one generation to the next. The most radiosensitive somatic tissues exposed to dental sources of radiation and the type of damage induced, are: bone marrow and leukemia; thyroid gland and thyroid cancer; the lens of the eye and cataract formation. According to White, salivary glands, especially the parotid gland, also are at risk for the development of malignant salivary gland disease.[1-3] In a review of current methods of estimating risk, White found that low doses of radiation, in the range of 0.2 Gy or less, carry more risk of causing cancer than was previously thought.[1]

The agencies most frequently cited for estimating the risks from radiation are the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR),[4] the committee on the Biologic Effects of Ionizing Radiation (BEIR) of the United States National Research Council[5] and the International Commision on Radiological Protection (ICRP).[6]

When genetic tissues are exposed to radiation, there is a risk of a congenital or heritable defect. The gonadal dose following a full month survey (FMX) is less than 0.01μSv in an adult female; for males, it is 10μSv or less.[1] Hiroshima survivor data indicate that damage to newborns did not occur in doses below 200 mSv to the genetic tissues.[7] White concluded that the risk of heritable defects from dental radiology is negligible.[1] It is thought that exposure to dental radiation of the fetus in utero could result in mental retardation of the newborn at threshold doses of 0.12-0.2 Sv; however, since the uterine dose from an FMX is less than 0.01μ SV, the risk of mental retardation from dental radiology is considered nonexistent.[1]

Therefore, the risks from dental radiation are essentially to the *somatic* tissues, rather than the *genetic* tissues, and the risk may be higher than previous estimates. Risks are defined differently depending upon whether the person is occupationally exposed, as for a dental healthcare worker (DHCW), or whether the exposure results from being a patient. Because we will be referring to quantities of radiation in several different radiation units, table 1 is included to illustrate the various equivalent doses.

Table 1. Dose Conversion Table

(m = Milli or 1,000th) (μ = micron or 1,000,000th)
(100 rem = 1 Sv) (100 rad = 1 Gy)
(1 rad = 1 rem) (1 Gy = 1 Sv)

mrad/mrem	rad/rem	Gy/Sv	mGy	μGy
1	0.001	0.00001	0.01	10
1000	1	0.01	10	10000
1000000	100	1	1000	1000000
100	0.1	0.0001	1	1000
0.1	0.0001	0.000001	0.0001	1

Maximum Permissible Doses

The National Council on Radiation Protection and Measurements (NCRP)[8] and the International Commission on Radiological Protection (ICRP)[6] have defined MPD as the maximum permissible dose equivalent that an occupationally exposed person or parts thereof shall be allowed to receive in a stated period of time. The definition embodies the principle that cells can repair radiation damage and that different tissues have varying radiosensitivities. Stated more simply: MPD is the maximum dose of radiation sustained over a period of time that a person can absorb without appreciable injury. The MPDs for both occupationally and non-occupationally exposed persons excludes radiation received from environmental/natural background sources, for which the annual effective dose is 3 mSv, and artificial radiation (such as medical and dental exposures), for which the annual effective dose is 0.6 mSv.[9] These exposures are excluded because they cannot be controlled.

Different MPDs have been developed for occupationally exposed persons than for patients. According to the most recent guidelines provided by the NCRP,[9] the maximum permissible effective whole body dose to an occupationally exposed dental healthcare provider is 50 mSv; for the general public, it is 1 mSv. However, because different tissues and organs have varying sensitivities to radiation, the equivalent dose limits vary among these tissues. For example, the MPD to the lens of the eye for occupationally exposed persons is 150 mSv; it is 500 mSv each for the skin, hands and feet. For the general public, the MPD is 15 mSv for the lens and 50 mSv for the skin.

For occupationally exposed pregnant workers, the MPD is 1/10th the normal recommended MPD.[9]

Dental HCWs who are not occupationally exposed have the same MPD as for the general public. At doses equal to the MPD, the risk is not zero, but it is small and consistent with risks encountered in other occupations. Thus, no matter how small the dose, there may be some effect.[10]

According to ICRP, no ill effects or injuries have beeen encountered as a result of exposures within the limits defined by the MPD.[6] It should be noted that NCRP and ICRP are private nonprofit organizations; therefore, their recommendations do not carry the force of law. However, most federal and state radiation regulatory bodies follow these recommendations.

Risk From Dental Radiation

Risk from dental radiation, often referred to in terms of absolute risk, is expressed as the number of extra fatal cancers in a given tissue or organism per million X-ray examinations. According to the BEIR V and the 1990 ICRP reports, the relative risk model is the most appropriate way to estimate risk. In 1992, White[1] compared the risk of fatal cancers per million full mouth surveys (FMX) to that of panoramic radiographs (PAN). His data were based on FMXs exposed at 70 kV D speed film and round open-ended cones (PID) and PANs using rare earth screens. For bone marrow, he reported 0.7 extra cancers per million FMXs and 0.06 extra cancers per million PANs. He also noted 0.1 and 0.01 extra cancers of the lung respectively for the FMX and PAN examinations; 0.1 (FMX) and 0.02 (PAN) extra cancers of the esophagus; 0.8 (FMX) and 0.06 (PAN) extra cancers of the thyroid. Overall, when all tissue sites were considered, White found 2.5 extra cancers per million FMXs and 0.21 extra cancers per million panoramic examinations. Danforth and Gibbs[11] have stated that the risks from dental radiation compare with similar one in a million risks that we take every day; for comparison, see table 2.[12]

According to several reports,[1-3] there may be an increased risk of malignant parotid salivary gland tumors associated with dental radiation. In his review, White[1] reported an overall 10-fold

Table 2: One in 1 million risk of fatal outcome

Risk	Outcome
20 minutes as 60-year-old male	natural death
2 months in Denver, CO	cosmic radiation
10 miles by cycle	accident
300 miles by automobile	accident
10 days typical factory work	accident
1 cigarette	chemical carcinogens
500 ml wine	alcohol-related death
125 ml whiskey	alcohol-related death
1500 ml beer	alcohol-related death

increase in the risk of developing cancer from the intraoral full mouth survey as compared to the panoramic examination. Underhill and colleagues[13] included the salivary gland data in their study, and found a 15-fold increase in the risk of developing a radiation-induced cancer using FMXs as compared PANs.

The risk of radiation damage to the eye is cataract formation. The type of dose response curve used in estimating this risk is the threshold type as opposed to the linear type. This means very little damage can be detected at doses less than the threshold dose, which for radiation-induced cataracts of the eye is about 2 Gy when the dose is received in a single exposure.[14-16] According to BEIR V, it is more than 5 GY when the dose is received as multiple exposures over a period of weeks.[5] When long round open-ended cones are used, the single film dose to the eye is 0.5 mGy, whereas for the panoramic it is 0.09 mGy per PAN.[14-16] Thus, the risk of producing damage to the eye in dental radiology is remote.

The reported gonadal dose from an FMX ranges from 2 to 20μGy with the protective apron in place.[17] The gonadal dose in panoramic radiology is much less than the FMX dose when the protective apron is in place, as the narrow slit beam of radiation is directed from below at an upwards angle of 5-7 degrees.[18]

Reducing Patient Dose

Advances in technology, greater patient awareness and the application of new devices by dentists offer many opportunities for reducing the dose of radiation to patients.

The use of higher kVp results in less radiation absorbed by the patient. In general, higher kVp radiation is more penetrating, resulting in less of the radiation being absorbed by the superficial soft tissues. Therefore, a lesser amount of the higher kVp radiation is needed to expose the film. In one study, there was a reduction of up to 23 percent between comparable density radiographs (overall darkness) with an increase in kVp from 70 to 90.[19] Today, many x-ray machines have fixed kilovoltages of 70 kVp or less. These devices are less desirable than those capable of settings up to 90/100 kVp.

The use of the long cone (PID) has always produced a lesser absorbed radiation dose to the patient than the short cone (PID).[20] This is because the collimator on an eight-inch short PID is about the size of a nickel, while the collimator for a long 16-inch PID is about the size of a dime. Thus, with the smaller collimator, less of the patient's tissues are irradiated, reducing the secondary radiation doses to the patient. Secondary radiation occurs when photons of radiation bounce off dense tissues such as bone and are redirected to another part of the body to produce exposures at distant sites, such as the gonads. Because this redirected radiation is internal, the use of protective aprons is of limited value in shielding patients against this type of radiation. Because of the inverse square law,[21] the exposure time for the long cone will be four times longer than for the short cone to produce films of the same density if the film speed, kVp and mA are kept constant. However, though the radiation exposures to the film are the same, as stated previously, more tissue is exposed with the use of the short cone.

Though the short cone may be more convenient, the selection of a machine with a recessed anode design has the convenience of a short cone and the dose reduction advantages of the long PID. To assess true cone length, study the machine specifications or measure from the dot representing the location of the focal spot on the tubehead to the tip of the cone. However, recessed anode tubeheads are difficult to find at the present time.

Using the long PID with rectangular collimation will further reduce patient doses from those received with the long round PID. Rectangular collimation can be achieved by Precision film holders, Rinn or Masgraf rectangular PIDs or the Rinn stainless steel rectangular collimator attached to the end of the round PID. Underhill reported the dose to the thyroid gland for a 20-film FMX using the long round cone is 628 μGy, while the dose using the long rectangular cone was 270 μGy. For the parotid gland, the dose for the FMX was 5,236 μGy, and for the rectangular cone, 859μ Gy, a considerable savings in dose.[22] Underhill reported a risk of 7.1-17 extra cancers for the FMX using the long round cone, while the risk using the long rectangular cone was 2.5-6.6 extra cancers per million FMXs.[13]

The leaded apron is useful in protecting the patient from scatter radiation. Scatter radiation occurs after the primary beam passes through the patient and bounces off dense objects in the room, reexposing the patient. Thus, the leaded apron designed for intraoral radiography should cover the thorax and abdominal area. In panoramic radiology, the poncho type, which hangs from the shoulders and protects both the front and back sides of the patient, is preferred. This is because both the front and back of the patient are exposed in panoramic x-ray projections.[22]

The thyroid shield can be used for intraoral radiography, but should not be employed in panoramic radiology as it will absorb portions of the lower part of the primary beam and produce voids in the image. It is interesting to note that in spite of the thyroid shield being in place for the FMX, Underhill reported doses of 628 μGy for the FMX using the long round cone, 270 μGy for the FMX using the long rectangular cone and only 47 μ Gy for the panoramic without the thyroid shield.[22]

Using faster film can reduce exposure by a factor of 40 percent to 50 percent.[23] In the United States, this will mean using the new KODAK EKTASPEED Plus film instead of KODAK D speed film. The recommended processing solution for this film is the KODAK Readymatic chemicals. The recommended darkroom safelight is a 7 1/2 watt bulb with the KODAK GBX II filter at the usual four feet from the countertop.

PAN vs FMX

Selecting a panoramic radiograph in lieu of the intraoral full mouth survey will result in a significant savings in radiation dose to the patient without

necessarily compromising the diagnostic benefit of the radiographs. White estimated that there is about 10 times less radiation dose to the patient from the panoramic radiograph than the FMX.[1]

White has advocated including the salivary glands, particularly the parotid, as tissues at risk for the development of extra cancers as a result of dental radiography. In 1988, Underhill and colleagues compared doses to the salivary glands from FMXs to those from PANs. They used E speed film, 90 kVp and the long round open-ended PID for the FMXs and rare earth screens for the PANs. They reported the following doses: for the parotid gland, the FMX delivered an average dose of 5,236 µGy versus 670 µGy for the PAN, nearly seven times less radiation for the PAN. For the submandibular gland, the FMX delivered an average dose of 8,984 µGy versus 375 µGy for the PAN, 24 times less radiation for the PAN. For the sublingual gland, the FMX delivered an average dose of 7,833 µGy versus 134 µGy for the PAN, nearly 59 times less radiation for the PAN.

Langlais and colleagues[24] have discussed in some detail evidence which indicates that a properly exposed panoramic radiograph may, in many instances, be used to interpret interproximal caries, especially in the posterior region; the level of alveolar bone in the assessment of periodontal disease; and periapical disease of pulpal or periodontal origin. Diagnosis of these dental diseases previously was believed by most to require full mouth survey and/or bitewings. While this recommendation may not be appropriate in all cases, there is mounting evidence that such diagnoses can be made with the aid of properly exposed panoramic radiographs. This phenomenon may be explained in part by the reports of several investigators who compared direct exposure intraoral film to intraoral screen/film images. They found that clinical judgement seemed to be affected more by contrast than by sharpness[25] and the higher contrast of the screen/film image over E speed film seemed to compensate for the inherent reduction in sharpness.[26] Panoramic films and rare earth screens are capable of producing sufficient contrast to distinguish both bony and soft tissue details, as well as the difference in densities between enamel, dentin and pulp.

Traditionally, resolution, which is a measurement of sharpness, has been used as the primary criteria to assess the efficacy of an image; adequate resolution has been the principal reason for advocating intraoral radiographs for the aforementioned diagnoses.[27] Scarfe and colleagues[28] calculated the horizontal angle of incidence of the panoramic beam required to routinely avoid interproximal overlap, especially as often occurs in the premolar area. They state that there are several machines with improved orthogonal projections available, though none of these machines were specifically designed on the basis of newer projection geometry data. However, since most of these newer machines are based on robotic principles and controlled by a specific computer chip, even older models can be updated when newer panoramic projection beam geometry becomes available. When there is a reduction of posterior interproximal overlap and sufficient contrast, then caries and many other subtle density changes will be readily detectable in panoramic radiographs.[29]

In a recent report using narrow beam panoramic radiology (Scanora/Soredex), Tammisalo and colleagues[30] found the panoramic image was better than intraoral radiographs for detecting periodontal and periapical pathology. Langlais and colleagues[24] reported that some investigators have observed that periapical rarefaction of bone is detected more easily on the panoramic radiograph than the corresponding periapical, though the reason for this so far defies full explanation.

Radiation doses from panoramic x-rays can be further reduced by approximately 40 percent by placing a filter of rare earth screen material over the narrow slit panoramic collimator without appreciably affecting image quality.

Direct Digital Imaging

The integration of direct digital x-ray imaging may reduce the radiation dose to patients. Intraoral direct digital systems average about 50 percent less radiation than the fastest current film-based images. Narrow beam digital panoramic devices have the potential of reducing radiation dose by at least 50 percent when these new machines are introduced to the market, most likely in 1995.

Several reviews on digital imaging have been presented.[31-33] Two types of intraoral digital systems currently are available. The first involves a screen-producing fluorescence transmitted by a fiberoptic bundle to a charge coupled device CCD and then to the computer or a direct exposure CCD type of detector. CCDs transmit the image information to the computer by a line similar to a telephone wire, thus allowing instantaneous viewing of the image. These CCD detectors are narrower than number 2 periapical film, so more exposures may be required for the full mouth survey. Therefore, the reduction in radiation from taking an FMX with a CDD digital device may be misleading.

The second type of detector is an image storage phosphor plate. This type of detector has no wire, but must be placed into the computer via a read-out device which processes the stored image electronically into a digital image format.

Each of these digital intraoral systems has advantages and disadvantages, but both have the following features in common: less primary radiation and diminished scatter per image; no film or chemical processing and associated devices, chemicals, maintenance and space needed; long-term savings as there is no need for materials and supplies such as film, mounts, chemicals for processing, processor maintenance and infection control; simplified infection control procedure requirements; rapid image acquisition; improved convenience and labor cost savings; fewer retakes because the density or contrast can be altered by digital image adjustments in the computer; expanded diagnostic yield by image

subtraction to detect early caries or periodontal disease; rapid consultation by a faxlike transmission to one or several colleagues with compatible equipment; and better patient patient communications by use of television monitors to explain the patient's oral condition. Several panoramic systems also are available or are under development and will have digital features similar to those of the direct digital systems described.

Whatever system is in use, retaking any radiograph doubles the radiation dose to the patient for that image. The obvious answer to this problem is to strive for perfection in techniques by continued learning. Dental healthcare workers have become adept at intraoral radiography over the century since Roentgen's discovery of x-rays in Germany in 1895. Intraoral film-positioning and beam-indicating devices are helpful, as is strict adherence to the manufacturer's instructions with regard to automatic processor operation and maintenance.

It is the authors' belief that panoramic radiology equipment, first introduced 35 years ago, although very popular, is less well understood than conventional intraoral radiography. The panoramic system is generally unforgiving of patient positioning and other technical errors, yet troubleshooting the image is very simple to learn. The first step in using panoramic radiography properly is to recognize deficiencies in image quality and projection geometry. Once that is accomplished, training of dental x-ray technologists becomes a rather simple procedure. As a result, the diagnostic quality of your panoramic radiographs will improve immensely.

Reducing Operator Risk

The following recommendations, as iterated by Preece,[34] have been in practice for many decades.

- Stand at least 6 feet away from the patient and in the safe quadrant, which is a position between 90 and 135 degrees to the primary beam.
- When distance and position requirements cannot be met, stand behind an impermeable barrier, such as a leaded wall or other similarly effective material such as concrete, cinderblock or a double thickness of sheetrock.
- Do not hold the film or other devices, such as the tubehead, during exposure.

For personnel who are worried about being exposed in a dental office, monitoring devices are available which accurately measure the exposure. Monitoring devices should not be worn when dental personnel have radiographs taken on themselves as patients. Under normal circumstances, personnel radiation monitoring is neither recommended by the authors nor is it required by most states.

The risk from exposure to radiation has always been a consideration in what we do for our patients and staff. The risk to patients for the very small doses received in dental radiology, although still acknowledged as slight, is believed to be greater (UNSCEAR 1988, BEIR V 1990 and ICRP 1990) than indicated in previous reports. With currently available devices and material, further decreases in patient exposure are possible. The risk of occupational exposure in dental radiology is virtually nonexistent when appropriate radiation hygiene practices are in force.

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Feature

X Rays: What is the Risk?

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Introduction

If it hasn't happened already, it will. It's simply a matter of time before one of your patients will ask: "How much radiation is involved with these x rays?" or "Aren't these x rays harmful?" or, "Are you using the latest methods to reduce my exposure to x rays?" Dentists and their office personnel are continually asked questions pertaining to the use of x rays. Your response, or that of your staff, may have a profound effect on your practice. To respond with a clear and concise answer will serve to increase their confidence in you as a practitioner. On the other hand, to simply ignore these questions, or treat them lightly, may create the impression of a lack of concern for their overall well being. This may not only result in a loss of the patient's confidence in your ability, but also the loss of a patient.

There is no question that ionizing radiation in general, and x rays in particular, have a potential harmful effect on humans. It is known beyond a shadow of doubt that if exposed to sufficient quantities of radiation, humans will experience an increased risk of nonfatal and fatal cancer, hereditary disease, or loss of life expectancy. It is the purpose of this article to provide you with the information to put these risks into perspective, allowing you to use x rays when needed for diagnosis.

Frederiksen

Radiation in our Environment

No matter who we are or where we live, we are subjected to quantities of radiation exposure from a variety of sources. Because not all of these sources are responsible for exposure of the whole body, the quantities of radiation they deliver are expressed in terms of effective dose. This unit, effective dose, is calculated from both whole- and partial-body exposures. It is the dose that may be expected to result in the same total risk of harm as that from a uniform whole-body exposure of the same magnitude. Effective dose is then a useful term that allows comparisons to be made between sources of radiation exposure which expose only portions of the body, such as radiographic techniques, and whole-body exposures, including those resulting from natural or background radiation. The unit of effective dose is the sievert (Sv). A millisievert (mSv) is one thousandth of a sievert.

Estimates of the radiation exposure of all persons living in the Unites States resulting from all sources have been made. By totaling these individual exposures and then dividing by the population, an average dose has been determined (1) (Table 1). In this manner, it has been estimated that an average individual living in an average location in the United States receives an effective dose of 3.6 mSv of radiation every year. Of this total, over 80 per cent (3.0 mSv) is the result of natural or background radiation. This means that every day of a person's life, they receive 0.008 mSv of radiation exposure from natural sources or sources over which they have no control. We are all concerned with the human contribution to radiation exposure; however, it is estimated that in total, this amounts to only 0.6 mSv. Including everything from the medical uses of radiation to consumer products (including some smoke alarms, airport inspection systems, and dental porcelain) to nuclear reactors, this category subjects an average individual to less than one third the radiation delivered by naturally occurring radon (2.0 mSv).

Dental x-ray examinations are estimated to be responsible for an average annual effective dose of less than 0.01 mSv (2). This figure, equal to only 2.5 percent that of medical x-ray diagnosis and 0.3 percent of the total average annual effective dose, is surprising when it is considered that dentists own over half of the x-ray machines in this country and perform an estimated 105 million examina-

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tions per year using 380 million pieces of film. In spite of these figures, the use of x rays in dentistry is not considered as a source of exposure and for that reason not listed in Table 1. The exclusion of dental x rays as a source may have resulted in part from the introduction of the term "negligible individual dose" (3). Formulated by the National Council on Radiation Protection and Measurements, a private, nonprofit organization whose findings are made into law by most states, the negligible individual dose is that quantity of radiation that can be dismissed. Currently, this dose is established at 0.01 mSv per year, a quantity equal to that of the estimated average annual effective dose resulting from dental x-ray examinations.

Exposure From Dental X Rays

Occupational Exposure. Within twenty-five years of Roentgen's discovery of x rays, it had been estimated that over 100 early pioneers in radiology had died of cancer caused by their exposure to radiation (2). This finding, among others, has resulted in the establishment of limits on the amount of radiation a person may be exposed to in the course of their occupation. The Texas Regulations for the Control of Radiation state that each registrant shall control the occupational dose to individual adults such that it will not exceed an annual effective dose of 0.05 Sv (4). This limit has been set in an attempt to ensure that the lifetime fatal cancer risk as a result of exposure to x rays will be similar to the risk of accidental death in "safe" industries where there is no exposure to radiation. Because even this dose carries with it some risk, all individuals are further urged to follow the principles of ALARA (As Low As Reasonably Achievable) which recognize that no matter how small the dose, there may be some risk of effect. The fact that the dental profession follows these principles may be illustrated by the fact that most recent data show that the annual effective dose of those occupationally exposed in the operation of dental x-ray equipment was 0.2 mSv (2). This figure is only 1/250 the allowable limit. This finding is perhaps one of the reasons that the State of Texas no longer requires radiation monitoring of dental employees.

Patient Dose. The dose delivered to the patient as a result of an x-ray examination is dependent in part on the specific area exposed, the size of the area exposed, and on the type of image receptor used. The latter may be either intraoral direct-exposure film, extraoral screen-type film, or some form of solid state detector as used in digital radiography, including computed tomography. Table 2 (5,6,7,8) lists the effective dose patients may receive by undergoing both some common and more specialized dental and medical radiographic examinations. By comparison of figures in the table, a lower GI series (barium enema) can be seen to deliver 27 times more radiation to the patient than a full-mouth series of oral radiographs and a radiograph of the chest about three times more than a panoramic film.

Risk

Risk is the chance or possibility of loss or injury. The probability of loss or injury may be considered in both relative and absolute terms. Relative risk can be illustrated by comparing doses received as a result of exposure to x rays for diagnostic purposes with natural or background radiation. Table 2 lists the days of equivalent natural exposure. It can be seen from these data that a panoramic radiograph delivers a dose to the patient equal to 3.3 days of natural radiation exposure, a bitewing examination 4.8 days, and a full-mouth survey 18.8 days. Additionally, by comparison, radon in our environment (2.00 mSv, Table 1) is responsible for an annual exposure of over 13 times that of a full-mouth survey of intraoral films. These figures can also be used to make comparisons between persons living in various locations of the U.S. For example, it has been estimated that the effective dose from cosmic radiation in Denver, Colorado, is 0.24 mSv higher than the U.S. average (2). This is because of Denver's higher elevation. This would mean that a patient living in an average location of the U.S. who had almost four panoramic and bitewing examinations every year (total effective dose for these examinations is 0.064 mSv, Table 2) would incur the same risk of potential harm from radiation as a patient living in Denver who was not exposed by these examinations.

In absolute terms, risk can be described by calculation of detriment. Detriment is a term used to represent a combination of the probability of occurrence of an unfavorable health effect resulting from radiation exposure and a judgment as to the severity of the effect (9). Thus, radiation detriment can be expressed as the total harm that would eventually be experienced by an exposed population of individuals and their descendants as a result of radiation exposure. This includes the probability of fatal cancer, the weighted probability of nonfatal cancer, the weighted probability of hereditary effects, and the relative length of life

X rays: What is the Risk?

lost. Detriment can be calculated on the basis of the probability of incidents per million of exposed population, the population at risk (Table 2). For some of the more common examinations, this probability ranges from less than 0.1 per million for a single-film tomogram that may be made for oral implant diagnostics, to 11 per million for a full-mouth survey, to 296 per million for a lower GI series.

Calculation of risk per million from the use of x rays allows for comparison with risks patients are subjected to in the course of their everyday lives. Table 3 lists some of these risks compiled from various newspaper and news magazine articles over the years. These data, expressed as the probability of either death or developing cancer, show that patients have about the same risk of choking to death (13 per million) as expressing some detriment from having a full-mouth survey (11 per million) made during the course of an oral examination. In all fairness, however, diagnostic x rays involve a risk generally much higher than that of being killed by falling airplane parts or in a shark attack.

Minimizing the Risk to Patients and Personnel

Although the risk from exposure to x rays may be compatible with everyday life, according to the principles of ALARA we should always try to employ techniques, equipment, and materials that will allow us to produce radiographs with the least amount of radiation. As an added benefit, everything we do to reduce patient exposure will reduce the possibility of exposure of ourselves and our personnel.

The following is a summary of methods of exposure reduction that can be used in oral radiography (2). Patient selection is probably the single most effective way in which exposure can be reduced (See *Guidelines*, this issue). If the decision is made that radiographs are not necessary, this represents a 100 percent reduction in patient exposure. An almost 50 percent reduction in patient exposure can be realized by using E-speed film rather than D-speed film. The use of digital intraoral imaging techniques also requires less radiation. Digital imaging has been found to require only 40 percent the radiation of E-speed film and 23 percent that of D-speed film (10). Rare-earth intensifying screens, such as Lanex® (Eastman Kodak Co., Rochester, NY), which may be used in extraoral radiography, are up to eight times more sensitive to x rays than conventional screens, resulting in a significant reduction in patient exposure. Long-cone instead of short-cone techniques for intraoral radiography may result in a 32 percent reduction in exposed tissue volume. Rectangular collimation will reduce the area of the patient's skin surface exposed by 60 percent over that of round collimation. Leaded aprons and collars can reduce the amount of scatter radiation to the patient's abdomen by 98 percent and to the thyroid gland by 92 percent. And finally, good darkroom techniques, including time-temperature processing, may contribute to exposure reduction. Six percent of dental radiographs may not be readable because of poor darkroom techniques. Radiographs that must be remade because of inadequate exposure or processing techniques result in a doubling of patient exposure.

Finally, to ensure that a dental office consistently produces high quality radiographs with a minimum of patient exposure, the American Dental Association recommends the establishment of a quality assurance program in each dental office (11). Such programs include inspection of the x-ray unit, darkroom, and ancillary equipment such as leaded aprons at suitable intervals and the establishment of written procedures for safe operation, exposure and processing techniques, and maintenance. Many of these items are required by the Texas Regulations for the Control of Radiation (4) (See *Message*, this issue).

The practice of dentistry requires lifelong learning. Every practitioner should keep in mind that developing and maintaining skills and acquiring knowledge is a continuous process. Every effort should be made to be aware of improvements in techniques in radiology and every field of dentistry so that patients may receive quality care.

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Table 1.

Average Annual Effective Dose of Ionizing Radiations to a Person in the United States

Source			Effective Dose (mSV)
Natural			
	External		
		Cosmic	0.27
		Terrestrial	0.28
	Internal		
		Radon	2.00
		Other	0.40
	Total		3.00
Man-Made			
	Medical		
		X-ray diagnosis	0.39
		Nuclear medicine	0.14
	Consumer products		0.10
	Other		
		Occupational	<0.01
		Nuclear fuel cycle	<0.01
		Fallout	<0.01
		Miscellaneous	<0.01
	Total		0.60
Total= Natural plus Man-Made			3.60

Dental not listed

X rays: What is the Risk?

Table 2.

Effective Dose by Radiographic Technique

Technique	Effective Dose (mSv)	Days Equivalent Natural Exposure	Probability (per million)
Dental			
Intraoral			
Periapical (15 films)	0.111	13.9	8.1
Bitewing (4 films)	0.038	4.8	2.8
Full-mouth survey (19 films)	0.150	18.8	11.0
Extraoral			
Panoramic	0.026	3.3	1.9
Film tomography *	<0.001-0.030	<0.1-3.8	<0.1-2.2
Computed tomography			
Maxilla	0.104	13.0	7.6
Mandible	0.761	95.1	55.6
Medical			
Lower GI series	4.060	507.5	296.4
Upper GI series	2.440	305.0	178.1
Chest	0.080	10.0	5.8

* Scanora® Integrated Imaging system (Orion/Soredex, Helsinki, Finland). The effective dose is dependent on the region of the jaws exposed and the collimation option used, i.e., round or rectangular.

Table 3.

How Safe ?

End Result And Cause	Probability of Occurrence (per million)
Cancer	
Exposure to termicide (Chlordane)	100-300
Herbicides and fungicides on fruits and vegetables	278
Death	
Choking	13.0
Boating accident	4.6
Tornado	2.2
Bathtub accident	0.6
Struck by lightning	0.5
Overseas terrorist attack	0.1
Falling airplane parts	0.1
Shark attack	0.003

Biological effects of radiation from dental radiography

Council on Dental Materials, Instruments, and Equipment

The harmful nature of high doses of X rays has been known for many years. However, for low doses, such as those commonly employed in dental radiographic procedures, the magnitude of the risk (or even if there is a risk) remains uncertain. (The concept of high and low doses is very subjective. Within this report 0.20 Gy (20 rads) is arbitrarily considered the demarcation between high and low doses. Units are defined in the next section.)

The principal risks associated with low doses of X rays are cancers, mutations, and congenital abnormalities.[1] A major problem in evaluating the risk of these effects is that there is no known method of distinguishing between those effects induced by radiation and those arising from other causes. Therefore, the only way to assess the magnitude of these risks is to look for excess incidence in irradiated populations. If this excess incidence is expected to be small, as from a diagnostic dose of X rays, then extremely large populations and long periods of observation are required. (The latent period for radiation-induced cancer, even from high doses, is years to decades.[2]) For example, to evaluate by epidemiologic methods the well-publicized breast cancer risk of mammography, a population of 60 million women, followed from age 35 to death, would be required for a reasonable chance of accurate results.[3] Half of the sample would receive mammographic examination at age 35; half would not. Obviously, such a study would require a massive international effort, would take at least 40 years to complete, and would be prohibitively expensive; thus it is not likely to be performed.[4] Similar considerations apply to evaluation of risks of all cancers and mutations in human beings from other low X-ray doses including dental radiography. Therefore, observations from human and animal populations exposed to large doses must be used for

Table 1 ■ Radiation doses to US population from environmental sources.*

Source	Average dose equivalent rate† (μSv/yr)
Natural	
Cosmic	280
Terrestrial	260
Internal	240 (marrow), 280 (gonads)
Artificial	
Atmospheric weapons test	40-50
Nuclear power industry	1
Building materials	30-40
Total (rounded)	800

*Data from BEIR III[1]; excludes occupational exposure.
†Whole body unless otherwise indicated; prorated over total population. For conversion, 10 μSv equal 1 mrem.

Table 2 ■ User doses from selected consumer products.*

Product	Body portion considered	Average dose equivalent to user (μSv/yr)‡
Luminous wristwatch	Gonads	10-30
Television receiver	Gonads	3 (females), 10 (males)
Combustion of fossil fuels		
Coal	Lungs	2-40
Oil	Lungs	0.02-0.4
Natural gas	Lungs	60-220
Tobacco products	Lungs	80,000
Airline travel†	Whole body	5

*Data from BEIR III[1].
†Average trip.
‡For conversion, 10 μSv equal 1 mrem.

risk estimation, thus leading to significant problems in the quantitative estimation of risks to humans from low doses of radiation.

Several excellent reviews of available data, together with discussions and interpretations, have been published. The latest reports of the committee on Biological Effects of Ionizing Radiation (BEIR)[1] of the National Academy of Sciences and of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)[2] have considered the problem of radiation from all sources. A 1980 symposium from the American Association of Physicists in Medicine (AAPM)[3] limited its consideration to exposures in the healing arts. All are recommended.

Radiation quantities and units

Three quantities are commonly used in discussions of radiation dosimetry: exposure, dose, and dose equivalent. Exposure refers to the quantity of radiation incident upon something and is generally measured in units called roentgens (R). However, when biological material is exposed to X rays, only a portion of the incident energy is absorbed; much of the energy is transmitted through the tissue without effect. The amount of energy absorbed is termed dose, and is traditionally measured in rads (1 rad is 100 ergs of energy absorbed per gram of absorber). The relationship of dose to exposure depends on both X-ray energy and the nature of the absorber. For example, with a diagnostic-energy X-ray beam, one R of exposure will deposit about 0.9 rads to soft tissue and 3 to 4 rads to bone.

Different types of radiations (such as X rays, neutrons, and alpha-particles) differ in the magnitude of their effects per rad. Thus the term dose equivalent has been introduced to compensate for this difference: it is the dose multiplied by the relative biological effectiveness (RBE) of the type of radiation employed, and is measured in rems. The RBE of X rays is, by definition, one, so for X rays the dose in rads is numerically equal to the dose equivalent in rems.

Recently, new units for dose and dose equivalent were introduced into the metric system.[4] The new unit of dose is the gray (Gy, 1 Gy = 100 rad) and that of dose equivalent is the sievert (Sv, 1 Sv = 100 rem). These new units are coming into widespread use and will be used in this report. In dental radiology, doses are quite small and are generally expressed in millirads (1 mrad = 0.001 rad) or micrograys (1 μ Gy = 0.000001 Gy). For conversion, 1 mrad is equal to 10 μGy. Similarly, 1 mrem is equal to 10 μSv.

For purposes of comparison with dental radiography, doses from environmental and various consumer product sources are given in Tables 1 and 2.

Genetic effects

It has been traditional to use the concept of relative risk in analyses of genetic risks of radiation.[1-3] Generally, a doubling dose, or the dose required to double the spontaneous mutation rate, has been determined. Recently, data from Japanese atomic-bomb survivors has been reanalyzed, providing an estimate of the doubling dose as 1.56 Sv (156 rems).[2] This recent estimate is in good agreement with previous estimates of 0.5 to 2.5 Sv (50 to 250 rems)[1] and 1 Sv (100 rems).[3] The effect of a small dose of radiation on human genetically-linked disease, as estimated by the BEIR and UNSCEAR committees, is given in Table 3, both for the first generation and at genetic equilibrium, which occurs after several generations. It must be emphasized that data in Table 3 are estimated, not proved.

Clearly, the information required for estimation of genetic risk is dose to the gonads. Recently published values of gonadal doses to patients from full-mouth intraoral dental radiographic examinations range from 2 to 20μGy (0.2 to 2 mrad), depending on beam

Table 3 ■ Estimated genetic risk per million live births for average population that has been exposed to a dose equivalent of 0.01 Sv (1 rem) per generation.

		UNSCEAR[2]		BEIR III[1]	
Disease classification	Current incidence	F1*	Equilibrium†	F1*	Equilibrium†
Autosomal dominant and x-linked	10,000	20	100	5-65	40-200
Irregularly inherited	90,000	5	45		20-900
Recessive	1,100	Slight	Very slow increase	Few	Very slow increase
Chromosomal aberrations	6,000‡	38	40	<10	Increase only slightly
Total	107,100	63	185	5-75	60-1,100
Percent of current incidence		0.06	0.17	0.005-0.07	0.06-1.0

*First postirradiation generation.
†Genetic equilibrium after several generations.
‡UNSCEAR suggested 4,000.

energy (kVp) and type of collimator.[8,9] These doses are numerically small, but not necessarily insignificant. Using the data in Teble 3 to estimate the genetic risk per unit dose, the gonadal doses from dental radiography should carry a very small risk of mutation—about one in a billion,[10] that is, about one recognizable mutation of any kind in the progeny of one billion people who receive an average, but unspecified, dental radiographic examination.

The Bureau of Radiological Health of the US Public Health Service has estimated for 1970 the genetically significant dose of X rays from exposure of patients in the United States during medical and dental examinations.[11] The genetically significant dose is the actual dose delivered to part of the population from medical and dental procedures, weighted by the probability in each exposed patient of conception of children, and then prorated for the entire population. The genetically significant dose is thus an estimate of the dose that, if administered uniformly to the total population, would be expected to carry the same genetic burden as the doses actually delivered to part of the population. In 1970, the estimated genetically significant dose was 200 μSv (20 mrem) from medical diagnostic procedures. From dental procedures, it was less than 1 μSv (0.1 mrem); thus the dental contribution to the genetic radiation burden of the American population in 1970 was excluded from the calculation. From these data and Table 1, it can be estimated that medical radiology contributes about 20% of the genetic radiation burden of the American population, whereas dental radiology contributes less than 0.1%. Use of radiologic procedures in the healing arts is increasing; however, technological advances will presumably reduce the gonadal dose per procedure so that the genetically significant dose will not increase and may decrease.

Table 4 ■ Sensitivity of various tissues to radiation-induced cancer.*

Site or type of cancer	Spontaneous incidence	Radiation sensitivity
Most common radiation-induced cancers		
Female breast	Very high	High
Thyroid	Low	Very high, especially in females
Lung (bronchus)	Very high	Moderate
Leukemia	Moderate	Very high
Alimentary tract	High	Moderate to low
Less common radiation-induced cancers		
Pharynx	Low	Moderate
Liver and biliary tract	Low	Moderate
Pancreas	Moderate	Moderate
Lymphomas	Moderate	Moderate
Kidney and bladder	Moderate	Low
Brain and nervous system	Low	Low
Salivary glands	Very low	Low
Bone	Very low	Low
Skin	High	Low
Least common radiation-induced cancers		
Larynx	Moderate	Low
Nasal sinuses	Very low	Low
Parathyroid	Very low	Low
Ovary	Moderate	Low
Connective tissue	Very low	Low
Radiation risk not demonstrated		
Prostate	Very high	Absent?
Uterus and cervix	Very high	Absent?
Testis	Low	Absent?
Mesothelium	Very low	Absent?
Chronic lymphatic leukemia	Low	Absent?

*Data from BIER III.[4]

Cancer

A few retrospective epidemiologic studies have suggested an association between diagnostic (including dental) X-ray exposure and cancer, especially leukemia;[12-15] however, such studies do not show cause and effect. They merely show an association. The association may be a case of X-ray exposure being the result of seeking medical care because of chronic illness associated with early undiagnosed leukemia, rather than a direct cause-and-effect relationship.

Cancer was not regarded as a major population risk from sublethal radiation doses until excess leukemia began to appear in the Japanese atomic-bomb survivors in the late forties. Since then, excess cancer has been identified in nearly all organs and tissues of the survivors.[4] Latent periods (the time between radiation exposure and development of clinical cancer) have ranged from a few years (for leukemia) to several decades.[1,2] In addition, excess cancer has appeared in many other populations. Uranium miners have been shown to get excess lung cancer from breathing radioactive radon gas; the risk appears greater in white than nonwhite miners.[16] A large population in England, treated with therapeutic doses of X rays for ankylosing spondylitis, have developed excess leukemia.[17] Tuberculosis patients in eastern Canada in the late forties were treated by repeated (up to 400 times) pneumothorax under fluoroscopic control. Excess breast cancer has been identified in the women in this study,[18] and in women treated with therapeutic X rays for postpartum mastitis.[19] Excess thyroid cancer has been found in a large population in the United States, who were treated years ago during childhood with therapeutic doses for tonsillitis, adenoids, and thymic enlargement. In this population, the risk in females was approximately twice that in males.[20] In Israel, some 1,300 children were treated with X rays for tinea capitis; excess cancers of the brain, salivary glands, and thyroid have been identified in this group.[21] The latest estimate of cancer risk in various organs, from BEIR III, is given in Table 4.

There are many problems in the estimation of the cancer risk from small radiation doses. There is much information for high doses, for both human beings and experimental animals;

Table 5 ■ Estimated specific organ cancer risks of radiation.*

Organ	Probability of radiation-induced cancer†
Breast	50-200
Thyroid gland	50-150
Lung	50
Marrow (leukemia)	15-25
Stomach	10-20
Brain	5-20
Colon	10-15
Liver	10-15
Lymphoma	4-12
Uterus	7-10
Salivary glands	5-10
Ovary	8
Bladder	4-7
Bone	2-5
·phagus	2-5
creas	2-5
ranasal sinuses	2-5

*Data from UNSCEAR.[1]
†Per 10,000 per Sv or per 1,000,000 per rem

Table 8 ■ Doses to organs in the head and neck from dental radiographic procedures (μGy per examination).*

No. of films	kVp	Source-subject distance (cm)	Shape of beam†	Dose to organs: Thyroid gland	Bone marrow	Salivary gland	Brain‡	Reference
Intraoral radiography								
14	65	20	Round	490		550		Richards and Webber[27]
14	90	20	Round	480		530		
22	90	40	Round	920		3,500		Winkler[28]
22	90	40	Rect	100		550		
21	80	20	R/Sh	200		4,100	470	Greer[29]
21	80	20	R/Op	390		4,950	890	
21	80	20	R/P	410		3,800	1,500	
21	80	40	R/Sh	230		2,500	300	
21	80	40	R/Op	400		3,750	400	
21	75	20	R/Sh	210		3,800	530	
21	75	20	R/Op	390		4,800	750	
21	75	20	R/P	430		3,850	980	
21	75	40	R/Sh	250		3,200	360	
21	75	40	R/Op	1,100		4,100	570	
21	90	20	R/Sh	330		4,100	640	
21	90	20	R/Op	410		5,150	850	
21	90	20	R/P	510		4,200	930	
21	90	40	R/Sh	170		3,050	300	
21	90	40	R/Op	380		4,350	540	
18	80	15	Round	4,280				Antoku, and others[30]
10					70			Wohni[31]
21	80	40	Round		160			White and Rose[32]
21	80	40	Rect		57			
4	75	30		400	800			Gregg[26]
1				30	10			UNSCEAR[2]
14§	60			500	50	6,000	200	Bengtsson[33]
16-22§			Round	730	100	2,880	480	Danforth and Gibbs[10]
21-22§			Rect	100	80	550	24	
2§‖			Round	390	40	560	240	
Panoramic tomography								
1	75			370		3,000		Kuba and Beck[31]
1	85-90			360-2,690				Antoku, and others[30]
1				100				Bushong, and others[34]
1					20			Wohni[31]
1	85-90			50-510		1,410-4,800		Manson-Hing and Greer[35]
1	75-80				11-33			White and Rose[32]
1	80					1,570		Weissman and Longhurst[36]
1§	75			100	10	3,000	50	Bengtsson[33]
1§				270	24	2,430	240	Danforth and Gibbs[10]

*For conversion 10 μGy equal 1 mrad
†Round, not further specified. Rect, rectangular. R/Sh, round beam, open lead-lined cylinder. R/Op, round beam, open unshielded cylinder. R/P, round beam, pointed cone.
‡Usually measured at pituitary gland.
§Representative estimate.
‖Bitewing.

however, as mentioned earlier, enormous study populations and long intervals of observation would be required to determine excess cancer incidence from small doses. Because there are no data for small doses, estimates of low-dose risk must be made by extrapolating from the effects of large doses—clearly a risky procedure. Until recently, most authorities have used a linear model for this extrapolation.[2] However, several lines of recent evidence suggest that so doing may overestimate the risk of small doses.[32] Despite these problems, the UNSCEAR Committee has estimated the lifetime cancer risk in individual organs per unit dose (Table 5). These data are estimates of average lifetime cancer risks for a population of the same age distribution as that used by UNSCEAR. Further, both UNSCEAR and BEIR committees have warned that their risk estimates are valid only over the range of doses from which the data were obtained. Thus, these data may not be applied directly for estimation of individual risk.

Because leukemia was the first radiation-induced cancer observed in the Japanese, it has received the most attention in the radiobiological literature. A concept analogous to the genetically significant dose, called the caput marrow dose, has been introduced.[33] The caput marrow dose is the dose that, *if administered uniformly to* the total population, would be expected to carry the same risk of leukemia as the doses actually delivered to part of the population from diagnostic procedures. For 1970, the caput marrow dose in the United States for medical radiology was estimated as 1,000 μGy (100 mrad), and that for dental radiology as 30 μGy (3 mrad). Comparing these data with the population dose from background sources (Table 1), it appears that medical radiology contributed about 55% of the leukemogenic burden from radiation in 1970 to the American population, whereas dental radiology contributed about 1.5%. Obviously, this approach assumes that the total population bone marrow dose, 1,830 μGy (183 mrad), in 1970 was harmful.

The somatic or cancer risk from dental radiographic procedures has been *estimated by use of the concept of detriment*,[24] in which the total risk from exposure of part of the body is the sum of individual risks to each organ exposed.[10,25,26] Use of this notion requires data detailing the dose to each sensitive organ in the body from each dental radiographic procedure. The risk to each organ is the product of the dose to that organ multiplied by the

Table 7 ■ Estimated cancer risk from dental radiology (cases per million examinations).

Examination	No. of films	Beam shape	Bengtsson[23]	Danforth and Gibbs[10]	Gregg[21]
Full-mouth, periapical and bitewing films	14-22	Round	12	8-17	
Full-mouth, periapical and bitewing films	21-22	Rectangular		1-2	
Bitewing	2	Round		3-7	
Dental, not further specified	4				3
Panoramic tomography	1		4	2-7	
Panoramic, intraoral source	1-2		2		
Skull	2-5			12-37	4
Chest	2			1-5	1.5

probability of cancer per unit dose in that organ. Examination of Tables 4 and 5 indicates that the organs at major cancer risk from dental procedures lie in the head and neck: thyroid, active bone marrow, brain, lymphatics, and salivary glands. Thus the cancer risk from dental procedures can be estimated as the sum of the risks to these five organs.

Several investigators have published doses from dental radiographic procedures measured at a variety of arbitrary sites in the head and neck (Table 6). Considerable disagreement is obvious in these data. All investigators reported in Table 6 obtained their data from adequately filtered and collimated beams. Round beams had diameters of 7 cm or less, as required by modern regulations. The data show reduced doses obtained with beams collimated rectangularly to the size of the films employed.

Using data from Tables 5 and 6, estimates of the total cancer risk from dental radiographic procedures have been calculated (Table 7).[10] For comparison, risks from chest and skull radiographic examinations have also been included. Because of the many assumptions involved in these calculations, it is appropriate to round the results to an order of magnitude—about one in a million—for the average dental radiographic examination, that is, one radiation-induced cancer at some time in the life span of one million individuals that receive an average, but unspecified, dental radiographic examination. (The data in Table 7 does not directly coincide with an order of magnitude risk of one in a million; however, the assumptions, approximations, and use of linear extrapolation make rounding to this order of magnitude appropriate.) This approach to risk estimation provides conclusions that differ from several that have been published.

This approach indicates that the risk from a single panoramic examination is about the same as that from a properly conducted full-mouth intraoral examination with rectangular collimation. The previous studies that have indicated greater risk for full-mouth intraoral examinations than for panoramic examinations have measured doses at arbitrary sites, most of which carry little or no radiobiological significance. The data in Table 7 are determined from dosimetry to organs of known sensitivity to radiation-induced cancer. It thus appears that the notions on relative risk of panoramic versus full-mouth intraoral examinations must be reconsidered.

Table 8 ■ Major radiation effects on the human embryo and fetus.*

Effect	Period of maximum sensitivity	Days after conception	Estimated minimal effective dose (Sv)†
Prenatal death	Preimplantation	0-9	0.1
Malformation	Organogenesis	15-50	0.1
Growth retardation	First trimester	15-90	0.1
Mental retardation	First trimester	15-90	0.1
Childhood cancer	First trimester	15-90	Unknown

*Data from UNSCEAR[1] and Brent and Gorson[39]
†For conversion, 1 Sv equals 100 rems

These are only risk estimates, not established facts, and thus provide only an approximation of the order of magnitude of the risk. They may be modified as additional data become available. Because they use compounded assumptions, particularly the linear dose-response model, they may be proved incorrect at some future date. The recent discovery of an apparent error in the dosimetry of the Hiroshima atomic bomb has cast some doubt on the validity of the Japanese data.[37] Dose recalculations are as yet incomplete; preliminary results suggest that the low-dose X-ray risk estimates may not be significantly changed by the new data.[38]

Embryo and fetus

The mammalian organism in utero is especially sensitive to the harmful effects of ionizing radiation.[3,39] An embryo or fetus undergoes rapid growth. Its immune system is undeveloped, and almost all exposures to radiation involve the whole body. Many studies with experimental animals have shown that X rays in sufficient doses can lead to a variety of adverse effects.[39] These effects are also known to occur in human beings as summarized in Table 8. For prenatal death and congenital abnormalities, most authors have suggested a threshold of about 0.1 Sv (10 rem). However, a few studies have shown minimal malformations from doses as low as 0.05 Sv (5 rem).[40] Similarly, most authors have considered a threshold of 0.1 Sv (10 rem) to apply to growth and mental retardation; a few cases of microcephaly have been found in the Japanese atomic-bomb survivors irradiated in utero with doses in the 0.01 to 0.1 Sv (1 to 10 rem) range.[3] These latter effects occur from exposure throughout pregnancy; the first trimester is most sensitive.

A large-scale retrospective epidemiologic study in England demonstrated a significant association between in utero exposure to diagnostic levels of X rays and childhood cancer, especially leukemia.[41] Since then, the study has been extended; and many similar studies have been carried out in several countries, including the United States. Most of these studies found similar associations, although a few were negative.[42] The weighted average results of all reported studies have indicated that the human embryo

Table 9 ■ Situations in which a person has a one in a million risk of dying.*

Risk situation	Cause of fatality
Being a man, age 60, for 20 minutes	Cardiovascular disease, cancer
Living in New York for two days	Air pollution
Living in Denver for two months	Cosmic radiation
Living in a stone building for two months	Natural radioactivity
Drinking water in Miami for one year	Carcinogens
Living near a polyvinyl chloride plant for ten years	Carcinogens
Riding in a canoe for six minutes	Accident
Riding a bicycle for ten miles	Accident
Riding in a car for 300 miles	Accident
Traveling by airplane for 1,000 miles	Accident
Traveling by airplane for 6,000 miles	Cosmic radiation
Working in a coal mine for one hour	Black lung
Working in a coal mine for three hours	Accident
Working in a typical factory for ten days	Accident
Smoking cigarettes, 1.4	Cardiovascular disease, cancer
Drinking wine, 500 cc	Cirrhosis
Drinking diet soda, 30 cans	Carcinogens

*Data from Pochin[19] and Wilson.[51]

may be exceptionally sensitive to the carcinogenic effects of radiation.[1,2,42] However, no excess childhood cancers were found in the Japanese atomic bomb survivors irradiated in utero.[43] Studies of a group of children who had received radiation in conjunction with routine pelvimetry at term found no excess childhood cancers.[44] Although there is some disagreement in the data, the above studies, taken as a whole, suggest that every precaution should be taken to minimize exposure to the unborn child.

The significant sensitivity of the embryo to radiation has led several countries to implement the 10-day rule, which requires that diagnostic exposure to the pelvic region in female patients of childbearing age be limited to the ten-day period following the onset of menses—unless there is compelling evidence that the patient cannot be pregnant or compelling medical reason to proceed with exposure even if she is pregnant.[45] This procedure has not been implemented in the United States.[46] Further, it applies only to involvement of the pelvic region in the primary beam. Therefore, the 10-day rule is not applicable to dental radiography. Occasionally, a patient may have a dental radiographic examination and subsequently be determined to have been pregnant at the time. There are no data concerning dose to the embryo from dental radiographic procedures. However, gonadal doses may be used as an approximation. These indicate that the dose to an embryo would not exceed 20 μGy (2 mrad) from either a full-mouth intraoral or a panoramic examination.[8,9] Current medical practice suggests that therapeutic abortion should be recommended on the basis of radiation exposure to the embryo only if the dose exceeded 0.1 Gy (10 rads). Obviously, doses from dental radiographic procedures should never approach that level.

Occupational exposure

The National Council on Radiation Protection and Measurements (NCRP) currently recommends a maximum permissible dose equivalent from occupational sources of 0.05 Sv (5 rem) per year.[47] A mean exposure of 100 μSv (10 mrem), range 50 to 600 μSv (5 to 60 mrem), in a one-month period among 231 dental personnel in 72 private dental offices has been reported.[48] In addition, the NCRP recommends an occupational limit of 0.005 Sv (500 mrem) to the embryo-fetus during the entire term of pregnancy.[49] Monitoring of occupational exposure of dental office personnel may provide protection to a dentist in the event of an illness or injury to an employee that could have been caused by radiation.

Summary and conclusions

Clearly, there is ample evidence of adverse effects of radiation in sufficient doses. There is at present no proof of such effects from doses commonly employed in dental practice; however, it has not been possible to prove the absence of such effects. Most experts now agree that there may be a small, difficult to quantify risk of cancer or genetic mutation from diagnostic exposure in patients and in personnel exposed during work. Prudence dictates acceptance of this position until proof to the contrary is available.

This report has presented recent attempts to quantify the risk to patients based on speculative calculations and extrapolations. Indices of population risks indicate that medical radiology is the largest source of humanmade genetic and leukemogenic radiation burden to the American public. Dental radiology contributes a small—but not necessarily insignificant—portion. Of major concern is the increasing use of radiation for diagnostic purposes in both medicine and dentistry. Technological advances have reduced exposure per examination; presumably this trend will continue so that total exposure of populations to radiation in the healing arts will not increase.

Recent analyses suggest that the cancer risk to a patient from a dental radiographic examination is of the order of one in a million; the genetic risk is substantially less, about one in a billion. The risks appear to be essentially equal for full-mouth intraoral and for panoramic examinations. These estimates are numerically quite small, but the effects are severe. Thus, these risks cannot be ignored. However, we currently accept risks of similar magnitude in our daily live. (Table 9).[50,51] In addition, the risk of failure to make an accurate diagnosis may be greater than the risk from exposure to the radiation from a justified and properly conducted radiographic examination. It therefore appears reasonable that the information gained from a justified and properly conducted radiographic examination outweighs the risk.

The risk estimates presented in this report are not established fact, and thus provide only approximations of the order of magnitude of risks. The estimates are useful for the a priori assessment of the risk of a dental radiographic procedure. They are not sufficiently accurate to permit meaningful calculation of the frequency of adverse effects of dental radiography.

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STATE OF ALASKA
1998 LEGISLATIVE SESSION

BILL NO. SB 160

Revision Date:
Title: Testing of radiological equipment
Sponsor: Senator Taylor
Requester: Senate L&C

Dept. Affected: Health and Social Services
BRU: Public Labs & Radiological
Component: Chief of Lab & Radiological Services
COMPONENT SERIAL NO. 2127
See also (SN#):

Expenditures/Revenues: (Thousands of Dollars)

OPERATING	FY99	FY00	FY01	FY02	FY03	FY04
PERSONAL SERVICES	(41.4)	(41.4)	(41.4)	(41.4)	(41.4)	(41.4)
TRAVEL						
CONTRACTUAL						
SUPPLIES						
EQUIPMENT						
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING	(41.4)	(41.4)	(41.4)	(41.4)	(41.4)	(41.4)
CAPITAL EXPENDITURES						
CHANGES IN REVENUES ( )						

FUND SOURCE (Thousands of Dollars)

1002 Federal Receipts						
1003 GF Match						
1004 GF						
1005 GF/Program Receipts	(41.4)	(41.4)	(41.4)	(41.4)	(41.4)	(41.4)
1037 GF/Mental Health						
Other (please specify)						
TOTAL	(41.4)	(41.4)	(41.4)	(41.4)	(41.4)	(41.4)

POSITIONS:

FULL-TIME	-1	-1	-1	-1	-1	-1
PART-TIME						
TEMPORARY						

Estimate of any current year (FY98) cost: $0.0

ANALYSIS: (Attach a separate page if necessary)

Currently, the Division of Public Health regulates all of the X-ray facilities in the state including dental, medical, chiropractic, veterinary and industrial. This bill proposes to move the responsibility for regulating the dental facilities to the Board of Dental Examiners. Dental facilities area are approximately half of all the X-ray facilities in the state. This proposal duplicates the service for a select category that is provided state wide .

3/4/98 Jmy

Prepared by: Peter M. Nakamura, MD, MPH
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Phone: (907) 465-3090
Date: 03/04/98

Approved by Commissioner: Karen Perdue, Commissioner
Agency: Department of Health & Social Services
Date: 3/4/98

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