RADIATION PROTECTION SERVICE

DEPARTMENT OF WELLBEING, SAFETY AND HEALTH

UNIVERSITY OF LEEDS

RADIATION RISK ASSESSMENT 28:
CARESTREAM DENTAL CS 2200 X-RAY UNIT

1. SCOPE AND PURPOSE

This radiation risk assessment is for the use of a Carestream Dental CS 2200 intraoral x-ray system.

The purpose of this risk assessment is to assess the risks from exposure to ionising radiation in order to identify the measures needed to restrict the radiation exposure of employees or other persons and it has been prepared in accordance with the guidance given in ACoP 8 to the Ionising Radiations Regulations 2017 (IRR17).

2. DOCUMENT CONTROL

Version	Author	Date of issue/review	Comments
1.0	ARC	13 April 2016	
2.0	ARC	25 September 2018	Review and update for IRR17

3. NATURE OF SOURCES OF IONISING RADIATION

The Carestream Dental CS 2200 is an intra-oral dental x-ray radiography system. The system is installed in 7.04h Brenner Building which is an ex-dark-room accessible through a revolving door from 7.04g.

The unit is used for taking radiographs of samples and is not used on patients or volunteers.

Operation of the unit is from a console mounted on the other side of the wall to the unit in the ante-room to the x-ray lab (7.04g). Entrance to the inner room where the x-ray unit is housed is through a revolving door. No personnel are required to be in the x-ray room whilst the x-rays are energised and operation is by holding down a button on the console so that the operator cannot remain in the x-ray room.

The x-ray tube is directed down onto a stainless steel sample tray with 3mm lead beam stop using a cylindrical beam limiter.

Normal operating parameters for generating x-rays are 70kV / 7mA / 0.143 seconds.

Further equipment details can be found on the RPS x-ray database.

4. DOSE ASSESSMENTS

Maximum leakage radiation dose rate specified by the manufacturer is < 0.25mGy ‘at maximum rate during one hour of use’ [a].

Measurements were undertaken by the UoL Radiation Protection Manager using a PTW UNIDOS with LS-01 chamber [b]. Measurements were taken with the tube head in the fixed downward position and with exposure settings of 70kV/7mA/0.129s.

Position	Dose per exposure
1. Beam @ 10cm	208µGy
2. Benchtop @ wall	780nGy
3. Wall @ 10cm from head	1.04uGy
4. Benchtop @10cm from head	1.77uGy
5. Operating console	3.0 nGy
6. @ floor in beam	3.6µGy
7. under bench in beam @50cm	22.4µGy
8. Far wall @ floor	11.7nGy
9. Adjacent room (7.04i) at wall (closest point to unit)	8.7nGy
10. Wall attenuation (next room @ wall, beam pointing at wall)	2.95µGy

Estimated doses should be compared with:

- University of Leeds dose constraint for radiation workers = 1mSv/year [c]
- Dose constraint for exposures to the public from any new source of radiation = 0.3mSv/year [d]
- Average radiation dose to the public in the UK = 2.7mSv/year [e]

EXTERNAL DOSES

Estimated radiation dose rates to which anyone can be exposed:

The projected maximum usage of each unit is 2000 radiographs per year.

- Radiation dose to an operator during normal operation of the x-ray unit is 0.006mGy/year and at the closest point in the adjacent room (not normally accessible) is < 0.02mGy/year. Therefore estimated body doses are <<1mSv (University dose constraint).

- Radiation dose to an operator if the x-ray head is misaligned (Position 10) is < 3µGy/operation.
  For 10 radiographs estimated exposure would be < 0.03mGy.
- Radiation dose to a person remaining in the room (Position 4) is < 1.8µGy/operation.
  For 10 radiographs estimated exposure would be < 0.02mGy.
- Radiation doses to a person close to the x-ray head could be much higher than this (typical dental cone tip doses are up to 1-2mSv per operation).

INTERNAL DOSES

Likelihood of contamination arising and being spread

Not applicable – x-ray source.

Estimated levels of airborne and surface contamination

Not applicable – x-ray source.

11. DOSIMETRY

The use of dosimetry is not appropriate for these activities as radiation levels would not be detected by dose meters.

12. SAFE USE AND MAINTENANCE

Safety features are checked regularly by the RPS.

13. ENGINEERING CONTROL MEASURES AND DESIGN FEATURES

Engineering controls and safety features are compliant with ACoP 9(2) of IRR17.

The x-ray system is housed in a separate room to the operating console.

A 3mm lead beam stop terminates the beam at the end of its useful path and reduces scattered dose levels

Warning lamps and an audible signal on the console indicate x-ray emission.

14. PLANNED SYSTEMS OF WORK

Local rules are in place and specify:

- Requirements for management of work, training and authorisation.
- Requirements for critical examinations.
- Requirements for monitoring of dose rates.
- Work instructions including instructions for controlling exposures.
- Contingency plans.

Operating instructions for the equipment are available.

15. PERSONAL PROTECTIVE EQUIPMENT

No additional PPE is required for this work.

16. ACCESS TO AREAS WHERE THERE ARE SIGNIFICANT DOSE RATES OR CONTAMINATION LEVELS

The system is located within a restricted access area and the x-ray system is housed in a separate room to the operating console.

Operation of the x-ray units is undertaken by trained operators.

17. RISK EVALUATION AND CONTROLS

	Risk evaluation	Control measures	Residual risk after controls		
			Likelihood	Severity	Risk
Radiation exposure during normal use	X-ray leakage and scatter dose rate <0.5µSvh^{-1} at all points and much less than this at operator position. Risk during normal use is negligible (very much less than the university's dose constraint of 1mSv/y).	Operator training. Local rules include working instructions and emergency procedures. Critical Examination before the x-ray tube is first used; if repaired, altered or moved. Regular checks of safety features and interlocks. Annual critical examination and audit by Radiation Protection Manager.	**Low**	**Low**	**Low**
Possible accident situations or failure of control measures and steps to prevent or limit their consequences	**Tube not orientated correctly** Exposure to scatter radiation if tube not orientated downwards. X-rays; scatter dose rate <3µGy/h. Estimated dose <0.03mSv**.**	Operator training. Local rules include instructions for operator to ensure that the x-ray head is correctly aligned. Critical Examination before the x-ray tube is first used; if repaired, altered or moved.	**Low**	**Low**	**Low**

	Person within x-ray room If a person remained in the x-ray room during operation the radiation exposure levels would be: X-rays; scatter dose rate <2µGy/operation. Estimated dose <0.02mGy for 10 radiographs.	Operator training. Access restrictions whilst the x-ray system is in use. Local rules and operating instructions include instructions for operator to ensure that the x-ray head is correctly aligned and that the room is clear of personnel before each operation. Critical Examination before the x-ray tube is first used; if repaired, altered or moved. Regular maintenance and servicing of the equipment.	**Low**	**Low**	**Low**
	Removal of panels / shielding giving access to unguarded x-ray beam Removal of panels or shielding could give access to areas where there is a high dose rate. Radiation exposure could exceed the University annual dose constraint of 1mSv.	Operator training. All repairs and modifications to the equipment must only be carried out by a qualified service engineer. The service engineer must have sole use of the room if servicing requires the removal of shielding or over-riding of safety features.	**Low**	**Medium**	**Low**
	Damage to the equipment by misuse, impact or fire X-rays; potential dose rate – $mSvh^{-1}$. If the equipment were subject to damage the x-ray shielding may be compromised and radiation exposure could exceed dose constraints.	If the equipment, enclosure or interlocks have been damaged in any way or a malfunction is suspected the user should: - switch the power off and remove the keys - inform the RPS who will arrange for the equipment to be checked by an engineer.	**Low**	**Medium**	**Low**

18. REFERENCES

[a] KODAK 2200 Intraoral X-ray System Installation & Service Manual, 09/2007.

[b] UoL report RPA REP1404 Dental X-ray Dose Assessment

[c] Management of Sources of Ionising Radiation - Guidance, Health and Safety Services, November 2016.

[d] Work with ionising radiation, Ionising Radiation Regulations 2017, Approved Code of Practice and Guidance, HSE, 2018.

[e] Ionising Radiation Exposure of the UK Population: 2010 Review, PHE-CRCE-026, Public Health England, April 2016.