

# Radioactive Materials Policy

This policy defines the principles and minimum standards, which will apply to the storage and care of radioactive material in the Royal Armouries collections and to objects held by the museum on loan.

The Royal Armouries will

- maintain a contract with a Radiation Protection Adviser (RPA) as required by regulation 14 of the Ionising Radiation Regulations 2017 (IRR17)
- appoint a Company Radiation Protection Supervisor (RPS) as required by regulation 18 (5) of IRR17
- ensure that radiation doses to staff and other persons are kept as low as reasonably practicable
- store and care for the radioactive collection material with reference to the published standards and guidelines in line with the Ionising Radiation Regulations 2017 (IRR17) and the Certificate of Registration issued under the Radioactive Substances Act 1993, which now has the status of a Permit under the Environmental Permitting (England and Wales) Regulations 2016. Radioactive material which is exempt from the permitting requirement under these regulations will be stored and cared for in line with the exemption conditions.
- survey all collection material to identify radioactive material
- test all new acquisitions suspected of a potential radiation risk
- keep records of all radioactive material in line with the standards set out by IRR17 and the environmental Permit
- register to work with radiation with the HSE
- ensure that all radioactive material is clearly labelled
- record the location of all radioactive material on the radiation register
- monitor the movement of radioactive material
- carry out an audit of radioactive material once every three years

The Royal Armouries will not

- carry out conservation work on any radioactive object without gaining advice from the RPA
- lend out radioactive material unless requested by the MoD

## X-Radiography Policy

This policy covers the use of the X-ray set for industrial radiography and the hire of any X-ray based analysers.

- The X-ray set for industrial radiography will be maintained in a dedicated room.
- Local Rules will be drawn up to identify safe working practices as required by regulation 18(1) of the IRR17.
- The Local Rules will be kept with the X-ray set.
- Only authorised employees as set out in the Local Rules will be allowed to enter the controlled area to use the X-ray set.
- All authorised employees will sign a record sheet to indicate that they agree to work in accordance with the Local Rules.
- Access by other employees/visitors will be carried out in accordance with the Local Rules and supervised by a Radiation Protection Supervisor or deputy Radiation Protection Supervisor at all times.
- The Radiation Protection Adviser will be contacted before hiring or purchasing any other X-ray equipment in order that a risk assessment and Local Rules can be drawn up.
- The Royal Armouries will obtain consent from the HSE for the use of its industrial radiography facility and register use of the portable XRF analyser with the HSE.

# Local Rules for the Use of the X-Radiography Room

## Part A: INFORMATION

### A1: General

These Local Rules are required by regulation 18 (1) of the Ionising Radiation Regulations (IRR17). The rules identify the safe working practices to be followed in the use of the X-ray set for industrial radiography in order to ensure compliance with the relevant regulations and to restrict workers' exposure to ionising radiation. They also detail the procedures to be followed in the event of an accident or emergency.

### A2 Equipment/Location

A dedicated room for industrial radiography using an Xstrahl X-ray set with MP1 controller and NDI 321 tube, maximum operating parameters 320 kV, 10 mA.

### A3: Appointment of Persons

The Company Radiation Protection Supervisor (RPS) appointed under regulation 18(5) of IRR17 is:

Name: Lauren Piper Telephone: 0113 220 1936

The deputy RPSs are:

Name: Mark Murray-Flutter Telephone: 0113 220 1876

Jamie Hood Telephone: 0113 220 1936

Lindsay Shepherd Telephone: 01329 848 510

The Health and Safety Officer is:

Name: Catherine Shaw Telephone: 0113 220 1817

The Radiation Protection Adviser (RPA) appointed under regulation 14 of IRR17 is:

Name: UKHSA (UK Health Security Agency),  
Leeds Telephone : 0113 267 9041

Contacts: Martin de la Mare (principal) Telephone: 0113 267 9041

Joanne Shaw (back up)  
(or any other person)

Telephone: 0113 267 9041

Emergency contact number  
(out of hours only)

Telephone: 07799 797 844

#### **A4: Designation of Areas**

A controlled area is designated within the X-ray room, demarcated by the walls and interlocked sliding door.

Entry into the controlled area is permitted as follows;

**Authorised employees**– the following persons are authorised to enter the controlled area to use the X-ray set. They have signed a record sheet to indicate that they agree to work in accordance with these Local Rules, in particular the written arrangements in Part B2.

Lauren Piper  
Jamie Hood

**Other employees and visitors from other museums/universities** wishing to have items radiographed may enter the radiography room to assist in positioning the items to be studied provided that they have read the local rules and are under the direct supervision of the RPS or their deputy. As soon as the positioning work has been completed, these persons must vacate to the control room. Under no circumstances is anyone other than those listed in section B2 (or a suitably qualified service engineer) permitted to operate the X-ray equipment.

**Service engineers** – may enter the controlled area under the terms of their own Local Rules. The Royal Armouries RPS should be informed prior to service engineers entering the controlled area and the controlled area hand-over form should be completed before work commences and after it has finished.

**Other persons** (Building Services staff, cleaners, visitors, etc.) – may only enter the area provided that the RPS has turned off the power to the X-ray set and removed the keys to the control panel.

#### **A5: Engineering Controls**

The following engineering controls are in place:

- i) The walls of the X-ray room are shielded to reduce external dose rates.

- ii) There are interlocks fitted to the access door to the X-ray room so that if the door is opened the generation of X-rays is terminated.
- iii) A number of emergency stop buttons are located inside and outside of the X-ray room and at the operator's position which, when pressed immediately terminates the generation of X-rays.
- iv) The X-ray set is under key operation and these are removed from the machine and locked away when it is not in use.

### **A6: Warning Signals**

Warning lights located in the control room and inside the X-ray room indicate when the mains supply to the X-ray set is on.

The x-ray set is fitted with exposure pre-warnings in the form of an audible buzzer and illuminated warning lights outside and inside the x-ray room and at the operator's position indicating "X-rays imminent".

Warning lights located on the inside and outside of the X-ray room and at the operator's position that illuminate indicating "X-rays on" when an exposure is taking place.

An illuminated sign indicating when X-rays are being generated is located on the X-ray control panel.

### **A7: Warning Signs**

Warning sign with the words "X-RAYS" and "CONTROLLED AREA" along with the radiation trefoil symbol is attached to the access door of the x-ray room.

Red prohibition sign with the words "NO UNAUTHORISED ACCESS" is attached to the access door of the X-ray room.

Signs displayed inside the X-ray room indicating "If alarm sounds press the emergency stop button and leave the room immediately".

Signs indicate in which orientation the X-ray set can be used and warn that it must not be pointed towards the door.

### **A8: Classified Workers/Personal Dosimetry**

The regular, authorised operators of the X-ray set are designated as classified workers. Other employees and visitors enter the X-ray room under written arrangements as given in Part B below.

Regular, authorised operators wear whole body dosimeter badges, which are issued to them by the RPS. The operators should immediately inform the RPS if they lose their dosimeter or if it is inadvertently exposed whilst not being worn.

**Part B: WORKING INSTRUCTIONS/WRITTEN ARRANGEMENTS****B1: Acting RPS**

The RPS shall ensure that in their absence a responsible deputy will be available to act as RPS.

**B2: Routine Operation/Written Arrangements**

- i) During normal circumstances the use of the X-ray room does not present a significant radiation hazard to employees provided warning signals and notices are observed and the manufacturer's operating instructions and the requirements of these Local Rules are complied with.
- ii) The X-ray room may only be used by the following authorised personnel:

Lauren Piper  
Jamie Hood

No unauthorised persons shall use or interfere with the X-ray set in any way.

- iii) The following are the maximum X-ray set parameters that may be used within the room;

320 kV, 10 mA

- iv) The X-ray beam must only be directed towards the floor and must never be pointed towards the door.
- v) The X-ray set must never be energised outside of the room.
- vi) No one must remain inside the X-ray room during an exposure and before an exposure takes place the operator must ensure that there is no-one inside the room.
- vii) Persons may not enter the room following an exposure unless it has been confirmed that the X-ray exposure has ended and the exposure warning light is extinguished. If the exposure fails to terminate the room must not be entered and the RPS shall be informed. The operators must not make use of interlocks to terminate an exposure.
- viii) Any malfunction of the X-ray set or its safety systems causing a failure to terminate an exposure at the end of the set period must be reported to the RPS and RPA immediately. Under the requirements of RIDDOR the RPS must then notify HSE of the occurrence.

**B3: Inspection/Maintenance**

Anyone suspecting that the X-ray set or any of the associated safety systems are not functioning satisfactorily or have been damaged must immediately bring this to the attention of the RPS.

At monthly intervals and following any service/maintenance work the RPS shall carry out the following checks:

- i) Operation of the pre-warning audible alarm.
- ii) Operation of the external warning lights.
- iii) Operation of door interlocks by turning down the x-ray set kV and mA to a minimum and slowly opening the door which should cause the generation of x-rays to terminate before the door can be opened any significant distance. It should be checked that closing the door again does not in itself cause the generation of x-rays to restart.
- iv) Presence of warning signs and notices and the Local Rules.
- v) Operation of the emergency stop.

The results of the checks shall be recorded.

Any maintenance or servicing work, other than changing bulbs, must only be carried out by appropriate external service engineers and only after authorisation by the RPS prior to their entry into the controlled area. On completion of the work it must be confirmed that the radiation levels are normal and that the warning and safety devices are operating satisfactorily. A written record shall be made to this effect including details of any work carried out.

**B4: Monitoring**

At monthly intervals the RPS shall carry out a routine radiation monitoring survey around the X-ray room and record the results along with the chosen operating parameters of the x-ray set. Particular attention should be made to dose rates around the outside of the door seals. Any significant increases in dose rates (a measurement greater than 2  $\mu\text{Sv/h}$  at the operator position) should be investigated by the RPS.

At intervals not exceeding 12 months the RPS shall ensure that the company's radiation monitor is tested by a qualified person. This service is currently provided by the UKHSA.

**B5: Dose Investigation Level**

Under the requirements of regulation 9(8) of IRR17 a formal dose investigation level must be set to ensure that radiation exposure to employees is being restricted as far as is reasonably practicable. For this application a dose investigation level of 2 mSv/annum is appropriate.

To ensure that the investigation level is not exceeded the dose rate monitoring programme identified in B4 above shall be carried out. In addition the operators must wear whole body dosimeters.

The RPS shall review the results of the dosimeter badges on an ongoing basis and the dose investigation level shall be reviewed annually.

**B6: Records**

The RPS shall ensure that the following records are kept and maintained:

- i) A record of the periodic inspections and any maintenance carried out on the X-ray set or safety feature.
- ii) The results of radiation monitoring surveys.
- iii) Dose records, which should be reviewed regularly.
- iv) Calibration certificates for the radiation monitor.
- v) The Radiation Safety Management file.

These records must be kept for a period of 2 years.

## Part C: Contingency Plan and Emergency Procedures

Four potential accident situations are considered reasonably foreseeable. Plans to follow in the event of these accidents are given below:

*C1: Failure of an electrical interlock leading to a person gaining access to the inside of the X-ray room while X-rays are being generated*

In the event of any suspected problem with the safety devices **SWITCH OFF THE SET USING AN EMERGENCY STOP AND ISOLATE FROM THE MAINS POWER SUPPLY. REMOVE THE CONTROL PANEL KEY.** This will terminate the generation of x-rays. The fault should be immediately reported to the RPS and the RPS should seek advice from the RPA and from a service engineer, as appropriate. The X-ray set must not be put back into use until it has been confirmed by a service engineer that all safety and warning devices are working correctly.

If it is suspected that any person has been exposed to X-rays as a result of the incident, follow the plan in C3 below.

An investigation into incident should be carried out and recorded in a written report. A copy of this written report should be kept for at least two years. If any person receives a radiation exposure as a result of the incident, this should be noted on any relevant dose record.

*C2: X-ray system failing to terminate after the end of the intended exposure period*

In the event of the X-ray system failing to terminate after the end of the intended exposure period, **SWITCH OFF THE SET USING AN EMERGENCY STOP AND ISOLATE FROM THE MAINS POWER SUPPLY. REMOVE THE CONTROL PANEL KEY.** This will terminate the generation of x-rays.

The RPS should be immediately informed and the RPS should seek advice from the RPA and from a service engineer, as appropriate. The X-ray set must not be put back into use until it has been confirmed by a service engineer that all safety and warning devices are working correctly.

This is a dangerous occurrence and is notifiable to the HSE under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013. Notification to the HSE should be made without delay (<http://www.hse.gov.uk/riddor/>). An investigation into incident should be carried out and recorded in a written report. A copy of this written report should be kept for at least two years. If any person receives a radiation exposure as a result of the incident, this should be noted on any relevant dose record.

*C3: Damage to the integrity of the shielding provided by the room by fire, impact or explosion*

In the case of a fire the operators should consider their own personal safety first and it may not be possible to turn off the power to the X-ray set. In this situation the emergency services dealing with the fire must be made aware of the presence of a source of ionising radiation.

Following a fire it must be assumed that the shielding around the X-ray tube may be damaged and the operation of the safety systems may be affected. In the event of any damage or suspected damage, the X-ray generator should be isolated from the mains supply and the RPS should seek advice from the RPA and from a service engineer. The equipment must not be used until it has been fully tested by a service engineer.

An investigation into incident should be carried out and recorded in a written report. A copy of this written report should be kept for at least two years. If any person receives a radiation exposure as a result of the incident, this should be noted on any relevant dose record.

*C4: Failure to follow the Local Rules leading to a person being inside the X-ray room when an exposure is initiated*

In the event if any accident or incident involving the X-ray set always **SWITCH OFF THE SET USING AN EMERGENCY STOP AND ISOLATE FROM THE MAINS POWER SUPPLY. REMOVE THE CONTROL PANEL KEY.** This will terminate the generation of X-rays.

If it is suspected that any person has been inside the X-ray room while the X-ray set was generating X-rays this must be immediately notified to the Company RPS and/or the Health and Safety Officer who should then immediately contact the RPA for advice.

Details of the incident should be recorded (eg time spent in the room, distance from the X-ray tube, whether an emergency stop was activated etc). The RPA will advise on any further actions necessary.

An investigation into incident should be carried out and recorded in a written report. A copy of this written report should be kept for at least two years. If any person receives a radiation exposure as a result of the incident, this should be noted on any relevant dose record.

---

The undersigned have read these Local Rules and agree to work in accordance with them:

Signed: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Signed: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Signed: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Signed: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

# X-Radiography Machine Warm-up and Usage

The warm-up helps extend the life of the x-ray tube and ideally should be carried out every other day. The following procedure must be carried out by a trained person, wearing a personal dosimeter and aware of the local rules.

## Key:

Room key no 100 in the key cabinet outside of the security control room. X-ray machine key in locked key in restricted access coded key cabinet in the Conservation laboratory.

## Safety:

Note local rules (copies on bench in x-ray room and in PHE (now UKHSA) RPA folder in Conservation)

Wear personal dose badge

Ensure no-one in X-ray room (controlled area) during x-rays on and door is shut.

Beware door is heavy – lean on it to open/close don't pull.

## Warm-up Procedure:

Check timer on console is in "off" position and focus is on the broad setting

Insert key into console and turn ¼ anti-clockwise (i.e. to 9 O'clock)

Turn on the mains power (circuit breaker near door) to vertical

Turn the key in the console ½ turn clockwise (i.e. to 3 O'clock)

Ensure the console reads '17 minutes' on the time display, if it says longer than this then it is on the incorrect warm-up cycle. If this is the case, press 'set' then type in '100' on the number key pad and press 'enter' to put it on the correct cycle.

Press green "on" button – siren will sound and "X-ray imminent" sign on the wall will illuminate

After 10 seconds the siren will stop and the wall sign will change to "X-rays on" and the timer on the console will start as the voltage is ramped up.

The warm up cycle takes approximately 17 minutes after which the X-rays automatically switch off.

After automatically switching off, the machine needs at least a further 5 minutes to cool down.

If the machine is not to be then used turn the key to 12 O'clock and remove. Switch the power off at wall.

## Usage:

Complete warm-up as above.

Turn the key in the console to 12 O'clock. The display should read '002' to indicate that it is on the manual setting (meaning the kV, mA and time can be manually set).

Hold the "pre-set" button down and alter kV and mA to desired level, making sure not to exceed 320 kV and 10 mA.

Set timer dials for time required in seconds and switch timer button to the “on” position.

Turn key in console ½ turn clockwise (i.e. to 3 O'clock)

Press green “on” button – siren will sound and “X-ray imminent” sign on the wall will illuminate

After 10 seconds the siren will stop and the wall sign will change to “X-rays on” and the timer on the console will start as the voltage is ramped up.

Once the allocated time has been reached the x-rays automatically switch off.

After automatically switching off, the machine needs at least a further 5 minutes to cool down.

If no more x-raying is to be carried out turn the key to 12 O'clock and remove. Switch the power off at wall.

All x-rays taken should be recorded in the x-ray log book with each x-ray plate carrying a running plate number for future reference.

**Problems:**

If the x-ray warm up sequence fails to start (there'll be a short bleep sound): Check “interlock” light on console. If this is illuminated then it is most likely that either the door isn't shut (close it) or one of the internal room emergency stop buttons has been pressed (twist to reset).

If x-ray warm-up sequence terminates before about 19 minutes: Check timer if you've been out of the room. Repeat the procedure from the start. If this does not work at second or third attempt leave it and contact the RPS.

If x-rays fail to shut off automatically after about 20 minutes use the red stop button on the console to terminate them manually. Don't attempt to use or warm-up the machine again. There are regulatory procedures to be followed and contact the RPS.

**Contacts:**

RPS	Lauren Piper x 1936
Radiation Protection Advisor	Martin de la Mare (UKHSA)
	Tel: 01132 679041

Service Engineers	Xstrahl Medical
	Tel: 01543 688920