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RADIATION PROTECTION SERVICE

DEPARTMENT OF WELLBEING, SAFETY AND HEALTH

UNIVERSITY OF LEEDS

RADIATION RISK ASSESSMENT 55:
LD DIDACTIC 554 800 X-RAY APPARATUS

1. SCOPE AND PURPOSE

This radiation risk assessment is for the use of LD Didactic 554 800 x-ray apparatus.

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	20 April 2018	
1.1	ARC	31 May 2018	Revision to dose rate information after modification.

3. NATURE OF SOURCES OF IONISING RADIATION

The LD Didactic 554 800 x-ray apparatus is a self-contained x-ray system used for undergraduate teaching and is designed for conducting a wide variety of experiments in physics and related disciplines.

Operating parameters for generating x-rays are up to 35kV HV at up to 1mA tube current.

The system is housed in a shielded and interlocked enclosure with accessible environmental dose rates specified to be less than 1µSv/h and is type approved for school use in Germany (BfS 05/07 V/Sch RöV)

System details can be found on the RPS x-ray database (XRID55-59).

4. DOSE ASSESSMENT

Manufacturer's specifications are that accessible dose rates are less than 1µSv/h at 10cm.

Radiation leakage surveys of each apparatus were undertaken by the UoL Radiation Protection Manager [a]

Radiation leakage was detected at the top of each enclosure directly above the tube position and the measured dose rate at this point was up to 0.5µSv/h. No radiation leakage was detected at any other point on the external surface of each enclosure.

The measured dose rates comply with manufacturer's specifications and with the standard for cabinet x-ray systems[b], however the exposure levels were not as low as reasonably practicable (ALARP). Physics technical staff therefore attached lead shielding to the inside of each enclosure and subsequent leakage surveys [c] show that the dose rate at this point has been reduced to <0.2µSv/h.

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 [d], and scatter dose rates up to a few mGy/h [e].

Estimated doses should be compared with:

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

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 <0.5µSv/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 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. SAFE USE AND MAINTENANCE

The equipment must be subject to a maintenance / service programme by competent personnel (Physics teaching technical staff).

7. ENGINEERING CONTROL MEASURES AND DESIGN FEATURES

X-ray enclosures are compliant with ACoP 9(2) of IRR17.

Engineering controls and safety features include:

- adequate shielding from metal and lead glass enclosure with additional lead shielding to top of enclosure;
- interlocked door access and door auto-locking;
- two mutually independent safety circuits for doors, high voltage and emission current (safety approval by TÜV Rheinland to regulations for PTB 2005 type approval).

Warning of x-ray emission by high voltage indicator.

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 in the lab manual and students operate the equipment under supervision.

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 teaching laboratory is secured and supervised by Physics teaching technical staff.

The lab is classified as an Undesignated Area as x-ray exposure levels during normal operation are negligible.

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 and supervision. Local rules include working instructions and emergency procedures. 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. Additional shielding fitted to enclosure to reduce exposures to ALARP levels.	**Low**	**Low**	**Low**

Possible accident situations or failure of control measures and steps to prevent or limit their consequences	**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 and supervision. All repairs and modifications to the equipment must only be carried out by a qualified service engineer or competent personell. 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**
	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**

12. REFERENCES

[a] UoL Critical Examinations CRIT 1803-1806

[b] BS EN 61010-2-091:2012, Safety requirements for electrical equipment for measurement, control and laboratory use. Part 2-091: Particular requirements for cabinet x-ray systems, British Standards Institution, 2013.

[c] UoL Critical Examinations CRIT 1812-1815

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

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

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

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

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