RADIATION PROTECTION SERVICE

SAFETY ADVISORY SERVICES

UNIVERSITY OF LEEDS

RADIATION RISK ASSESSMENT NO 25
HAZARD IDENTIFICATION & RISK ASSESSMENT FOR A RIGAKU PRIMUS II X-RAY FLUORESENCE ANALYSER

DESCRIPTION

1) The Rigaku Primus II XRF analyser is within an enclosed cabinet with the x-ray generator sitting inside a purpose built housing. Access to the x-ray beam can only be achieved by removing the securing bolts holding enclosure panels in place and then further dismantling the x-ray housing and shielding.

2) In normal operational use samples are placed in sample holders and then in position on a drawer. Sample holders are then are picked up by a sample changer mechanism and moved into a shielded position for analysis. There is no exposure to x-rays when loading samples.

3) The x-ray tube operates at 60 kV, 66 mA. From data supplied in British Standards BS 4094 Part 2: 1971 it is estimated that if the instrument casing were removed and the x-ray tube operated without shielding, unshielded radiation dose rates will be approximately 120 Sv h^{-1} at a distance of 100 mm from the x-ray tube collimator.

Version	Author	Checked	Approved	Date of issue
1.1	ARC	-	-	30th September 2015

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 inherent shielding fitted to the instrument resulting in the leakage of radiation from the cabinet.	Penetrating x-rays; dose rate 12 Sv h^{-1}. If a person were exposed by standing adjacent to a leakage point, their exposure would exceed an investigation level / dose constraint of 1 mSv in ~1/3rd of a second.	**Health – Low** The likelihood of the shielding becoming misaligned during normal use is extremely low, and would require an act of gross negligence to achieve this. **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 Health and Safety Executive under RIDDOR.	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 it's 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 under RIDDOR). If the equipment is moved vertically more than 1 m, or out of the laboratory, the Radiation Protection Manager must carry out a Critical Examination before the x-ray tube is re-energised.

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
	(2) Removing the inner instrument casing and overriding the existing engineered safety then gaining access to the x-ray chamber whilst the x-ray tube is generating x-rays and the shutter is open.	Penetrating x-rays; scatter dose rate ~3.6 Sv h^{-1} at 1000 mm from the x-ray tube. If a person were standing in front of the cabinet with the inner casing removed, their exposure would exceed the investigation level / dose constraint of 1 mSv in ~1 second. Hand accessible dose rates are very high; national limits on extremity exposures would be exceeded in a few seconds. The dose constraint would be exceeded in 1/3rd second.	**Health – Low** It is not possible for a user to easily / inadvertently override the safety features and remove the casing; consequently the risk of exposure through accident or negligence is low. **Collateral – Medium** The unshielded dose rate exceeds the dose rate limit for the designation of Controlled Areas, and thereby the potential for legislative infraction, should a person deliberately by-pass the safety systems, is real.	Users must be trained in the operation of the equipment and must follow appropriate protocols. No one should attempt to bypass any of the safety features.

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
Damage / fire				
	Damage to the equipment by fire.	Penetrating x-rays; dose rate <12 Sv h^{-1}. If the equipment was damaged but still operable, and a person was exposed by standing adjacent to a leakage point, their exposure would exceed the investigation level / dose constraint of 1 mSv in ~1/3rd second.	**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 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 RPM 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 3-12 Sv h^{-1}. Hand accessible dose rates are very high; national limits on extremity exposures would be exceeded in a few seconds.	**Health – High** Removal of the cabinet covers could give access to areas where there is a high dose rate. **Collateral – Medium** Dose rate exceeds internal guidelines and national dose rate limit for the designation of Controlled Areas; potential for legislative infraction.	All repairs and modifications to the equipment must only be carried out by the manufacturer or by a qualified service engineer approved by the RPS. If the equipment is serviced on site the service engineer must have sole use of the laboratory.