



University of
St Andrews

Risk Assessment No 9 - X-Ray Beam Alignment Risk Assessment for the Use of Radiation Generator Equipment where Interlocks have been bypassed.

HSE Registration Under the Ionising Radiations Regulations 2017

Document type	Procedure
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RISK ASSESSMENT 9 - X-Ray Beam Alignment Risk Assessment for the Use of Radiation Generator Equipment where Interlocks have been Bypassed - HSE Registration Under the Ionising Radiations Regulations 2017

Location

Building :

Room Number(s) Room

Details of Equipment

Name of Equipment:

kV: Current: Serial Number

Name of Equipment:

kV: Current: Serial Number

Name of Equipment:

kV: Current: Serial Number

Name of Equipment:

kV: Current: Serial Number

Description of Work and Scope of the Assessment

High risk activities involving the use of open beam X-ray crystallography equipment for alignment or maintenance purposes. This assessment only deals with situations where the shielded cabinet/enclosure interlocks have been disengaged.

This risk assessment has been carried out in accordance with the Ionising Radiations Regulations 2017 (IRR17) Approved Code of Practice (ACoP). This risk assessment only addresses the radiological risks associated with the type of equipment detailed above.

Who is at risk?

Only those registered on the RadProt programme as 'Users' for this particular operation can undertake the work. Signature on RadProt is seen as signature for this risk assessment for workers. No cleaners, trades staff or unauthorised personnel will be allowed into the room where there the interlocks to the cabinets/enclosures have been bypassed.

Specialised engineers from specific external contracting companies who are there to maintain the X-ray equipment which may require disengaging the shielding interlocks would also be at risk. All such maintenance / repair work will require that they complete the Radiation Controlled Area and Equipment Handover Form (see Appendix 1). Work on such interlock bypassed equipment must be accompanied by a specific System of Work produced by the company for their activities which has to be approved by the local DRPS and University Radiation Protection Officer (URPO). Control of the unit will be passed to the service engineer.

ACoP Paragraph 70 - Matters to be considered in an assessment, where relevant

70(a) - Nature of the radiation sources likely to be present

X-ray sources. There should be no need to disengage modern equipment with the interlocked shielding cabinet as alignment of the beams can be achieved using computer systems external to the X-ray cabinet.

This risk assessment applies to equipment where alignment cameras are not available and cannot be retrofitted to the internal mechanisms of the X-ray equipment and the shielded cabinet or enclosure has to be opened to align the X-ray beam.

Any work undertaken by external maintenance engineers will require the room management to be handed over the maintenance company while the equipment interlocks have been bypassed - see Form in Appendix 1

70(b) - Estimated dose rates

For radiation protection the X-ray output of an X-ray source can be divided into two components as follows.

(i) **Main beam radiation:** Radiation dose-rates in the collimated main beam can be up to about 5 Grays/second, exposure to which can lead to overexposure of and in some cases serious injury to skin, immediately underlying tissues and eyes depending on absorbed dose and area irradiated. You should contact your manufacturer for exact details for your machine.

(ii) **Scattered radiation:** Radiation dose-rates due to unshielded scattered radiation can be of the order of one to tens of mGrays in close proximity to the x-ray output

The dose rate for a direct X-ray beam has been estimated using the equation below

$$\frac{0.5 \times V \times I}{D^2} \text{ grays/s}$$

Where V = Voltage (kVp), I=Current (mA) with 1mm beryllium filtration, D = Distance from tungsten target (cm)

Users of equipment with interlocks bypassed will continuously measure the dose rate or counts per second on a scintillation probe contamination monitor (or a Model X Compensated Geiger Muller Tube designed to measure X-rays) of scattered X-ray radiation. Written records of such monitoring will be kept.

It is not expected that the dose rates will be above 2.5 $\mu\text{Sv/h}$ outside the cabinet in the absence of shielding due to scatter. This is due to the results from whole body and extremity dosimeter readings. The main beam however could produce a dose of approximately 5 Grays/second thus potentially could cause a serious injury. Therefore, whenever beam alignment is being undertaken, the area of the room must be regarded as a 'Controlled' area under the Ionising Radiations Regulations 2017 with a written system of work (see Appendix 2). The room where such work is undertaken should have a sign on the door making the area a 'Controlled Area' eg



Access to this room should only be for named authorised individuals. There should be no access for any other workers.

70(c) - Likelihood of contamination arising and being spread
None
70(d) - Results of previous personal dosimetry and area monitoring
No extremity doses greater than 0.2 mSv/2 months have been measured on University staff carrying out this work. No whole-body doses above 0.1 mSv have been detected.
70(e) - Advice from manufacturers or suppliers about safe use and maintenance of equipment
<p>When the equipment has its interlocked shielding over-ridden, the manufacturer and the University recommend that the room where this is done is designated as a restricted 'Controlled Area' working area. The door to the laboratory will have a sign identifying it as a 'Controlled Area' posted on it and only authorised personnel may enter and handle the apparatus during this procedure. Signage would be:</p> <div data-bbox="220 779 576 1014" data-label="Image"> </div> <p>Before conducting the alignment, verify that the shutter is closed and that there is no X-rays leakage.</p> <p>When making adjustments to the X-ray optics system, minimize the potential scattered radiation radiation dose by setting the X-ray intensity as low as possible. Additionally, keep your body as far from the X-ray beam as possible, and minimise the period of time spent on the alignment procedure.</p>
70(f) - Engineering Controls, etc. In place or planned
<p>To avoid accidental activation of the X-ray equipment when it is switched off, the HV key, which allows the high-voltage power source to be activated, must be removed and stored securely away from the equipment.</p> <p>Because the interlocked shielding must be disengaged for beam alignment a dose rate meter or scintillation probe monitor will be used to monitor any scattered radiation throughout the process.</p> <p>During beam alignment a leaded acrylic shield containing a PIN diode is fitted to the collimator to minimize the risk of exposure to the main beam or scattered radiation.</p> <p>All adjustments must be made without the fingers approaching the X-ray beam when live.</p> <p>All reflective objects which may cause X-ray scatter should be removed before the work starts.</p> <p>Whole body and extremity radiation dosimeter badges will also be worn during the operation to identify if the operator has received a radiation dose.</p> <p>Fail-safe warning lights indicating x-rays on and shutter open.</p> <p>Flashing warning light indicating interlock override.</p> <p>Emergency off (EMO/Emergency) button for immediate shutdown</p>

70(g) - Planned Systems of Work

The X-ray collimator tube will be covered with a leaded acrylic shield **PRIOR** to beam alignment to avoid scattered radiation from the main beam.

For engineers from external contractors undertaking repair or general maintenance of the equipment, they must take control of the management of the room and complete the attached form in Appendix 1. The maintenance/repair engineer must provide the local DRPS with information with respect to what they are proposing and where/when the beam is active, they must have a 'System of Work' which is approved by the local DRPS and URPO. Responsibility for the adjustment of the unit is then formally transferred to them. All such work by an external contractor will require the Form in Appendix 1 to be completed where the room is handed over to the company. This will confirm they will have responsibility for the area while they are working where the interlocks have been bypassed. The Work Instruction for University staff carrying out the work is found in the Work Instructions - Local rules.

Where the activity is undertaken by University staff, they have to provide a 'System of Work' (shown in Appendix 2) which must be followed by all workers

70(h) - Estimated airborne and surface contamination levels

None.

70(i) - Effectiveness and suitability of PPE

None required. Only normal laboratory protective equipment is required - Laboratory coats, eye protection and if appropriate nitrile disposable gloves

70(j) - Unrestricted access to high dose rates or significant contamination

If there is need for direct access to X-ray beams (beams should be covered during alignment process) then a new specialised risk assessment which highlights all controls to eliminate or minimise the risk to workers or others must be produced and signed off by the DRPS and URPO. This risk assessment would not be sufficient for work on open uncovered high powered X-ray beams

70(k) - Possible accident situations, their likelihood and severity

To avoid accidental activation of the X-ray equipment when it is being set up, the HV keys which allow the power source to be activated must be removed and stored securely away from the equipment

Exposure to main X-Ray Beam The consequences of an operator putting their hands in the main X-ray beam would be a very severe dose which could cause burns and would have other biological effects. If anybody accidentally put their hand in the main X-ray beam then they **MUST** be taken to hospital immediately, by ambulance if necessary with this risk assessment

Cover comes off the X-ray equipment If the leaded acrylic shielded PIN diode over the beam collimator falls off during beam alignment, then an open beam situation would arise, with potential for exposure to the direct beam. In this situation the emergency stop (EMO) button must be activated, and the power supply to the system switched off. The room must be evacuated and locked off. The DRPS and URPO must be called. If there is evidence that the operator or anybody else in the room has been exposed to the direct beam, then they must be taken to hospital and medical staff told that the individual may have been exposed to an direct X-ray beam.

Shutter does not operate If the shutter does not close when the interlocked enclosure door is opened and thus there could be exposure to an open beam, then the enclosure door should be immediately closed and the shutter closed by the control software software or the EMO button activated. The room should then be evacuated and the room locked.

The DRPS and the URPO must then be informed, and an engineer contacted for advice and repair.

Warning lights fail Warning lights should show that a beam is present. If a bulb fails, then the equipment must be switched off and made inactive. The lights must be repaired prior to the equipment being reused.

Exposure to main X-Ray Beam The consequences of an operator putting their hands in the main X-ray beam would be a very severe dose which could cause burns and would have other biological effects. If anybody accidentally put their hand in the main X-ray beam then they **MUST** be taken to hospital immediately, by ambulance if necessary.

Scattered radiation Workers may be exposed to scattered radiation. At all times during this process, the operator should be undertaking radiation measurements. If there are any dose/counts above background then the shutter should be closed and enclosure doors closed. If scattered radiation is still measured, then the equipment EMO button should be pressed and the equipment power supply shut off. The room should then be locked off. The DRPS and URPO must be notified as soon as reasonably practicable.

Fire In the event of a fire or overheating with smoke etc (due to X-ray equipment or other equipment), then the EMO button must be activated and the power supply switched off immediately. The door to the laboratory must be shut. The operator should then activate the fire alarm system to evacuate the building. The operator should then call the Scottish Fire and Rescue Service on 999 or 112. They must tell the fire service the building name, postcode for the building, room number where the fire is and any other information they request.

70(k) - Possible accident situations, their likelihood and severity

Foreseeable X-ray Incident	Actions to be taken
Fire	In the event of a fire in a room with X-ray equipment, press the emergency stop button and the equipment switched off by removing the key to the power source (if this is feasible). Then evacuate the room (helping any injured person out of the room), closing the door (and following the Fire Action Notice, activate the fire alarm to evacuate the building). Call the Fire Service on 999 or 112 and tell them there is a fire and that the fire is in a room with a X-ray generator. Wait for the fire service to arrive and then give details of the incident. Notify the URPO and DRPS and Head of School about the fire as soon as possible.
Flood	In the event of a flood in a room with X-ray equipment, press the emergency stop button. Depower the equipment and then remove the key to the power source. Evacuate every body in the room, seal the room and then call the DRPS or URPO urgently. Contact ERstates with regard to dealing with the flood. Do not let anybody into the room until the flood has been dealt with.
Electrical Issue	In the event of an issue which is deemed an electrical problem, press the emergency off button and switch the power off to the equipment. A notice to say the equipment cannot be used and is 'Out of Service'. A specialist engineer should be called for as soon.

Foreseeable X-ray Incident	Actions to be taken
X-ray radiation detected outside the interlocked shielded cabinet/enclosure	If any X-ray radiation is detected outside the interlocked shielded cabinet/enclosure. Press the emergency stop button (or emergency shutter release). Depower the equipment and remove the keys for activating the equipment. Shut the room and do not allow access to the equipment. Call the specialist maintenance engineers. Notify the local DRPS and the URPO of this situation
X-ray radiation detected when interlocked shielding has been bypassed cabinet/enclosure	If any X-ray radiation is detected when the interlocked shielding has been bypassed for a cabinet/enclosure. Press the emergency stop button (or emergency shutter release). Depower the equipment and remove the keys for activating the equipment. Shut the room and do not allow access to the equipment. Call the specialist maintenance engineers. Notify the local DRPS and the URPO of this situation
Somebody has been exposed to the direct X-ray Beam	If any X-ray radiation is detected when the interlocked shielding has been bypassed for a cabinet/enclosure. Press the emergency stop button (or emergency shutter release). Depower the equipment and remove the keys for activating the equipment. Call an ambulance immediately stating that a person has received an X-ray Burn. Please take risk assessment for the work and any other information about the type of X-ray, the dose they may have received. You must inform the DRPS and URPO as soon as possible about such an exposure
The interlocks on the X-ray equipment fail	If the interlocks on the X-ray equipment fail such that the X-ray beam remains on when the door to the cabinet/enclosure is opened, then the shielded door should be closed immediately, the emergency stop button pressed, and the equipment depowered with the key to the power source removed. The equipment should be taken out of service immediately and the door to the room with the equipment should be locked. A specialist repair engineer should then be called. The Head of EHSS and the URPO as well as local DRPS must be notified as soon as practicable
Emergency X-ray shutter does not work and beam still active	In this situation, press the emergency stop button and depower the system. Remove the key for the power source. Lock the room. Inform the Head of EHSS and the URPO as soon as practicable
The lights showing the status of X-ray beams fails	The equipment must be taken out of service immediately, depowered and the key to the power source removed. The lights should then be repaired by a suitably trained individual

70(l) - Consequences of failure of Control Measures including Systems of Work

See Table 1

70(m) - Steps taken to prevent accidents, or limit their consequences

See Table 1. All warning lights and interlocks tested for correct operation monthly.

TABLE 1

	Who is Affected	Hazard		Initial Risk			Controls	Residual Risk		
		Description	Effect	SF	FF	R	List of Controls Required	SF	FF	R
1	X-Ray Operator	External radiation dose due to exposure to main X-ray beam.	Localised radiation burn and risk of cancer	4	3	12	Strict adherence to Work Instructions - Local Rules is required. Only highly trained and experienced operators to undertake the operation of X-ray beam alignments where interlocks are bypassed. Leaded acrylic shielding will surround the main main open X-ray beam to eliminate X-ray exposure. Monitoring of radiation during procedure. Signage posted to warn other workers of the work in progress.	3	2	6
2	X-ray Operator	Radiation dose due to scatter from the main X-ray beam	Possible risks of cancer	3	2	6	Leaded acrylic shielding will surround the main main open X-ray beam to eliminate X-ray exposure from X-rays. All work should only be done in a room designated as a 'Controlled Area' with authorised personnel wearing appropriate dosimeter badges. All authorised personnel must have been trained in the processes used for beam alignment. Monitoring of radiation during procedure.	3	1	3

	Who is Affected	Hazard		Initial Risk			Controls	Residual Risk		
		Description	Effect	SF	FF	R	List of Controls Required	SF	FF	R
3	X-ray Operator	Failure of the shutter to close and stop the X-ray beam resulting in potential exposure to scattered or main X-ray beam	Possibility of raising risk of some form of cancer.	3	2	6	Strict adherence to the local rules. Regular checks on function. Checks that all warning lights change when the shutter is closed. Regular maintenance of equipment. Room evacuated if the shutter does not shut off the X-ray beam.	1	1	2
4	Specialist Maintenance contractors	Radiation dose due to exposure to the main X-ray beam	Localised radiation burn and risk of cancer	4	3	12	Leaded acrylic shielding will surround the main main open X-ray beam to eliminate X-ray exposure from the X-rays. All work should only be done in a room designated as a 'Controlled Area' with authorised personnel wearing appropriate dosimeter badges. All authorised personnel must have been trained in the processes used for beam alignment. Monitoring of radiation during procedure.	3	2	6
5	Specialist Maintenance contractors	Radiation dose due to scatter from the main X-ray beam	Possibility of raising risk of some form of cancer.	3	2	6	A shielded unit will surround the direct X-ray beam to eliminate X-ray exposure. Only trained and authorised users will have access to equipment. The management of the room will be handed over to the external contractor using form (Appendix 1). All contractors must	2	2	4

							submit a 'System of Work' which must be approved by the local DRPS and URPO. Monitoring of radiation during procedure.			
6	Administrative Staff	Radiation dose due to scatter from the main X-ray beam	.	3	2	6	No administrative staff allowed in the laboratory when interlocks are bypassed on X-ray equipment. Signage on the door stating that the area is a 'Controlled Area' and that only authorised personnel have access.	1	1	1
7	Cleaners	Radiation dose due to scatter from the main X-ray beam		3	2	6	Cleaners will not have access to the room when interlocks are bypassed on X-ray equipment. Signage on the door that the area is a 'Controlled Area' and that only authorised personnel have access.	1	1	1

Matrix of Risk Level					
Severity Factor (SF)					
Frequency Factor (FF)		Slightly Harmful (1)	Harmful (2)	Very Harmful (3)	Extremely Harmful (4)
	Very Unlikely (1)	1	2	3	4
	Unlikely (2)	2	4	6	8
	Possible (3)	3	6	9	12
	Probable (4)	4	8	12	16
Risk (R) = Frequency factor (FF) x Severity of Harm (SF)					
Risk Rating (R)	Classification	Action Required			
1-2	Low	No additional controls			
3-4	Acceptable	Consider additional controls			
6-9	Moderate	Additional controls to be made			
12-16	High	Task must not be completed. Look for alternative method			

ACoP Paragraph 71 – Outcomes of the assessment

71(a) - Actions taken to keep exposures ALARP

Signage on the entrance door to show that the interlocks have been bypassed on the X-ray equipment being used and that the area is now a 'Controlled Area' with the following sign posted on the door:



A system of work has to be in place which details all the actions that must be taken to eliminate the risk or if this not possible then to minimise the risks to occupants as well as other staff. The System of Work will be specific for each machine and should be added to this risk assessment - see Appendix 2

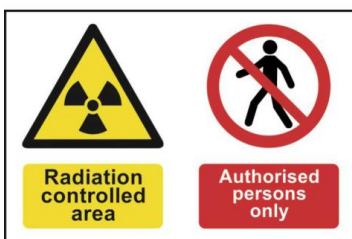
71(b) - What Engineering Controls, Warning Signals and other Safety Systems are necessary

The direct X-ray beam will be covered by appropriate shielding to avoid scatter from the main beam during alignment process.

Equipment has fail-safe warning lights to show when X-ray beams are active.

Flashing warning light indicating interlock override.

Door to the laboratory will have warning signs stating the room is now a 'Controlled Area' and only authorised personnel are allowed in:



The area must be monitored during the whole of this operation and records kept of the monitoring.

All workers undertaking this operation must wear a whole body dosimeter as well as a finger dosimeter for the whole of this operation. Such dosimeters are issued by Environmental, Health and Safety Services.

EMO button on equipment for emergency shutdown if necessary.

71(c) - Whether PPE is appropriate and if so what type

None appropriate. General laboratory protective equipment only

71(d) - Dose Constraints

An investigation action level of 0.5 mSv/ 2 months on an extremity dosimeter has been adopted.

71(e) - Protection of female employees

Females will be warned of the risks of working with open X-ray beams. No expectant mother will be allowed to undertake this work

71(f) - Investigation levels

An investigation action level of 0.5 mSv/ 2 months on an extremity dosimeter has been adopted.

71(g) - Maintenance and testing schedules

A regular maintenance contract held with manufacturer. Regular internal inspections of equipment will be via a specialist external maintenance engineering company.

71(h) - Contingency Plans

To avoid accidental activation of the X-ray equipment when it is switched off, the HV key (if present), which allows the high-voltage power source to be activated, must be removed and stored away from the equipment

Foreseeable X-ray Incident	Actions to be taken
Fire	In the event of a fire in a room with X-ray equipment, press the emergency stop button and depower the equipment - remove the HV key. Evacuate the room (helping any injured person out of the room), close the door and follow the Fire Action Notice. Activate the fire alarm to evacuate the building. Call the Fire Service on 999 or 112 and tell them there is a fire and that the fire is in a room with an X-ray generator. Wait for the fire service to arrive and then give details of the incident. Notify the URPO and DRPS and Head of School about the fire as soon as possible.
Flood	In the event of a flood in a room with X-ray equipment, press the emergency stop button. Switch off the equipment and then remove the key to the power source. Evacuate and seal the room then call the DRPS or URPO. Contact Estates with regard to dealing with the flood. Do not let anybody into the room until the flood has been dealt with and electrical supply checked.
X-ray radiation detected outside the interlocked shielded cabinet/enclosure when shutter open	If any X-ray radiation is detected outside the interlocked shielded cabinet/enclosure when the shutter is open, immediately close the shutter or press the EMO button and assess the situation. If necessary, Switch off the equipment and remove the HV key for activating the equipment. Shut the room and do not allow access to the equipment. Call the specialist maintenance engineers and notify the local DRPS and the URPO of the situation.
X-ray radiation detected inside cabinet/enclosure during beam alignment when interlocked shielding has been bypassed	If any X-ray radiation is detected inside the cabinet/enclosure when the interlocked shielding has been bypassed during beam alignment immediately close the shutter or press the EMO button and assess the situation. If necessary, Switch off the equipment and remove the HV key for activating the equipment. Shut the room and do not allow access to the equipment. Call the specialist maintenance engineers and notify the local DRPS and the URPO of the situation.

Foreseeable X-ray Incident	Actions to be taken
Electrical Issue	In the event of an electrical issue with the X-ray generator, press the EMO button and switch the power off to the equipment and remove the HV key. Post a notice to say the equipment cannot be used and is 'Out of Service'. A specialist engineer should be called for as soon as possible.
Somebody has been exposed to the direct X-ray beam	If any X-ray radiation is detected or someone is exposed to the direct X-ray beam when the cabinet/enclosure interlocked shielding has been bypassed press the EMO button. Switch off the equipment and remove the HV key for activating the equipment. Call an ambulance immediately stating that a person has received an X-ray burn. Please take risk assessment for the work and any other information about the type of X-ray and the dose they may have received. You must inform the Head of EHSS, DRPS and URPO as soon as possible about such an exposure.
The interlocks on the X-ray equipment fail	If the interlocks on the X-ray equipment fail such that the X-ray beam remains on when the door to the cabinet/enclosure is opened, then the shielded door and shutter should be closed immediately. If the shutter does not close, press the EMO button, power off the equipment and remove the HV key. The equipment should be taken out of service and the door to the room with the equipment should be locked. A specialist repair engineer should then be called. The URPO as well as local DRPS must be notified as soon as practicable.
Emergency X-ray shutter close button does not work and beam still active	In this situation, press the EMO button and switch off the system. Remove the HV key for the power source. Lock the room. Inform the URPO and the DRPS as soon as practicable. Contact engineer to fix button.
The lights showing the status of X-ray beams fails	The equipment must be taken out of service immediately, switched off and the HV key removed. The lights should then be repaired by a suitably trained engineer.

71(i) - Training needs

All users of the equipment must be trained. All users must undertake the annual X-ray awareness course run by Aberdeen Radiation Protection Services. All staff will then have to pass a test by ARPS or on the University of St Andrews Radiation Protection Course on the Moodle site at URL: <https://moody.st-andrews.ac.uk/moodle/course/view.php?id=2905>

The operator carrying out beam alignment must have been instructed how to do so by the manufacturer.

Other staff instructed in the meaning of warning signs and indicator lights during their specialist induction training within the School/Unit.

71(j) - Designation of Controlled and Supervised Areas

Room will be deemed a 'Controlled Area' under the Ionising Radiations Regulations 2017 for this operation (beam alignment). As such the room must have a sign on the door which shows this designation:



Only those identified on the approved RadProt system will be allowed into this area and be designated as 'Authorised' persons.

71(k) - Access restrictions and other precautions for designated areas

The laboratory will only be available to authorised personnel undertaking the beam alignment process. Other laboratory equipment in this area will not be available during this operation while the room is designated as a 'Controlled Area'. Other laboratory equipment will only be available after the room 'Controlled Area' status as been removed.

71(l) - Designation of persons

Workers will follow the System of Work shown in Appendix 2. Workers will not need to be 'Classified' as defined by the Ionising Radiations Regulations 2017 as the dosimetry records of workers undertaking this operation are below 6mSv annually. (see Regulation 21 of the Ionising Radiation Regulations 2017)

71(m) - Personal dosimetry

Whole body dosimeter badges and extremity badges for fingers will be issued to Users by Environmental, Health and Safety Services for this operation.

71(n) - Leak testing of radioactive sources

N/A

71(o) - Responsibilities of managers

Ensure that this risk assessment is complied with by all Users and that the Working Instructions for this work and Local Rules are followed, as well as all relevant and required staff are properly trained.

71(p) – Monitoring / auditing program to ensure compliance with IRR77

Radiation Protection Adviser to audit operations every two years, the University Radiation Protection Officer will inspect the facilities and records on an annual basis.

Appendix 1

RADIATION CONTROLLED AREA AND EQUIPMENT HANDOVER FORM

Part 1: School/unit – Handover of Controlled Area and Equipment to Company Representative			
SITE:		CONTROLLED AREA / ROOM:	
COMPANY CARRYING OUT WORK:			
REASON FOR HANDOVER:			
IDENTIFY KNOWN HAZARDS WITH CONTROLLED ARE OR EQUIPMENT:			
As an authorised representative of the School/Unit I hereby hand over the controlled area and equipment as above. Information has been exchanged to enable appropriate risk assessment to be made.		Company: As an authorised, and suitably trained, representative of the company, I accept responsibility for the controlled area and equipment. I will work in compliance with my employer's procedures and Local Rules.	
School/Unit Representative:	Signature:	Company Representative:	Signature:
Date:	Time:	Date:	Time:
Part 2: COMPANY REPRESENTATIVE – Handover of Controlled Area and Equipment to School/Unit			
Please tick all applicable categories of work carried out. See visit / service report for full details.			
Category of Work		Details	
<input type="checkbox"/> Routine Service			
<input type="checkbox"/> Fault Diagnosis / Repair			
<input type="checkbox"/> Installation of Part(s)			
<input type="checkbox"/> Upgrade / Modification		<input type="checkbox"/> Hardware / <input type="checkbox"/> Software	
<input type="checkbox"/> Incident Response			
<input type="checkbox"/> RPA Inspection			
<input type="checkbox"/> Exposure Protocol Changes			
<input type="checkbox"/> Other			
<input type="checkbox"/> Shielding	<input type="checkbox"/> Interlocks / Exposure termination	<input type="checkbox"/> Safety features / warning devices	
<input type="checkbox"/> Beam quality / filtration / grid	<input type="checkbox"/> Collimation / alignment / field sizes	<input type="checkbox"/> Detector dose / input dose	
<input type="checkbox"/> 1. Equipment is OPERATIONAL following work as indicated above and detailed on the visit / service report.			
<input type="checkbox"/> 2. Equipment is PARTIALLY OPERATIONAL, but limitations may exist, please refer to visit / service report.			
<input type="checkbox"/> 3. Equipment is NOT OPERATIONAL and MUST NOT BE USED.			
Part 3: School/Unit – Returning Equipment to Use			
I confirm that I have been authorised as a competent practice representative <input type="checkbox"/>			
I confirm that the above Company has provided information and that I have reviewed the associated service report (if applicable) and appropriate checks have been carried out in accordance with my employer's procedures <input type="checkbox"/>			
<input type="checkbox"/> 1. I am satisfied that the equipment is in a satisfactory condition for use.			
<input type="checkbox"/> 2. I am NOT satisfied that the equipment is satisfactory for use. Reason: Actions taken:			

School/Unit Representative:	Signature:	Company Representative:	Signature:
Date:	Time:	Date:	Time:

EXAMPLE

Written System of Work for Alignment of X-Ray Beams Where Shielding Interlocks have been Bypassed

Alignment procedure for Rigaku MicroMax-007 HFM X-ray Generator

PUSHING THE RED EMO BUTTON WILL SHUT OFF THE EQUIPMENT IN AN EMERGENCY

BSRC DRPS: Dr. Magnus S. Alphey, Level 2 office BSRC Annexe, ext. 7257

Location of equipment: BSRC Annexe, B213a

Persons responsible for equipment:

Dr. Magnus S. Alphey, BSRC Annexe, Level 2 office, ext. 7257

1. This system of work is only appropriate for the Rigaku MicroMax-007 HFM X-ray generator. You must read through this BEFORE starting any work with the instrument. This system of work must be followed, and no deviation from it is permissible without written instruction from Dr. Magnus S. Alphey or Dr. Paul Szawlowski.
2. Only Dr. Magnus Alphey and Rigaku engineers are authorized to carry out this system of work. **Dr. Magnus Alphey holds the interlock override key and only these named persons may use the key.**
3. If any fault is found with the equipment before commencing work under this approved system, or any fault occurs in the equipment during operation, or any incident occurs which may result in accidental radiation exposure, then the generator must be turned off and the following persons informed:

DRPS - Dr. Magnus Alphey, BSRC Annexe, Level 2, ext. 7257; email msa31@st-andrews.ac.uk

URPO - Dr. Paul Szawlowski, EHSS, Walter Bower House, ext. 2753; email: pwss@st-andrews.ac.uk

4. Only the following persons are authorized to be present in room B213a BSRC Annexe during alignment or when interlocks have been overridden

Dr. Magnus Alphey
Dr. David Cordes
Dr. Paul Szawlowski
Rigaku engineers

5. You must not leave room B213a if the override key is in use.

6. Individuals authorized to operate the instrument under this 'system of work' are required to wear a body dosimeter on the upper chest and a finger TLD.

7. Ensure that a safety sign is posted on the lab door notifying staff that the room is now temporarily classified as a 'Controlled Area' and that only authorised persons are allowed in the room. The appropriate safety sign is:



8. Sequence of operating instructions:

- (a) Switch on the x-ray generator and set to the minimum operating power compatible with the operation to be carried out.
- (b) Check that the X-rays ON warning lamp and the beam shutter indicator lamps are operating.
- (c) With the beam shutter closed, check with a radiation monitor that no levels of radiation above background are detected in the working area.
- (d) Set up the tools required for alignment to be carried out.
- (e) Attach the leaded acrylic shield containing PIN diode to the end of the collimator.
- (f) Insert and activate the override key in the interlock system.
- (g) Open the shutter manually using the X-ray generator front control panel whilst directing the switched on radiation monitor towards the shutter.
- (h) Using the radiation monitor, check that there is no significant radiation scatter from the shutter and working area. If there is, close the shutter immediately and leave the enclosure, close the door, remove the override key, and contact Dr. Magnus Alpey or Dr. Paul Szawlowski.
- (i) In an emergency X-rays can be switched off immediately by hitting the red EMO button on the front control panel of the x-ray generator.



- (j) The radiation monitor should be positioned as close as possible to the person carrying out the alignment procedure.
- (k) Stand behind the cathode to carry out alignment where possible.
- (l) Adjust optics to align and optimize X-ray beam based on PIN diode output readings.
- (m) On completion of beam alignment work close the shutter and check that there is no radiation scatter using a monitor. Remove the override key, remove the leaded acrylic shield containing PIN diode from the end of the collimator, exit enclosure and close enclosure door. Check that safety interlocks function normally, i.e. use the control PC to open the shutter, check that opening the enclosure door triggers the interlock and closes the shutter (warning lamps should go off), and check that the emergency shutter close button works. Check for leakage around the enclosure and record results.

(n) If the shutter or warning lights do not work, or radiation leakage outside the enclosure is detected, close the door and close the shutter, or press the EMO button, and inform Dr. Magnus Alpey or Dr. Paul Szawlowski.

This 'system of work' is invalidated if any alterations are carried out to the equipment that in any way affects operation of the instrument beam-shutters, safety interlocks, indicator lamps, or radiation shielding provided with the equipment.

A copy of the manufacturers instructions for beam alignment is located with the machine and must be followed.

This system of work was updated by Dr. Magnus Alpey 22nd Jun

Assessor (sign):



Dr Paul Szawlowski, University Radiation Protection Officer and Deputy Director of Environmental, Health and Safety Services (12/07/2021)

Version number	Purpose / changes	Document status	Author of changes, role and school / unit	Date
v1.0	New Document	Approved	Dr Paul Szawlowski	12/07/2021