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RADIATION PROTECTION SERVICE

DEPARTMENT OF WELLBEING, SAFETY AND HEALTH

UNIVERSITY OF LEEDS

RADIATION RISK ASSESSMENT 24:
GE BRIVO CT385 SCANNER

1. SCOPE AND PURPOSE

This radiation risk assessment is for the use of a GE BRIVO CT385 CT scanner.

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	7 August 2015	
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 GE BRIVO CT385 scanner is a high resolution 16-slice computed tomography system.
Typical operating parameters for generating x-rays are 140kV / 130mA.
The x-rays are highly collimated and emitted in short (1.5 second) bursts directed from the tube to detector as a sheet within the scanning gantry.
The scanner and table are located in a dedicated room (7.126d) lined with code 6 (2.65mm) lead sheeting and with a lead glass door panel and viewing window. The scanning room door has an arm actuated interlock which stops x-ray production when opened and then requires control panel reset. The room is a temporary 'Controlled Area' whilst scans are under way.
The operating position is outside the scanning room and no personnel remain in the room whilst a scan is underway.
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 (XRID36).

4. DOSE ASSESSMENTS

Scatter dose measurements taken by the manufacturer show that dose rates at 2m from the gantry along the table axis are approximately $0.8 mSv h^{-1}$.
The attenuation factor for code 6 lead is 2×10^{-4}, therefore the calculated dose rate at the closest point to the scanner outside the room is $<0.2 \mu Sv h^{-1}$.
A leakage and scatter radiation survey was undertaken by the UoL Radiation Protection Manager using a calibrated PTW ionisation chamber [a].
Measured dose rates were: $<0.1 \mu Sv h^{-1}$ at the scanner room door, operator's position and adjacent lab
$0.1 \mu Sv h^{-1}$ at the viewing window

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 <0.1µSv/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 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 an area dose meter (TLD) is appropriate to show that radiation levels are less than the dose constraint.

6. MANUFACTURER'S ADVICE ON SAFE USE AND MAINTENANCE

Manufacturer's guidance on safe use and maintenance are followed and incorporated in the operating instructions.

The equipment is subject to a maintenance / service contract.

Safety features such as interlocks, warning lamps, and emergency stops are checked and tested regularly.

7. ENGINEERING CONTROL MEASURES AND DESIGN FEATURES

The x-ray scanning room is compliant with ACoP 9(2) of IRR17.

Engineering controls and safety features include adequate shielding, interlocked door access and emergency stops within the room.

Warning lamps are fitted to indicate x-ray emission and an illuminated door sign shows Yellow 'Controlled Area – x-rays' when x-rays ready for generation, and Red 'Do not enter' when x-rays produced

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 scanning room is a temporary 'Controlled Area' whilst scans are under way and is controlled by interlocked access and operator supervision.

The operator area is classified as an Undesignated Area as x-ray exposure levels during normal operation are $<0.1\mu Svh^{-1}$, access is via key fob.

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 $<0.1\mu Svh^{-1}$ at all points. Less than $0.1\mu Svh^{-1}$ 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. Regular dose rate monitoring around the enclosure. Critical Examination before the x-ray equipment 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	**Person remaining in scanner room during operation**	Operator training. Access to scanner room is restricted to authorised personnel and safe working	**Low**	**Medium**	**Low**

steps to prevent or limit their consequences	X-ray leakage and scatter dose rate 0.8mSvh^{-1} at 2m from gantry. Estimated dose rate adjacent to scanner – several mSvh^{-1}.	procedures ensure that no-one remains in the scanning room when scans are initiated.			
	Door interlock malfunction X-ray leakage and scatter dose rate 0.8mSvh^{-1} at 2m from gantry. Estimated dose rate adjacent to scanner – several mSvh^{-1}.	Operator training. Access to scanner room is restricted to authorised personnel and safe working procedures ensure that no-one attempts to enter the scanning room when scans are in progress. Regular maintenance and servicing of the equipment and safety features.	**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. 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**
	Damage to the equipment by misuse, impact or fire X-rays; potential dose rate – Svh^{-1}. 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.	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] UoL Critical Examination CRIT 1418 XRID36 SEE

[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.