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RADIATION PROTECTION SERVICE

DEPARTMENT OF WELLBEING, SAFETY AND HEALTH

UNIVERSITY OF LEEDS

RADIATION RISK ASSESSMENT 37:
SCANCO XTREME CT X-RAY SYSTEM

1. SCOPE AND PURPOSE

This radiation risk assessment is for the use of a Scanco XtremeCT x-ray imaging 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	9 October 2017	
2.0	ARC	9 February 2018	Major update for IRR17
2.1	ARC	6 September 2018	Minor revisions

3. NATURE OF SOURCES OF IONISING RADIATION

The XtremeCT is a high resolution peripheral quantitative computed tomography (HR-pQCT) system designed to measure bone density and 3D microarchitecture of bone (distal radius or tibia).

Typical operating parameters for generating x-rays are 60kV / 0.9mA.

The system is fully shielded except for an access port intended for the insertion of the hand or foot of a patient.

The system in use in the university is used only for material samples and is NOT USED FOR MEDICAL EXPOSURES.

System details can be found on the RPS x-ray database (XRID5).

4. DOSE ASSESSMENTS

Manufacturer's specifications are that the effective dose to a patient is less than 5µSv per measurement.

A full leakage and scatter radiation survey was undertaken by the UoL Radiation Protection Manager using a calibrated PTW ionisation chamber [a].

Dose rates were: $15\mu Sv h^{-1}$ at the aperture

$0.25\mu Sv h^{-1}$ at the edge of the screen shield

$<0.2\mu Sv h^{-1}$ at any point outside the restricted area without the screen in place

$0.04\mu Sv h^{-1}$ at the operator position

From x-ray tube emission data estimated radiation dose rates close to the unshielded tube will be of the order of up to 30 Gy/h [b], and scatter dose rates up to a few mGy/h [c].

Estimated doses should be compared with:

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

EXTERNAL DOSES

Estimated radiation dose rates to which anyone can be exposed:

- Radiation dose rates at the operator position during normal operation of the x-ray unit and enclosure are negligible.
- Accessible dose rates of <0.25µSv/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 rates of 15µSvh^{-1} at the aperture.
- Radiation dose rates if there is a failure or malfunction of shielding or interlocks could be up to 30Svh^{-1} in the primary beam and scatter dose rates of up to a few mSvh^{-1}.

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. MANUFACTURER'S ADVICE ON SAFE USE AND MAINTENANCE

The equipment is maintenance free but a Scanco engineer is called for any repairs. Safety features checked on every use.

7. ENGINEERING CONTROL MEASURES AND DESIGN FEATURES

X-ray enclosure are fabricated from aluminium, steel and lead and are compliant with ACoP 9(2) of IRR17.

Enclosure interlocks: 2 of opposing mode push switch type at the bottom of each door, 1 of push switch at the top of each door.

Emergency stop: twist-lock on top LHS of instrument, plus an emergency stop on the workbench next to PC console.

A key for operating the unit is kept in a secure location.

An illuminated warning lamp is used to indicate when x-rays are produced.

A Wardray lead/Perspex mobile medical screen is placed in front of the access port prior to generating x-rays.

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 a file in the 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 laboratory is secured with a programmable key-fob system and only authorised personnel have access.

A tape barrier is used to further restrict access to the area within 1m of the front of the XtremeCT whilst it is in operation.

The lab is demarcated as a Supervised Area whilst x-rays are being produced.

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 <0.25µSvh^{-1} at all points except for 15µSvh^{-1} at aperture. Less than 0.1µSvh^{-1} at operator position. Risk during normal use is negligible (very much less than the university's dose constraint of 1mSv/y).	Operator training. Tape barrier to restrict access to the area in front of the aperture. Shielded screen placed in front of the aperture to reduce scatter dose rates. Local rules include instructions for operator to ensure that the screen and tape barrier are in place. Regular dose rate monitoring around the enclosure. Critical Examination before the x-ray tube is first used; if repaired, altered or moved. Regular maintenance and servicing of the equipment. 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	**Operation without screen shield** X-ray leakage and scatter dose rate <0.25µSvh^{-1} at all points outside the restricted area. Estimated dose at all positions outside the taped off restricted area without the screen would be <<1mSv per year.	Operator training. Local rules include instructions for operator to ensure that the screen and tape barrier are in place.	**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. Dose rate could exceed dose constraint and legal dose limits.	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**
	Interlocks not functioning and panels open X-rays; potential dose rate – Svh^{-1}. Scatter dose rate - mSvh^{-1}. If the interlocks failed the equipment should fail to safe and not be operable. However if the equipment was still operable radiation exposure could quickly exceed dose constraints and legal dose limits.	Regular dose rate monitoring around the enclosure. 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**
	Damage to the equipment by misuse, impact or fire X-rays; potential dose rate – Svh^{-1}.	If the equipment, enclosure or interlocks have been damaged in any way or a malfunction is suspected the user should:	**Low**	**Medium**	**Low**

	Scatter 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 and legal dose limits.	- switch the power off and remove the keys - inform the RPS who will arrange for the equipment to be checked by an engineer			
	Failure of systems of work If the equipment was operated without a screen or barrier in place and the operator approached the aperture then they may be exposed to an external radiation dose rate (see estimated doses above) of 15μSvh^{-1} at the aperture which may result in doses >1mSv if the operator remained in this position for >67 hours in a year.	Operator training. Local rules include instructions for operator to ensure that the screen and tape barrier are in place.	**Low**	**Medium**	**Low**

12. REFERENCES

[a] UoL Critical Examination CRIT 1625 XRID5 MechEng

[b] Handbook of Radiological Protection, Part 1: Data, HMSO 1971.

[c] Radiation Shielding for Diagnostic X-rays, BIR/IPEM 2000.

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

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

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