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RADIATION PROTECTION SERVICE

DEPARTMENT OF WELLBEING, SAFETY AND HEALTH

UNIVERSITY OF LEEDS

RADIATION RISK ASSESSMENT 33:
PLANMECA PRO-X WITH SIMULATION CABINET

1. SCOPE AND PURPOSE

This radiation risk assessment is for the use of Planmeca ProX intraoral X-ray units housed within shielded enclosures.

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	18 September 2017	
2.0	ARC	20 September 2018	Review and update for IRR17

3. NATURE OF SOURCES OF IONISING RADIATION

The Planmeca ProX is an intra-oral dental x-ray radiography unit. Three of these units are installed in the Clinical Skills Labs and are used for teaching students to take radiographs on samples (i.e. not used on patients).
Each unit is housed in a Planmeca Intra simulation cabinet which has 2mm lead shielding and door interlocks.
The x-ray tube is directed down to a sample and HD sensor using a cylindrical beam limiter and the head is fixed in this position.
Maximum operating parameters for generating x-rays are 70kV / 8mA / 2 seconds and exposure parameters are fixed at 60kV/8mA/0.125s for student operations.
Further equipment details can be found on the RPS x-ray database.

4. DOSE ASSESSMENTS

Leakage radiation measurements taken by Planmeca show a maximum dose rate of 1.25µGy/h at 5cm from the external surface of the cabinet (bottom of door) [a]. These measurements were undertaken using maximum exposure values of 70kv/8mA/2s and using a beam orientation that would produce the largest leakage value.
Measurements were also 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, with the cylindrical beam limiter attached and with exposure settings of 60kV/8mA/0.125s, i.e. with the settings and orientation used by students. The chamber was positioned as close as possible to the enclosure outer surface, except for position 4 where the chamber was placed within the enclosure.

Position	Air Kerma nGy per operation
1. Centre of right-hand door.	0
2. Door join – lowest point.	0
3. Left-hand side of unit.	0
4. Inside door (interlocks defeated)	133

Positions 1-3: No radiation doses were measured above the instrument resolution of 0.3nGy. (Position 2 was at the point of maximum leakage measured by the manufacturer).

Position 4: The chamber was positioned just inside the door at the front of the enclosure with the door open and interlock defeated.

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 10 radiographs per student per year.

- Radiation dose to an operator during normal operation of the x-ray unit and enclosure is negligible.
- Accessible dose rates of <0.5µSv/h close to the enclosure would result in <1mSv dose if the operator remains in this position with the system operating for a whole working year. Therefore estimated body doses are <<1mSv (University dose constraint).
- Radiation dose to an operator if the x-ray head is misaligned is < 1.25µGy/h.

For 10 radiographs at the maximum 2s exposure radiation dose would be 1.25x2/3600x10 = 7nGy.

- Radiation dose to an operator if interlocks are defeated is 133nGy per operation, so for 10 exposures the dose would be 1.33µGy.
- Radiation doses if the interlocks are defeated and the x-ray head misaligned 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.

5. DOSIMETRY

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

6. SAFE USE AND MAINTENANCE

Safety features and interlocks are checked regularly (monthly) by the RPS.

7. ENGINEERING CONTROL MEASURES AND DESIGN FEATURES

X-ray enclosures are purpose designed laminate cabinets with 2mm lead shielding and compliant with ACoP 9(2) of IRR17.
Engineering controls and safety features include adequate shielding and interlocked door access.

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

8. 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 kept in each lab.

9. PERSONAL PROTECTIVE EQUIPMENT

No additional PPE is required for this work.

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

The units are located within the Clinical Skills teaching labs.

Access is restricted and operation of the x-ray units is under the supervision of trained demonstrators.

11. 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 <1.25µGy/h at 5cm. Estimated dose <0.01µSv/y**.**	Bracket holding tube in position. Operator training. Local rules include instructions for operator to ensure that the x-ray head is correctly aligned and the enclosure doors/interlocks functioning correctly. Critical Examination before the x-ray tube is first used; if repaired, altered or moved.	**Low**	**Low**	**Low**

	Interlocks not functioning and doors open If the interlocks failed the equipment should fail to safe and not be operable. However if the equipment was still operable radiation exposure levels would be: X-rays; scatter dose rate 0.133µGy/operation. Estimated dose 1.33µGy for 10 radiographs.	Regular interlock checks. Operator training. Local rules include instructions for operator to ensure that the x-ray head is correctly aligned and the enclosure doors/interlocks functioning correctly. Critical Examination before the x-ray tube is first used; if repaired, altered or moved. Regular maintenance and servicing of the equipment.	**Low**	**Medium**	**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**

12. REFERENCES

[a] Planmeca Test Report, Doc number D0005639-1, Planmeca 2016-08-24.

[b] UoL Critical Exam report CRIT1719 XRID50 LDI.

[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.