

KODAK 2200 Intraoral X-ray System

User's Manual



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CE 0459



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1 Safety and Regulatory Information

The information contained in this manual is based on the experience and knowledge relating to the subject matter gained by Eastman Kodak Company prior to publication. No patent license is granted by this information.

Eastman Kodak Company reserves the right to change this information without notice, and makes no warranty, express or implied, with respect to this information. Kodak shall not be liable for any loss or damage, including consequential or special damages, resulting from any use of this information, even if loss or damage is caused by Kodak's negligence or other fault.

Conventions Used in This Manual



CAUTION:

Caution points out procedures that you must follow precisely to avoid damage to the system or any of its components, yourself or others, loss of data, or corruption of files in software applications.

Note

Notes provide additional information, such as expanded explanations, hints, or reminders.

Important

Important highlights critical policy information that affects how you use this manual and this product.

General Safety Guidelines

- This product is designed and manufactured to ensure maximum safety of operation. Operate and maintain it in strict compliance with the safety precautions and operating instructions contained in this manual.
- This product meets all the safety requirements applicable to medical equipment. However, anyone attempting to operate the system must be fully aware of potential safety hazards.
- There are no user serviceable parts in this system. The product must be installed, maintained, and serviced by qualified service personnel according to procedures and preventive maintenance schedules in the product service manual. If your product does not operate as expected, contact your Service Representative.
- Do not modify this product in whole or in part without prior written approval from Eastman Kodak Company.
- The assembly, extensions, adjustments, modifications, and repairs must be performed by an authorized Service Representative. Your radiology system must be installed in premises that comply with applicable standards.
- Personnel operating and maintaining this system should receive training and be familiar with all aspects of operation and maintenance.

-
- To ensure safety, read all user manuals carefully before using the system and observe all Caution, Important, and Note callouts located throughout the manual.
 - Keep this manual with the equipment.
 - Reading this manual does *not* qualify you to operate, test, or calibrate this system.
 - Unauthorized personnel are not allowed access to the system.
 - If the product does not operate properly or fails to respond to the controls as described in this manual:
 - Follow the safety precautions as specified in this manual.
 - Stop using the equipment and do not make or authorize any changes to it.
 - Immediately contact your Service Representative, report the problem, and await further instructions.
 - X-ray systems manufactured by Eastman Kodak Company comply with safety standards throughout the world for optimum protection against radiation risks.
 - Be aware of the product specifications and of system accuracy and stability limitations. Consider these limitations before making any decision based on quantitative values. If you have any doubts, consult your Sales Representative.



CAUTION:

X-rays can be dangerous if used incorrectly. Take precautions even when following the instructions in this manual.

Use conventional commercially available equipment to protect yourself and your



CAUTION:

against scattered radiation risks.

- If you fail to comply with these instructions, Eastman Kodak Company will not be responsible for the safety reliability, and characteristics of the equipment.

Warnings and Safety Instructions



CAUTION:

Do not operate the equipment in the presence of explosive liquids, vapors, or gases. Do not plug in or turn on the system if hazardous substances are detected in the environment. If these substances are detected after the system has been turned on, do not attempt to turn off the unit or unplug it. Evacuate and ventilate the area before turning off the system.

DANGER: THIS IS AN ELECTRICAL UNIT. DO NOT EXPOSE IT TO WATER SPRAY. SUCH ACTION MAY CAUSE AN ELECTRICAL SHOCK OR A MALFUNCTION OF THE UNIT.

WARNING

The user is responsible for the operation and maintenance of this unit.
This unit must only be operated by legally qualified persons.
The cover of the unit must not be opened by the operator.
Inspection and maintenance operations should only be carried out by an approved Kodak Dental Systems technician.

WARNING

This unit must be installed in an x-ray room that complies with current installation standards. From this location, visual or audio communication must be maintained with the patient, together with access to the control interface during exposure.

WARNING

Do not operate the unit if there is the threat of an earthquake.
Following an earthquake, ensure that the unit is operating properly before using it again.
Failure to observe this precaution may expose patients to hazards.

WARNING

X-ray equipment can be hazardous to patients and the operator if the exposure safety factors and operating instructions are not observed.

WARNING

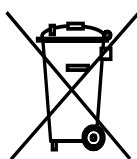
Do not place objects within the field of operation of the unit.

WARNING

We recommend that the patient and the operator wear protective lead-lined aprons, unless other Radiation Protection Protocols apply locally.
Ensure that any parts of the unit that may come into contact with the patient and the operator have been disinfected after each patient has been exposed to x-rays.
If the unit develops a fault, turn it off (O) and display a sign that states “Out of Service.”

WARNING

The operator must ask the patient to refrain from moving during the entire period of exposure.



In the European Union, this symbol indicates that when the last user wishes to discard this product, it must be sent to an appropriate facility for recovery and recycling.

Contact your local Kodak representative or refer to www.kodak.com/go/recycle for additional information on the collection and recovery programs available for this product.

Labeling Summary

Safety Labels



CHASSIS GROUND STUD



ATTENTION: CONSULT ACCOMPANYING DOCUMENTS



CAUTION: IONIZING RADIATION

IEC Symbols Used

The system may have labels with one or more of the following symbols. These symbols indicate the IEC standards to which the system conforms.



Caution — consult accompanying documents



Protective earth



Power ON



Power OFF

Regulatory Information

The product conforms to the following safety standards: IEC/EN 60 601-1 Medical Electrical Equipment General Requirements for Safety, IEC/EN 60 601-2 Medical Electrical Equipment Electro-Magnetic Compatibility Requirements and Tests.

CE Conformity

The Kodak intraoral x-ray system is a Class II b medical device, which bears the following mark of conformity:  .

U.S. Regulations



CAUTION:

U.S. federal law restricts this device to sale by or on the order of a dentist.

2 System Overview

Components

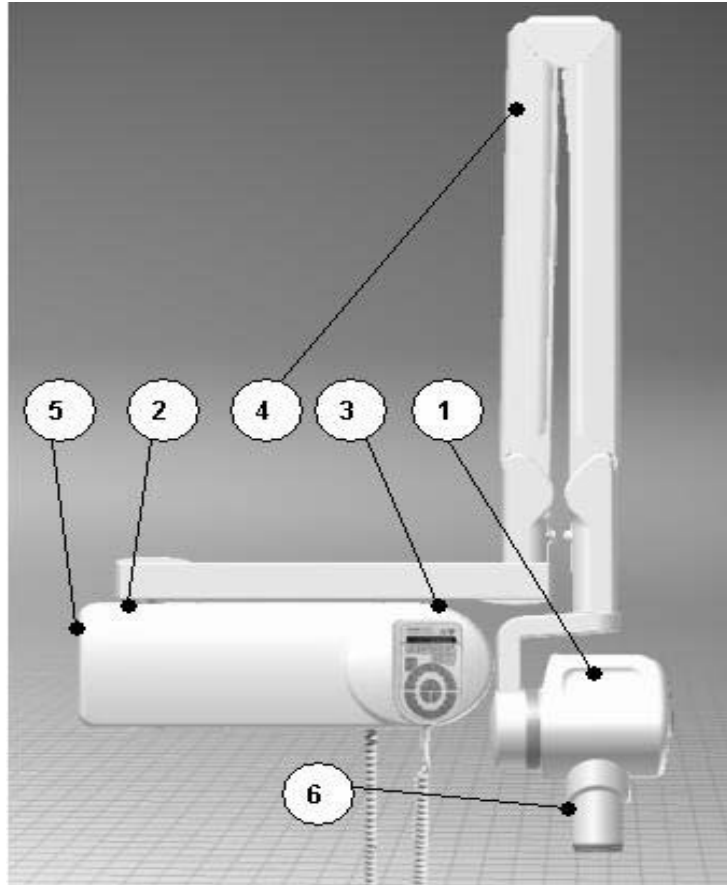


Figure 1. KODAK 2200 Intraoral X-ray System

① High-frequency x-ray generator

- Transformer and associated electronics, and an oil-bathed x-ray tube
- Beam-limiting device
 - Radiation diameter – 6 cm (2 3/8 in.)
 - Distance from x-ray tube focal spot to skin – 20 cm (7 7/8 in.)
- Angle scale and handle to facilitate positioning

② Wall framework

- Contains the high-frequency generator's control electronics

③ Control timer unit

- Anatomical selection and digital display of parameters (kV, mA, exposure time)
- Self-test of the microprocessor each time the unit is activated
- Alarm during incorrect operation
- RVG key that automatically adjusts the exposure parameters (time and mA) if you are using RVG (RadioVisioGraphy)

④ Scissor arm

- Wall-mounted with a choice of extensions

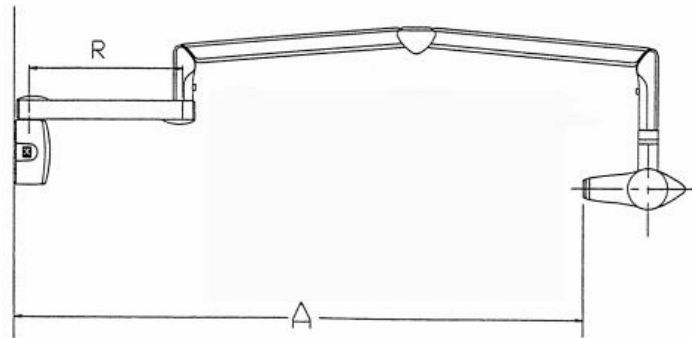


Figure 2. Side view of KODAK 2200 Intraoral X-ray System

Table 3. Types of Scissor Arms

Extension	R	Span A
CG 645	47.0 cm (18.5 in.)	170.0 cm (66 15/16 in.)
CG 646	64.8 cm (25.5 in.)	188.0 cm (74 in.)
CG 648	82.5 cm (32.5 in.)	205.0 cm (80 11/16 in.)

⑤ On/off switch

- Contains built-in light

⑥ Rectangular collimator (optional)

- Different sizes adapted to films and RVG sensors

Additional options

- Separate control timer
- An additional beam-limiting device measuring 10 cm (4 in.) that limits radiation to a diameter of 6 cm (2 3/8 in.) on the skin
- Separate exposure switch (if the control panel is attached to the wall framework)
- Ceiling-mounted unit
- Floor-mounted unit
- Unit mounted on mobile stand

Ceiling-mounted Unit

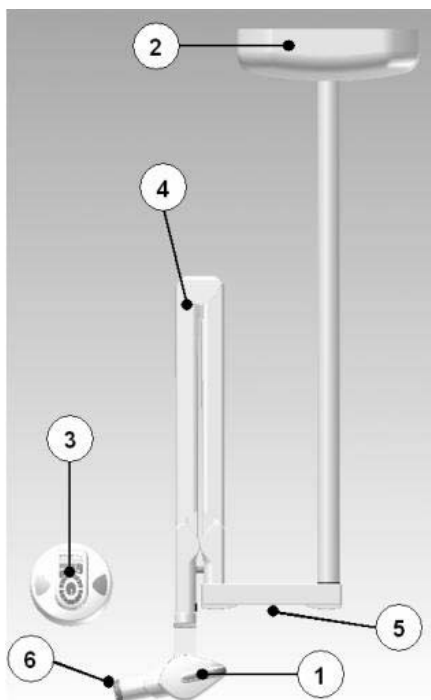


Figure 4. KODAK 2200 Intraoral X-ray System ceiling-mounted unit

- ① High-frequency x-ray generator
- ② Ceiling-mounted unit containing the high-frequency x-ray generator's control electronics
- ③ Separate timer/control unit for the x-ray generator
- ④ Scissor arm
- ⑤ On/off switch with built-in light
- ⑥ Rectangular collimator

Mounted on Mobile Stand (Optional)

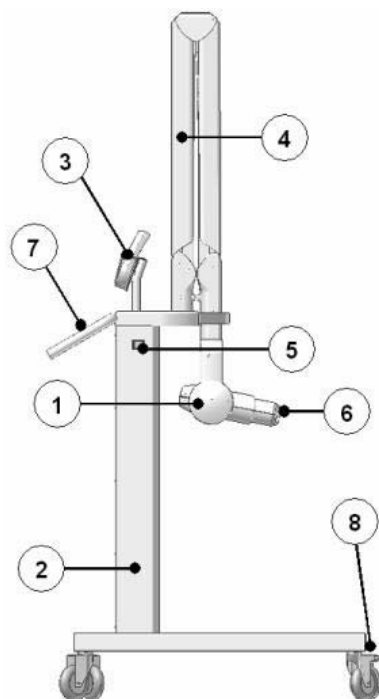


Figure 5. KODAK 2200 Intraoral X-ray System mounted on mobile stand

- ① High-frequency x-ray generator
- ② Mobile stand containing the high-frequency x-ray generator's control electronics
- ③ Timer/control unit for the x-ray generator
- ④ Scissor arm
- ⑤ On/off switch with built-in light
- ⑥ Rectangular collimator
- ⑦ Handle
- ⑧ Foot brake

Floor-mounted Unit (Optional)

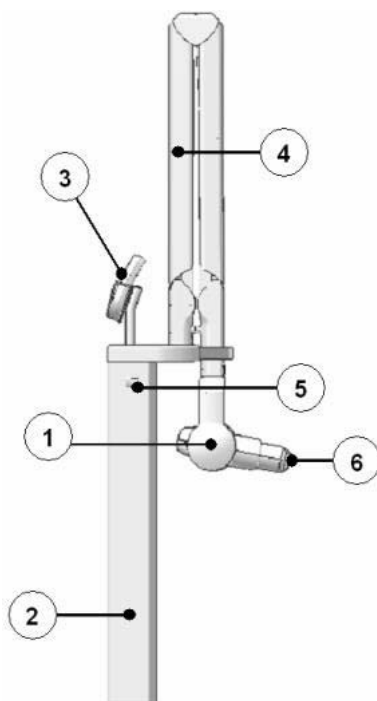


Figure 6. KODAK 2200 Intraoral X-ray System floor-mounted unit

- ① High-frequency x-ray generator
- ② Floor column containing the high-frequency x-ray generator's control electronics
- ③ Timer/control unit for the x-ray generator
- ④ Scissor arm
- ⑤ On/off switch with built-in light
- ⑥ Rectangular collimator

Control Timer Unit

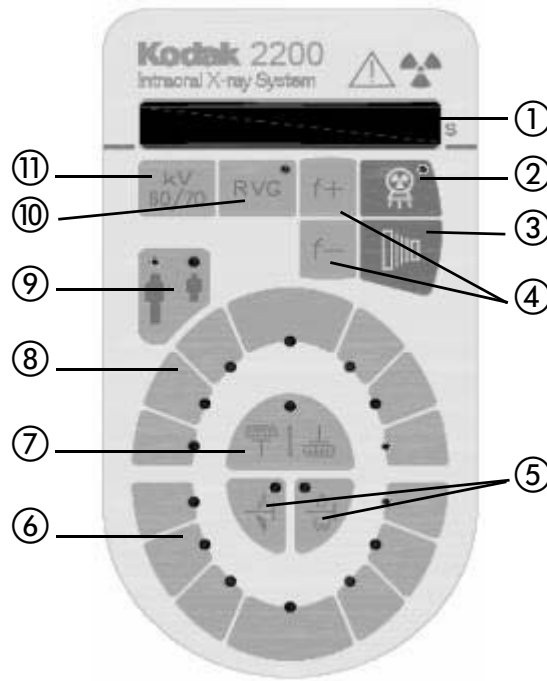


Figure 7. KODAK 2200 Intraoral X-ray System control timer unit

- ① LCD (liquid crystal display)
- ② X-ray emission indicator light
- ③ Radiography control
- ④ Receptor sensitivity selector
- ⑤ Bitewing functions
- ⑥ Mandible programming
- ⑦ Occlusal function
- ⑧ Maxillary programming
- ⑨ Adult/child selector
- ⑩ RVG function
- ⑪ kV selector

3 Using the System

Every dental specialist would like to produce high-quality intraoral radiographs that reveal maximum detail with the minimum dose to the patient, show teeth and anatomic structures accurately with a minimum of distortion or magnification, and have optimal density and contrast to maximize their use for the detection of dental diseases.

To obtain high-quality intraoral radiography with maximum details, take extra care in all three steps of the radiography process: positioning the patient, the x-ray generator, and the imaging system; exposing the film or the sensor; and processing the film.

Positioning

Positioning the patient

Seat the patient with the sagittal plane vertical.

- For radiography of the upper maxillary, the Frankfort plane (nose-ear plane) must be horizontal
- For radiography of the lower maxillary, the occlusal plane must be horizontal



Figure 8. Patient positioning

Positioning the x-ray generator

The scissor arm allows you to accurately position the generator for any type of exposure. The beam-limiting device maintains a distance of at least 20 cm (8 in.) between the focal spot and the skin, which allows you to use either the paralleling technique or the bisecting technique.

Paralleling technique

The positioning tool used in the paralleling technique allows you to align the beam and the receptor. An adapted collimator reduces the dosage by limiting surface exposure.

Bisecting technique

When using the bisecting technique, do not use a rectangular collimator. This limits the risk of misaligning the x-ray beam and the image receptor.

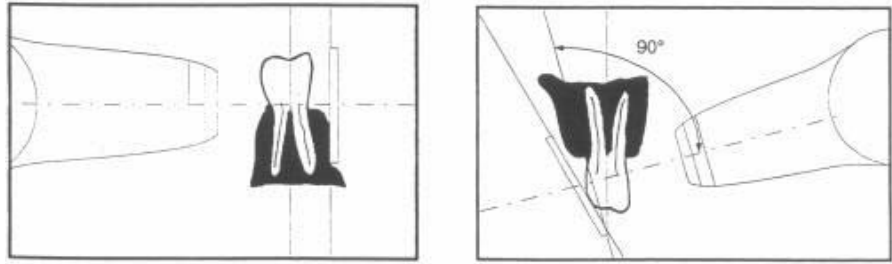


Figure 9. Paralleling technique (left) and Bisecting technique (right)

Positioning the imaging receptor

Using the KODAK 2200 Intraoral X-ray System, you may create an x-ray image on one of three different types of imaging receptors:

- Conventional silver halide films, such as KODAK INSIGHT or KODAK ULTRA-SPEED dental films
- Digital sensors, such as KODAK RVG sensor
- Phosphor plate

Properly placing the receptor is critical. Check your dental radiography text for information about proper placement of the imaging receptor.

Improperly positioning the film or sensor results in errors on the radiograph, such as distorted teeth and roots, elongation, magnification, and/or overlapping contacts. The paralleling technique generally reduces the risk of such errors. However, if you improperly position the system, angulation errors can occur (angulation of the receptor to the tooth itself).

If the exit pattern of the beam is not aligned with the imaging receptor, then part of the radiograph will not be exposed to radiation and the final radiograph will have some clear (unexposed) areas. This defect is called “cone cuts”.

The imaging receptor is marked to indicate the tube side. If the orientation is not correct, the resulting radiograph is lighter and may show artifacts, such as foil pattern or sensor cable.

Exposure

Exposure Parameters

Because each receptor (film, digital sensor, or phosphor plate) has its own sensitivity to x-ray radiation, the choice of receptor affects the exposure parameters. For instance, sensitivity class for conventional dental films is characterized with a letter D, E, or F where F is more sensitive than E, and E more sensitive than D. Consequently, the required dose for the correct exposure goes down with each increase in sensitivity.

Adjust for these differences in sensitivity by changing the exposure times (f+, f- of the operating controls) as indicated in Table 22 on page 5-8.

Like film, different digital sensors have varying sensitivities, as indicated in Table 23 on page 5-8, so you need to adjust exposure for sensors as well.

Use the tables, which are established under manufacturers' standard conditions, as guidelines and adjust your exposures as needed, based on the results you get from your system's exposure and processing.

Procedure

1. Turn on the system.

The following displays light up:

- On button.
- Tooth or special exposure selector (bitewing or occlusal).
- Child or adult selector.
- Display unit showing exposure parameters: kV, mA, type of film used, exposure time.

2. Program the generator using the control unit.

- a. Select the exposure mode (RVG or film) depending on the equipment.

The displays shows:

- 7 mA for film.
- 4 mA for RVG (use this mode to prevent overexposure of digital sensors).

- b. Select the receptor type (Table 22 on page 5-8 or Table 23 on page 5-8)

- c. Select the kV value:

- 60 kV for high-contrast radiographs.
- 70 kV for lower-contrast radiographs that provide a wider latitude and more levels of gray (for periodontal work).

- d. Select the type of patient: child or adult.

- e. Adjust the receptor based on the patient's size:

- Increase the receptor type (f+) for large patients (due to risk of underexposure).
- Reduce the receptor type (f-) for small patients (due to risk of overexposure).

- f. Select the tooth or the exposure.

The unit displays the exposure time.

Note

Exposure times range from 0.027 to 1.19 sec. for conventional films and from 0.014 to 0.624 sec. for digital sensors.

3. Make an exposure.
 - a. Press the radiology control key.

 **CAUTION:**

The operator must instruct the patient to refrain from moving during the entire exposure.



The x-ray emission indicator lights up and an audible signal is emitted.

- b. Keep pressing until the x-ray emission light goes out and the audible signal stops.

 **CAUTION:**

If you stop pressing the control key before the exposure ends, a manipulator alarm is activated. It indicates that the x-ray emission was interrupted prematurely and that there is a risk of underexposure. The digital display alternates between display of OP ERROR and the amount of selected time not used. To stop the alarm, select a tooth or special exposure (Bitewing or Occlusal).

Processing

When using conventional film, process the film according to manufacturer's instructions. Develop the film under safelight conditions in an automatic processor or manually.

If you use an automatic processor, refer to the processor's manual. Be sure to maintain the mechanically and keep the solutions replenished.

If you develop film manually, follow precisely the manufacturer's recommendations for solution preparation, development time, and solution temperature. Any deviation from the manufacturer's recommendations (such as a solution that is too concentrated or diluted, too hot or cold, or if film is processed for the wrong amount of time), will adversely affect the quality of the final radiograph.

Additional Features

- KODAK 2200 Intraoral X-ray System uses a high-frequency technology that has several advantages:
 - Shorter exposure times, reducing the risk of blur due to movement of the patient or film during exposure.
 - Reduction in x-ray dose to patients because the KODAK 2200 System emits fewer soft rays absorbed by patients that do not contribute to the radiological picture.
- Choice of high voltage between 60 kV and 70 kV:
 - 60 kV for high-contrast radiographs giving a clear image of the endodontal instruments or clearly displaying tooth decay.
 - 70 kV for better reproduction of levels of gray (soft tissue), useful for periodontal work.
- A thermal safety system prevents the generator from overheating in case of intensive use. This system can prohibit any exposure as long as the generator did not cool down. A **COOLING** error message appears on the display unit and an audible signal is emitted until the cooling period is over.

CAUTION:

Do not turn off the system. If you turn off power, the microprocessor does not calculate the cooling time, and for safety reasons considers that the system has not gone into the cooling cycle.

- While the exposure is taken, the exposure time counts off on the control unit display.

If the exposure is interrupted (such as by releasing the key), the audible and visible manipulator alarm is activated and the remaining exposure time is displayed. This information makes it easier to decide whether to develop the film or to start another exposure. (If the remaining time is short, you may develop the film.)

To stop the manipulator alarm, press any tooth selection or exposure type (bitewing or occlusal).

- The system includes a self-test function that is activated when turning the system on while simultaneously pressing the RVG key for a few seconds.

The self-test checks:

- All the lights on the control unit.
- The audible alarm and display unit.

At the end of the self-test, the total number of exposures taken by this unit since it was installed is displayed. A short beep indicates the test is over.

At the end of the test, the systems returns to normal operation.

4 Care and Maintenance

General Maintenance

To make sure that the system functions correctly, you must have it serviced annually by an authorized KODAK Dental Systems dealer. In addition, every three months inspect the equipment and make sure of the following:

Generator

- The certification label is legible.
- There are no oil leaks.

Mechanical support

- The wall framework is securely attached to the wall.
- All the labels are legible.
- The scissor arm is stable in all positions.

Control unit and electrical installation

- The symbols are legible.
- The control unit cable and the power supply cable are in good condition.
- The ground is correctly installed.
- The radiology control key returns to its initial position after use.

Functioning



- The audible signal is audible and the x-ray emission light is visible when you make an exposure (Occlusal, film type 9, 60 kV, 7 mA).



- The message "OP. ERROR" is displayed when you make an exposure (Occlusal, film type 9, 60 kV, 7 mA) and release the control button before the exposure time has elapsed.

Timer self-test

- Turn off the system.
- Press and hold the RVG key and turn on the system. When the first light comes on, release the RVG key.

All the control unit functions and indicator lights will be tested one by one. At the end of the test, the total number of exposures made by the machine is displayed.

- A short beep indicates that the test has ended.

Important

If the result of any of these checks is not satisfactory, discontinue using the equipment and contact an authorized Kodak Dental Systems technician.

Cleaning

Clean the outside of the system with a damp paper towel or soft cloth using an alcohol-based, non-corrosive cleaner.

Disinfecting

If necessary, wipe off surfaces with disinfectant.




CAUTION:

- Do not allow liquids to drip into the system.
- Do not spray cleaner or disinfectant directly onto the machine.
- Protect the system from contamination using barriers available from dental distributors.
- Follow the manufacturer's safety recommendations when using the cleaner or disinfectant.

Error Messages

Table 10. Error messages

Error message	Cause	How to cancel
COOLING	Cooling cycle; this message can appear during a period of intensive use.	Do not turn off the system. The error message will disappear when the system returns to a satisfactory temperature.
 CAUTION: If you turn off power to the system, the microprocessor does not calculate the cooling time, and for safety reasons considers that the system has not gone into the cooling cycle.		
OP. ERROR plus audible alarm	Release of the radiography control button before the end of the exposure. The display shows the remaining exposure time. (Based on this time, decide whether to develop the film or make another exposure.)	Press any key on the arch to stop the alarm.
KV ERROR	The generator's high voltage value is different from the required value.	Turn off the system and restart. If the problem persists, call a qualified service technician and discontinue using the equipment.
POWER ERROR	Over- or under-tension of the main power. Power supply problem on the filament. Cut filament.	Turn off the system and restart. If the problem persists, call a qualified service technician and discontinue using the equipment.

Troubleshooting

Table 11. Troubleshooting

Problem	Cause	Solution
Nothing lights up	Unit is disconnected.	Connect the unit.
	Fuse F1 is burned out or defective.	Replace the fuse.
	Circuit breaker is off.	Turn on the circuit breaker.
Control unit does not light up	Control unit is disconnected.	Connect the control unit.
	Fuse F1 is burned out or defective.	Replace the fuse.
	Control unit is defective.	Call a qualified service technician.
No x-ray emission	Generator is cooling.	Wait for the COOLING message to disappear.
	Radiology control key is defective.	Call a qualified service technician.
X-ray emission works, but exposure is too light or completely white	Wrong receptor type is being used.	Change the receptor type. (Refer to Table 22 on page 5-8 and Table 23 on page 5-8.)
	Generator is positioned incorrectly.	Adjust the position of the generator.
	Exposure time is too short.	Increase the exposure time.
	Development time is too short.	Increase the development time. (Refer to the development instructions.)
	Developer is too cold.	Heat the developer.
	Developer is too old or diluted.	Replace with fresh developer.
	RVG key is incorrectly selected.	Verify your exposure settings. (Refer to the exposure procedure.)
	Receptor is facing the wrong way.	Reposition the receptor.
	Unit was incorrectly installed.	Call a qualified service technician.
X-ray emission works, but exposure is too dark	Wrong receptor type is being used.	Change the receptor type. (Refer to Table 22 on page 5-8 and Table 23 on page 5-8.)
	Exposure time is too long.	Decrease the exposure time.
	Development time is too long.	Decrease the development time. (Refer to the development instructions.)
	Developer is too hot.	Cool the developer.
	Developer is too concentrated.	Adjust the concentration or replace the developer.
	RVG/film key was incorrectly selected.	Verify your exposure settings. (Refer to the exposure procedure.)

5 Specifications

According to IEC Standard 601-2-7

Manufacturer

Kodak -Trophy

A subsidiary of Eastman Kodak Company

4, rue F. Pelloutier - Croissy-Beaubourg

77437 Marne-la Vallée Cedex 2

France

Models

- Dental X-ray diagnosis devices, class 1, type B, intermittent use
- KODAK 2200-TR: equipped with tube TRX 708 from KODAK-TROPHY
- KODAK 2200-C: equipped with tube OCX / 65-G from CEI

Electric power supply (during exposure)

- 230–240 V AC ($\pm 10\%$), 50 Hz, 5 A, apparent resistance 0.5 Ω
- 100–110–130 V AC ($\pm 10\%$), 50/60 Hz, 12 A, apparent resistance 0.2 Ω

Electric power supply (no exposure)

- 230–240 V AC ($\pm 10\%$), 50 Hz, 100 mA
- 100–110–130 V AC ($\pm 10\%$), 50/60 Hz, 100 mA

Rated high voltage and maximum corresponding current

- Film mode: 70 kV, 7 mA
- RVG mode: 70 kV, 4 mA

Current/voltage combinations for a maximum output power of:

- 490 W in film mode, 70 kV / 7 mA
- 280 W in RVG mode, 70 kV / 4 mA

Rated power for exposure time of 0.1 sec.

- Film mode: 490 W
- RVG mode: 280 W

Rate of use

- At 70 kV, 7 mA and 0.1 sec. and at the maximum tank temperature: one exposure every 8 sec.

Minimum value of the current/time product in the range of conformity

- 0.07 mAs at 7 mA
- 0.04 mAs at 4 mA

Selection of parameters

- Film mode: 70 kV / 7 mA and 60 kV / 7 mA
- RVG mode: 70 kV / 4 mA and 60 kV / 4 mA

Area of conformity to IEC standard 60601-2-7 (2002)

- Reproducibility of the emitted radiation: conform
- Linearity of the emitted radiation: conform
- Precision in radiography: conform

Measurement conditions

- kV: Indirect measurement using a kV peakmeter
- mAs: Direct measurement in the circuit using a mAs-meter
- Exposure time: Indirect measurement on the kV signal at 75% of the peak value

Storage and transportation conditions

- Temperature: -10°C to 60°C (14°F to 140°F)
- Relative humidity: 10% to 95%
- Atmospheric pressure: 700 to 1060 hPa

Dimensions and weight

• Control unit:	16 x 9 x 4 cm (6.3 x 3.5 x 1.6 in.)	0.4 kg (0.9 lb)
• Wall framework:	51.4 x 18.9 x 10.8 cm (20.2 x 7.4 x 4.3 in.)	4.3 kg (9.5 lb)
• X-ray emitting unit:	43.8 x 22.6 x 12 cm (17.2 x 8.9 x 4.7 in.)	4.3 kg (9.5 lb)
• Scissor arm:	87.3 x 13.3 x 6.3 cm (34.4 x 5.2 x 2.5 in.)	9 kg (19.8 lb)
• Mobile stand (optional):	90 x 60 x 110 cm (35.4 x 23.6 x 43.3 in.)	40 kg (88.2 lb.)
• Floor column (optional):	24 x 23 x 90 cm (9.4 x 9.1 x 35.4 in.)	20 kg (44.2 lb.)
• Ceiling column:	50 x 50 x 154 cm (19.7 x 19.7 x 60.6 in.)	12,8 kg (28.2 lb.)

Scissor arm

- Equipped with gas jack specially designed for this application; proven to function correctly after more than 400,000 cycles.

Electromagnetic compatibility

- KODAK 2200 Intraoral System complies with the European Directive 89/336/EEC and the IEC 60601.1.2 (2001) standard.
Classification: Group 1, Class B.

X-ray Generator

Table 12. Main characteristics of the x-ray generator

	<i>KODAK-TROPHY</i> type TRX 708	CEI type OCX/65-G
Rated high voltage	70 kV	70 kV
Rated anodic power	490 W	490 W
Maximum heat accumulated in the anode	8,700 J	10,000 J
Rated value of focal spot (IEC 60336/1993)	0.7 mm (0.027 in.)	0.7 mm (0.027 in.)
Target materials	Tungsten	Tungsten
Target slope	19°	19°
Filtration due to fixed materials	0.6 mm (0.023 in.) eq. Al	0.6 mm (0.023 in.) eq. Al

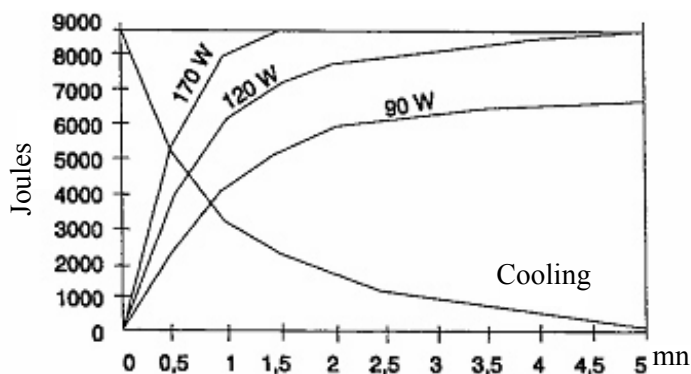


Figure 13. Heating and cooling curves for KODAK-TROPHY TRX 708 tube

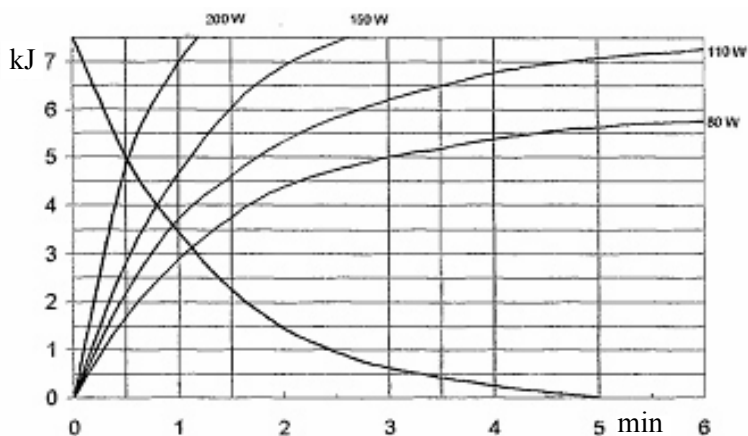


Figure 14. Heating and cooling curves for CEI OCX/65-G tube

Equipped X-ray Generator

Table 15. Equipped x-ray generator

IEC standard 60601-2-28 (1993)	Conform
Type of protection against electric shocks	Class I
Degree of protection against electric shocks	Type B
Rated value of inherent filtration	1.5 mm (0.059 in.) eq. Al
Rated value of additional filtration	1.0 mm (0.039 in.) eq. Al
Rated value of total filtration	2.5 mm (0.098 in.) eq. Al
Beam-limiting cone, focal spot/skin distance	20 cm (7 7/8 in.)
Maximum accumulated heat	32,500 J
Maximum continuous thermal dissipation	7 W
Amount of leaking radiation at maximum rate during one hour of use	< 0.25 mGy
Maximum field of symmetrical radiation	6 cm (2 3/8 in.) diameter
Position and tolerances of the focal point on the reference axis	0 mm +/-0.5 mm (0.020 in.)

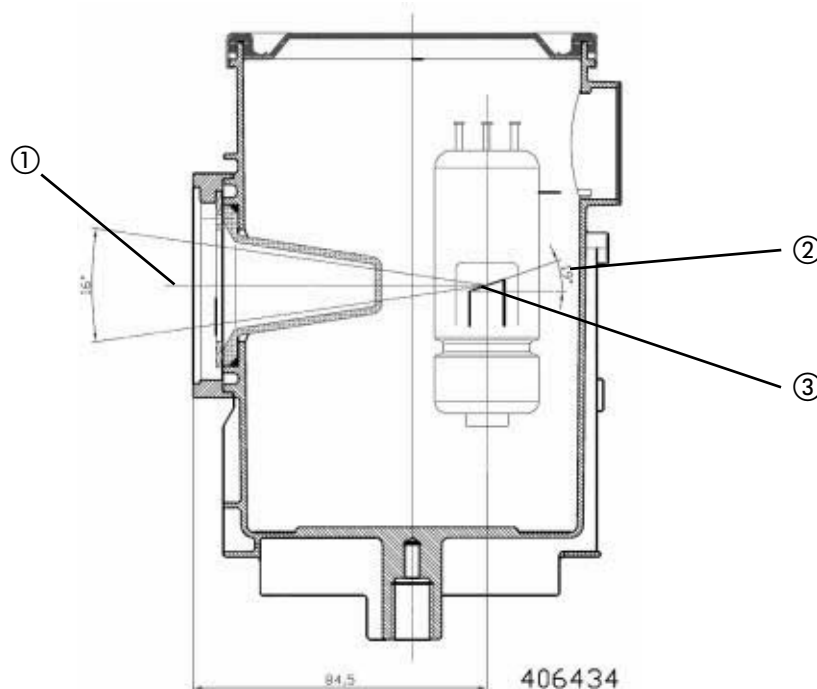


Figure 16. X-ray generator

- ① Reference axis
- ② Target angle
- ③ Focal point

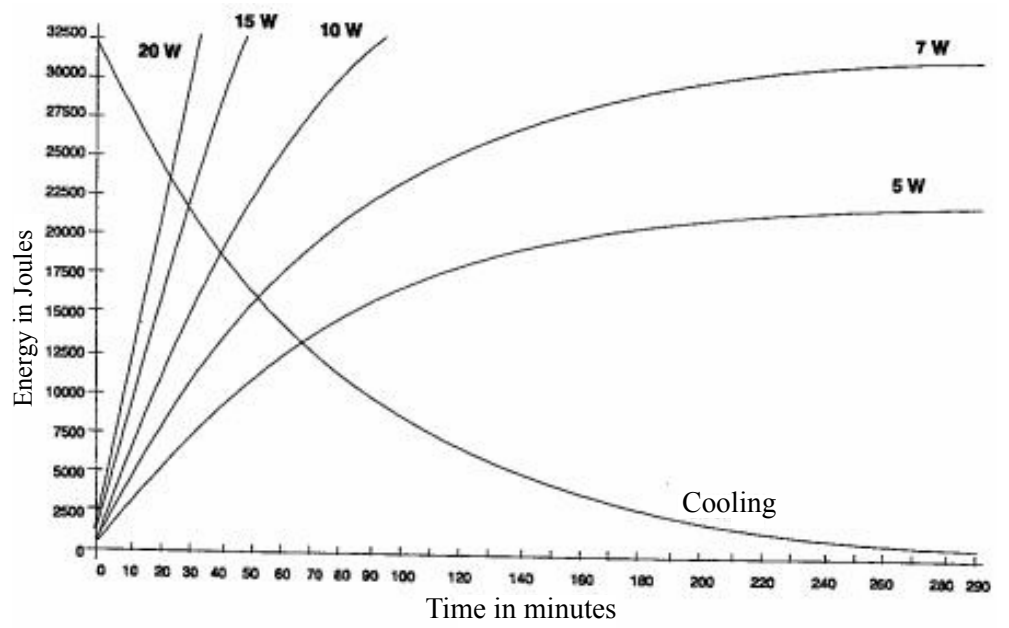


Figure 17. Heating and cooling curves of the KODAK 2200 system tube head

Position of Identification Labels

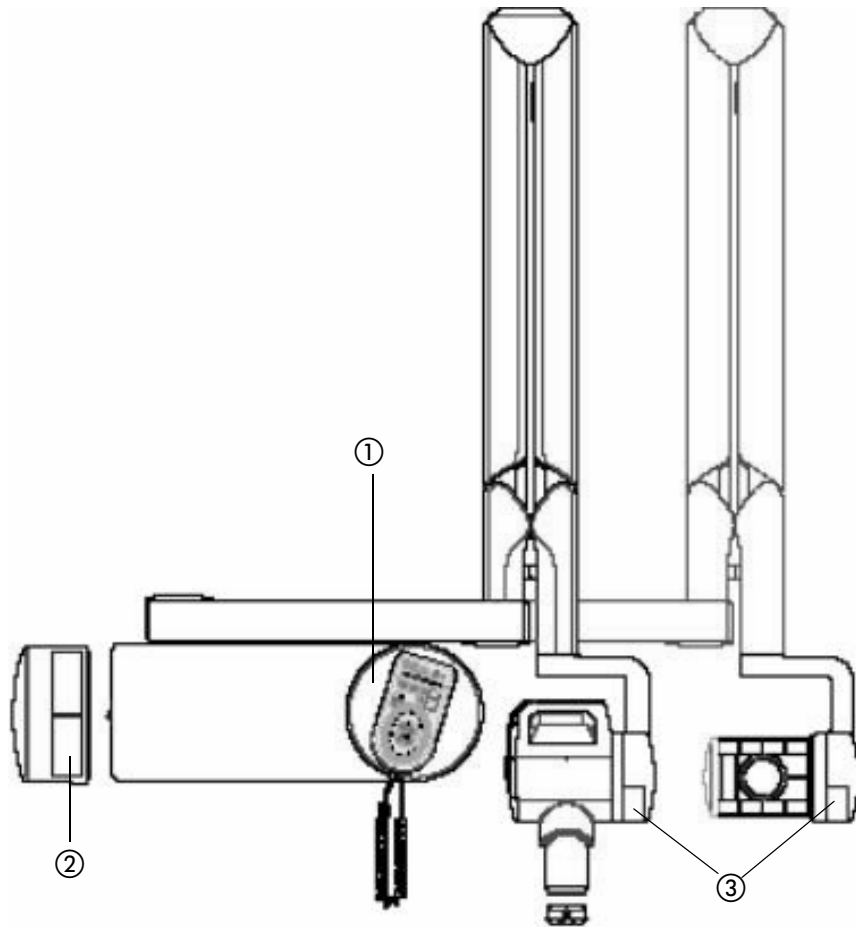


Figure 18. Identification labels

- ① WARNING: MAGNETIC AREA
- ② Machine identification
- ③ X-ray emitting unit

Tables of Exposure Times

The following exposure time tables were established with a unit equipped with a standard cone that corresponds to a focus-to-skin distance of 20 cm (8 inches).

Table 19. Exposure times in seconds for type 6 films

70kV - 7mA	Cone 20 cm (8 in.)		60kV - 7mA	Cone 20 cm (8 in.)	
Maxillary	Child	Adult	Maxillary	Child	Adult
Incisor	0.12	0.18	Incisor	0.24	0.37
Bicuspid	0.12	0.18	Bicuspid	0.24	0.37
Premolar	0.15	0.23	Premolar	0.31	0.47
Molar	0.18	0.27	Molar	0.36	0.54
Mandibular			Mandibular		
Incisor	0.10	0.15	Incisor	0.19	0.29
Bicuspid	0.10	0.15	Bicuspid	0.19	0.29
Premolar	0.11	0.16	Premolar	0.22	0.33
Molar	0.12	0.18	Molar	0.24	0.37
Bitewing			Bitewing		
Anterior	0.10	0.15	Anterior	0.19	0.29
Posterior	0.12	0.18	Posterior	0.24	0.37
Occlusal	0.20	0.31	Occlusal	0.40	0.61

Table 20. Exposure times in seconds for type 6 sensors

70kV - 4mA	Cone 20 cm (8 in.)		60kV - 4mA	Cone 20 cm (8 in.)	
Maxillary	Child	Adult	Maxillary	Child	Adult
Incisor	0.06	0.10	Incisor	0.13	0.19
Bicuspid	0.06	0.10	Bicuspid	0.13	0.19
Premolar	0.08	0.12	Premolar	0.16	0.25
Molar	0.09	0.14	Molar	0.19	0.29
Mandibular			Mandibular		
Incisor	0.05	0.08	Incisor	0.10	0.15
Bicuspid	0.05	0.08	Bicuspid	0.10	0.15
Premolar	0.06	0.09	Premolar	0.11	0.17
Molar	0.06	0.10	Molar	0.13	0.19
Bitewing			Bitewing		
Anterior	0.05	0.08	Anterior	0.10	0.15
Posterior	0.06	0.10	Posterior	0.13	0.19
Occlusal	0.11	0.16	Occlusal	0.21	0.32

Table 21. Exposure time corrections depending on selected type of film or sensor

Position	Correction	Coefficient
0	-73%	0.27
1	-67%	0.33
2	-59%	0.41
3	-49%	0.51
4	-36%	0.64
5	-20%	0.80
6	0	1.00
7	+25%	1.25
8	+56%	1.56
9	+95%	1.95

Table 22. Choice of film type (film mode 7 mA)

Manufacturer	Name	Film type setting
Kodak	<i>Insight</i>	2
Kodak	E-speed	3
Kodak	Ultra-speed	6
Kodak	D-speed	6
Other films	Speed class F	2 or 3
Other films	Speed class E	4 or 3
Other films	Speed class D	6 or 7

Note

If you use a long cone (30 cm or 12 in.), increase exposure times by changing film type to 3 steps higher.

Table 23. Choice of sensor type (RVG mode 4 mA)

Manufacturer	Name	Sensor type setting
Kodak	RVG 5000	7
Trophy	RVG Access	7
Kodak	RVG 6000	6
Trophy	RVG Ultimate	6
Trophy	RVG Reference Hi Resol mode	6
Trophy	RVGui Hi resol mode	6
Trophy	RVG THD	4
Trophy	RVG Reference Hi Sensi mode	1
Trophy	RVGui Hi Sensi mode	1
Other brands	Adjust your sensor type	*

Note

If you use a long cone (30 cm or 12 in.), increase exposure times by changing film type to 3 steps higher.

Emitted Doses

To obtain the dose in $\text{mGy}\cdot\text{cm}^2$, multiply values in the tables by the exposed surface. The exposed surface depends on the collimator that is used and is indicated in Table 28 on page 5-13.

Table 24. Dose measured at extremity of 20 cm (8 in.) cone: film mode

70 kV—7 mA								60 kV—7 mA							
t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)
0.010	0.09	0.260	2.22	0.510	4.35	0.760	6.48	0.010	0.06	0.260	1.58	0.520	3.17	1.020	6.21
0.020	0.17	0.270	2.30	0.520	4.43	0.770	6.57	0.020	0.12	0.270	1.64	0.540	3.29	1.040	6.33
0.030	0.26	0.280	2.39	0.530	4.52	0.780	6.65	0.030	0.18	0.280	1.71	0.560	3.41	1.060	6.46
0.040	0.34	0.290	2.47	0.540	4.60	0.790	6.74	0.040	0.24	0.290	1.77	0.570	3.53	1.080	6.58
0.050	0.43	0.300	2.56	0.550	4.69	0.800	6.82	0.050	0.30	0.300	1.83	0.600	3.65	1.100	6.70
0.060	0.51	0.310	2.64	0.560	4.78	0.810	6.91	0.060	0.37	0.310	1.89	0.620	3.78	1.120	6.82
0.070	0.60	0.320	2.73	0.570	4.86	0.820	6.99	0.070	0.43	0.320	1.95	0.640	3.90	1.140	6.94
0.080	0.68	0.330	2.81	0.580	4.95	0.830	7.08	0.080	0.49	0.330	2.01	0.660	4.02	1.160	7.06
0.090	0.77	0.340	2.90	0.590	5.03	0.840	7.16	0.090	0.55	0.340	2.07	0.680	4.14	1.180	7.19
0.100	0.85	0.350	2.98	0.600	5.12	0.850	7.25	0.100	0.61	0.350	2.13	0.700	4.26	1.200	7.31
0.110	0.94	0.360	3.07	0.610	5.20	0.860	7.33	0.110	0.67	0.360	2.19	0.720	4.38	1.220	7.43
0.120	1.02	0.370	3.15	0.620	5.29	0.870	7.42	0.120	0.73	0.370	2.25	0.740	4.51	1.240	7.55
0.130	1.11	0.380	3.24	0.630	5.37	0.880	7.50	0.130	0.79	0.380	2.31	0.760	4.63	1.260	7.67
0.140	1.19	0.390	3.33	0.640	5.46	0.890	7.59	0.140	0.85	0.390	2.38	0.780	4.75	1.280	7.80
0.150	1.28	0.400	3.41	0.650	5.54	0.900	7.67	0.150	0.91	0.400	2.44	0.800	4.87	1.300	7.92
0.160	1.36	0.410	3.50	0.660	5.63	0.910	7.76	0.160	0.97	0.410	2.50	0.820	4.99	1.320	8.04
0.170	1.45	0.420	3.58	0.670	5.71	0.920	7.84	0.170	1.04	0.420	2.56	0.840	5.12	1.340	8.16
0.180	1.53	0.430	3.67	0.680	5.80	0.930	7.93	0.180	1.10	0.430	2.62	0.860	5.24	1.360	8.28
0.190	1.62	0.440	3.75	0.690	5.88	0.940	8.02	0.190	1.16	0.440	2.68	0.880	5.36	1.380	8.40
0.200	1.71	0.450	3.84	0.700	5.97	0.950	8.10	0.200	1.22	0.450	2.74	0.900	5.48	1.400	8.53
0.210	1.79	0.460	3.92	0.710	6.05	0.960	8.19	0.210	1.28	0.460	2.80	0.920	5.60	1.420	8.65
0.220	1.88	0.470	4.01	0.720	6.14	0.970	8.27	0.220	1.34	0.470	2.86	0.940	5.72	1.440	8.77
0.230	1.96	0.480	4.09	0.730	6.22	0.980	8.36	0.230	1.40	0.480	2.92	0.960	5.85	1.460	8.89
0.240	2.05	0.490	4.18	0.740	6.31	0.990	8.44	0.240	1.46	0.490	2.98	0.980	5.97	1.480	9.01
0.250	2.13	0.500	4.26	0.750	6.40	1.000	8.53	0.250	1.52	0.500	3.05	1.000	6.09	1.500	9.14

Note

Dose accuracy: +/- 30% (mGy)

Table 25. Dose measured at extremity of 20 cm (8 in.) cone: RVG mode

70 kV—4 mA								60 kV—4 mA							
t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)
0.010	0.05	0.255	1.24	0.380	1.85	0.505	2.46	0.010	0.03	0.260	0.91	0.510	1.78	0.760	2.65
0.020	0.10	0.260	1.27	0.385	1.88	0.510	2.48	0.020	0.07	0.270	0.94	0.520	1.81	0.770	2.68
0.030	0.15	0.265	1.29	0.390	1.90	0.515	2.51	0.030	0.10	0.280	0.97	0.530	1.85	0.780	2.72
0.040	0.19	0.270	1.32	0.395	1.92	0.520	2.53	0.040	0.14	0.290	1.01	0.540	1.88	0.790	2.75
0.050	0.24	0.275	1.34	0.400	1.95	0.525	2.56	0.050	0.17	0.300	1.04	0.550	1.92	0.800	2.79
0.060	0.29	0.280	1.36	0.405	1.97	0.530	2.58	0.060	0.21	0.310	1.08	0.560	1.95	0.810	2.82
0.070	0.34	0.285	1.39	0.410	2.00	0.535	2.61	0.070	0.24	0.320	1.11	0.570	1.98	0.820	2.86
0.080	0.39	0.290	1.41	0.415	2.02	0.540	2.63	0.080	0.28	0.330	1.15	0.580	2.02	0.830	2.89
0.090	0.44	0.295	1.44	0.420	2.05	0.545	2.65	0.090	0.31	0.340	1.18	0.590	2.05	0.840	2.92
0.100	0.49	0.300	1.46	0.425	2.07	0.550	2.68	0.100	0.35	0.350	1.22	0.600	2.09	0.850	2.96
0.110	0.54	0.305	1.49	0.430	2.09	0.555	2.70	0.110	0.38	0.360	1.25	0.610	2.12	0.860	2.99
0.120	0.58	0.310	1.51	0.435	2.12	0.560	2.73	0.120	0.42	0.370	1.29	0.620	2.16	0.870	3.03
0.130	0.63	0.315	1.53	0.440	2.14	0.565	2.75	0.130	0.45	0.380	1.32	0.630	2.19	0.880	3.06
0.140	0.68	0.320	1.56	0.445	2.17	0.570	2.78	0.140	0.49	0.390	1.36	0.640	2.23	0.890	3.10
0.150	0.73	0.325	1.58	0.450	2.19	0.575	2.80	0.150	0.52	0.400	1.39	0.650	2.26	0.900	3.13
0.160	0.78	0.330	1.61	0.455	2.22	0.580	2.83	0.160	0.56	0.410	1.43	0.660	2.30	0.910	3.17
0.170	0.83	0.335	1.63	0.460	2.24	0.585	2.85	0.170	0.59	0.420	1.46	0.670	2.33	0.920	3.20
0.180	0.88	0.340	1.66	0.465	2.26	0.590	2.87	0.180	0.63	0.430	1.50	0.680	2.37	0.930	3.24
0.190	0.93	0.345	1.68	0.470	2.29	0.595	2.90	0.190	0.66	0.440	1.53	0.690	2.40	0.940	3.27
0.200	0.97	0.350	1.70	0.475	2.31	0.600	2.92	0.200	0.71	0.450	1.57	0.700	2.44	0.950	3.31
0.210	1.02	0.355	1.73	0.480	2.34	0.605	2.95	0.210	0.73	0.460	1.60	0.710	2.47	0.960	3.34
0.220	1.07	0.360	1.75	0.485	2.36	0.610	2.97	0.220	0.77	0.470	1.64	0.720	2.51	0.970	3.38
0.230	1.12	0.365	1.78	0.490	2.39	0.615	3.00	0.230	0.80	0.480	1.67	0.730	2.54	0.980	3.41
0.240	1.17	0.370	1.80	0.495	2.41	0.620	3.02	0.240	0.84	0.490	1.71	0.740	2.58	0.990	3.45
0.250	1.22	0.375	1.83	0.500	2.44	0.625	3.04	0.250	0.87	0.500	1.74	0.750	2.61	1.000	3.48

Note

Dose accuracy: +/- 30% (mGy)

Table 26. Dose measured at extremity of 30 cm (12 in.) cone: film mode

70 kV—7 mA								60 kV—7 mA							
t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)
0.010	0.04	0.260	0.98	0.510	1.93	0.760	2.88	0.010	0.03	0.260	0.70	0.520	1.41	1.020	2.76
0.020	0.08	0.270	1.02	0.520	1.97	0.770	2.92	0.020	0.05	0.270	0.73	0.540	1.46	1.040	2.81
0.030	0.11	0.280	1.06	0.530	2.01	0.780	2.95	0.030	0.08	0.280	0.76	0.560	1.52	1.060	2.87
0.040	0.15	0.290	1.10	0.540	2.05	0.790	2.99	0.040	0.11	0.290	0.78	0.570	1.57	1.080	2.92
0.050	0.19	0.300	1.14	0.550	2.08	0.800	3.03	0.050	0.14	0.300	0.81	0.600	1.62	1.100	2.98
0.060	0.23	0.310	1.17	0.560	2.12	0.810	3.07	0.060	0.16	0.310	0.84	0.620	1.68	1.120	3.03
0.070	0.27	0.320	1.21	0.570	2.16	0.820	3.11	0.070	0.19	0.320	0.87	0.640	1.73	1.140	3.09
0.080	0.30	0.330	1.25	0.580	2.20	0.830	3.14	0.080	0.22	0.330	0.89	0.660	1.79	1.160	3.14
0.090	0.34	0.340	1.29	0.590	2.23	0.840	3.18	0.090	0.24	0.340	0.92	0.680	1.84	1.180	3.19
0.100	0.38	0.350	1.33	0.600	2.27	0.850	3.22	0.100	0.27	0.350	0.95	0.700	1.89	1.200	3.25
0.110	0.42	0.360	1.36	0.610	2.31	0.860	3.26	0.110	0.30	0.360	0.97	0.720	1.95	1.220	3.30
0.120	0.45	0.370	1.40	0.620	2.35	0.870	3.30	0.120	0.32	0.370	1.00	0.740	2.00	1.240	3.36
0.130	0.49	0.380	1.44	0.630	2.39	0.880	3.33	0.130	0.35	0.380	1.03	0.760	2.06	1.260	3.41
0.140	0.53	0.390	1.48	0.640	2.42	0.890	3.37	0.140	0.38	0.390	1.06	0.780	2.11	1.280	3.46
0.150	0.57	0.400	1.52	0.650	2.46	0.900	3.41	0.150	0.41	0.400	1.08	0.800	2.17	1.300	3.52
0.160	0.61	0.410	1.55	0.660	2.50	0.910	3.45	0.160	0.43	0.410	1.11	0.820	2.22	1.320	3.57
0.170	0.64	0.420	1.59	0.670	2.54	0.920	3.48	0.170	0.46	0.420	1.14	0.840	2.27	1.340	3.63
0.180	0.68	0.430	1.63	0.680	2.58	0.930	3.52	0.180	0.49	0.430	1.16	0.860	2.33	1.360	3.68
0.190	0.72	0.440	1.67	0.690	2.61	0.940	3.56	0.190	0.51	0.440	1.19	0.880	2.38	1.380	3.74
0.200	0.76	0.450	1.70	0.700	2.65	0.950	3.60	0.200	0.54	0.450	1.22	0.900	2.44	1.400	3.79
0.210	0.80	0.460	1.74	0.710	2.69	0.960	3.64	0.210	0.57	0.460	1.25	0.920	2.49	1.420	3.84
0.220	0.83	0.470	1.78	0.720	2.73	0.970	3.67	0.220	0.60	0.470	1.27	0.940	2.54	1.440	3.90
0.230	0.87	0.480	1.82	0.730	2.77	0.980	3.71	0.230	0.62	0.480	1.30	0.960	2.60	1.460	3.95
0.240	0.91	0.490	1.86	0.740	2.80	0.990	3.75	0.240	0.65	0.490	1.33	0.980	2.65	1.480	4.01
0.250	0.95	0.500	1.89	0.750	2.84	1.000	3.79	0.250	0.68	0.500	1.35	1.000	2.71	1.500	4.06

Note

Dose accuracy: +/- 30% (mGy)

Table 27. Dose measured at extremity of 30 cm (12 in.) cone: RVG mode

70 kV—4 mA								60 kV—4 mA							
t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)	t (s)	D (mGy)
0.010	0.02	0.255	0.55	0.380	0.82	0.505	1.09	0.010	0.02	0.260	0.40	0.510	0.79	0.760	1.18
0.020	0.04	0.260	0.56	0.385	0.83	0.510	1.11	0.020	0.03	0.270	0.42	0.520	0.81	0.770	1.19
0.030	0.07	0.265	0.57	0.390	0.85	0.515	1.12	0.030	0.05	0.280	0.43	0.530	0.82	0.780	1.21
0.040	0.09	0.270	0.59	0.395	0.86	0.520	1.13	0.040	0.06	0.290	0.45	0.540	0.84	0.790	1.22
0.050	0.11	0.275	0.60	0.400	0.87	0.525	1.14	0.050	0.08	0.300	0.46	0.550	0.85	0.800	1.24
0.060	0.13	0.280	0.61	0.405	0.88	0.530	1.15	0.060	0.09	0.310	0.48	0.560	0.87	0.810	1.25
0.070	0.15	0.285	0.62	0.410	0.89	0.535	1.16	0.070	0.11	0.320	0.50	0.570	0.88	0.820	1.27
0.080	0.17	0.290	0.63	0.415	0.90	0.540	1.17	0.080	0.12	0.330	0.51	0.580	0.90	0.830	1.29
0.090	0.20	0.295	0.64	0.420	0.91	0.545	1.18	0.090	0.14	0.340	0.53	0.590	0.91	0.840	1.30
0.100	0.22	0.300	0.65	0.425	0.92	0.550	1.19	0.100	0.15	0.350	0.54	0.600	0.93	0.850	1.32
0.110	0.24	0.305	0.66	0.430	0.93	0.555	1.20	0.110	0.17	0.360	0.56	0.610	0.94	0.860	1.33
0.120	0.26	0.310	0.67	0.435	0.94	0.560	1.21	0.120	0.19	0.370	0.57	0.620	0.96	0.870	1.35
0.130	0.28	0.315	0.68	0.440	0.95	0.565	1.22	0.130	0.20	0.380	0.59	0.630	0.98	0.880	1.36
0.140	0.30	0.320	0.69	0.445	0.96	0.570	1.24	0.140	0.22	0.390	0.60	0.640	0.99	0.890	1.38
0.150	0.33	0.325	0.70	0.450	0.98	0.575	1.25	0.150	0.23	0.400	0.62	0.650	1.01	0.900	1.39
0.160	0.35	0.330	0.72	0.455	0.99	0.580	1.26	0.160	0.25	0.410	0.63	0.660	1.02	0.910	1.41
0.170	0.37	0.335	0.73	0.460	1.00	0.585	1.27	0.170	0.26	0.420	0.65	0.670	1.04	0.920	1.42
0.180	0.39	0.340	0.74	0.465	1.01	0.590	1.28	0.180	0.28	0.430	0.67	0.680	1.05	0.930	1.44
0.190	0.41	0.345	0.75	0.470	1.02	0.595	1.29	0.190	0.29	0.440	0.68	0.690	1.07	0.940	1.46
0.200	0.43	0.350	0.76	0.475	1.03	0.600	1.30	0.200	0.31	0.450	0.70	0.700	1.08	0.950	1.47
0.210	0.46	0.355	0.77	0.480	1.04	0.605	1.31	0.210	0.33	0.460	0.71	0.710	1.10	0.960	1.49
0.220	0.48	0.360	0.78	0.485	1.05	0.610	1.32	0.220	0.34	0.470	0.73	0.720	1.11	0.970	1.50
0.230	0.50	0.365	0.79	0.490	1.06	0.615	1.33	0.230	0.36	0.480	0.74	0.730	1.13	0.980	1.52
0.240	0.52	0.370	0.80	0.495	1.07	0.620	1.34	0.240	0.37	0.490	0.76	0.740	1.15	0.990	1.53
0.250	0.54	0.375	0.81	0.500	1.08	0.625	1.35	0.250	0.39	0.500	0.77	0.750	1.16	1.000	1.55

Note

Dose accuracy: +/- 30% (mGy)

Table 28. Exposure surface versus type of collimator used

Collimator type	Format (mm)	Used with digital sensor	Used with film	Exposure surface (cm²)
A	19 x 24	Size 0	-	4.6
B	23 x 35	Size 1	Size 0 22 x 35	8.3
C	31 x 39	Size 2	Size 1 24 x 40 Size 2 31 x 41	12.1
Standard cone	60 mm diameter	-	Size 3 27 x 54 Size 4 57 x 76	28.3



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