

RADIATION PROTECTION SERVICE

SAFETY ADVISORY SERVICES



UNIVERSITY OF LEEDS

RPA GENERIC RISK ASSESSMENT NO 13: HAZARD IDENTIFICATION & RISK ASSESSMENT FOR THE USE OF AN X-RAY DOSING FACILITY

DESCRIPTION

- 1) The x-ray tube lies horizontally inside a sarcophagus and the x-ray beam is direct into an adjacent irradiation chamber. Access to the sarcophagus and irradiation chamber is via lockable cabinet covers, in the first instance and thence via shielded doors. The status of the access door interlocks (and also the hazard warning annunciator, emergency stop buttons, oil coolant flow rate) are monitored by the programmable console; a failure of any of the safety devices would result in the x-ray beam being terminated. The dosing facility has been designed and manufactured in compliance with the requirements specified in BS 61508-1:2002 ('Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems – Part:1 General Requirements') for low complexity E/E/PE safety-related systems (section 3.4.4 of BS EN 61508-4:2002 'Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems – Part:4 Definitions and Abbreviations).
- 2) The maximum operational output of the x-ray tube is 320 kVp, 10 mA, and estimated radiation dose rates directly in front of, or at a distance of 100 mm the tube window are in excess of 100 Sv h⁻¹.

<u>Version</u>	<u>Author</u>	<u>Date of issue</u>
1.1	Dr Ian K Haslam (Radiation Protection Adviser)	7 th November 2006

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HAZARD & RISK ASSESSMENT

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
Exposure to unshielded x-radiation	External irradiation			
	(1) Damage to, or misalignment of the radiation shielding, which may permit the leakage of radiation from the cabinet.	Penetrating x-rays; dose rate 0.3 Sv h ⁻¹ . If a person were exposed by standing adjacent to a leakage point, their exposure would exceed the dose constraint (annual dose limit) of 1 mSv in ~12 seconds.	Health – Low The likelihood of the shielding becoming damaged during normal operational use is extremely low, and would require gross negligence on the part of the operator or a substantial impact. Collateral – Low The unshielded dose rate exceeds internal guidelines and national dose rate limit for the designation of Controlled Areas, and thereby the potential for legislative infraction should there be a failure is very real. However, the likelihood of such a failure is low. Critical failure of the equipment may be reportable to the HSE.	The x-ray generator and the cabinet enclosure are manufactured to a high standard and are not expected to leak radiation. The equipment has been subject to a 'Critical Examination' which found no failings with the system or its safety devices. Failure of the x-ray tube or any of the safety features under normal operational conditions would cause the x-ray beam to terminate (this is not reportable). If the equipment is moved a Radiation Protection Adviser must carry out a Critical Examination before the x-ray tube is energised.

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
	(2) Overriding the door interlocks and gaining access to the x-ray chamber whilst the x-ray tube is generating x-rays and the shutter is open.	<p>Penetrating x-rays; scatter dose rate $\sim 0.2 \text{ Sv h}^{-1}$ at 300 mm from the x-ray tube.</p> <p>If a person were standing in front of the cabinet with the door open, their exposure would exceed the dose constraint of 1 mSv in ~ 20 seconds.</p> <p>Hand accessible dose rates are very high; national limits on extremity exposures would be exceeded in ~ 20 seconds. The dose constraint would be exceeded instantaneously.</p>	<p>Health – Low</p> <p>It is not possible for a user to deliberately or inadvertently override the safety features; consequently the risk of exposure through accident or negligence is low.</p> <p>Collateral – Low</p> <p>Although the unshielded dose rate exceeds the dose rate limit for the designation of Controlled Areas, and thereby there is potential for legislative infraction, the system was designed and manufactured in such a manner as to render this condition highly unlikely.</p>	<p>Users must be trained in the operation of the equipment and must follow appropriate protocols.</p> <p>No one should attempt to bypass any of the safety features.</p>

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
Damage / fire				
	Damage to the equipment by impact or fire.	Penetrating x-rays; dose rate 0.3 mSv h ⁻¹ . If the equipment was damaged but still operable, and a person was exposed when standing adjacent to a leakage point, their exposure would exceed the dose constraint (annual dose limit) of 1 mSv in ~12 seconds.	Health - Low If the equipment were subject to high-energy impact there is the low possible that misalignment might occur. It is unlikely that the equipment would remain operable after sustaining fire damage.	If the equipment has received a significant knock, has been close to a fire, or has been damaged in any other way the user should (1) switch off and isolate the power, then (2) inform the RPS, the RPA and the manufacturer to seek advice before using the equipment.
Unauthorised maintenance / servicing				
	Access to an unguarded x-ray beam.	Penetrating x-rays; dose rate >100 Sv h ⁻¹ . Hand accessible dose rates are very high; national limits on extremity exposures would be exceeded in <10 seconds. The dose constraint would be exceeded instantaneously.	Health - Low Removal of the cabinet covers could give access to areas where there is a high dose rate. However, the covers are secured by locks to which only the engineers have keys. Unauthorised access would require a person 'picking' the lock or breaking into the cabinet. Given the level of	All repairs and modifications to the equipment must only be carried out by the manufacturer; a service contract is in place.

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
			management control, this condition is highly unlikely. Collateral – Low Dose rate exceeds internal guidelines and national dose rate limit for the designation of Controlled Areas; potential for legislative infraction.	