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Author: RDoull	Reviewed by: SFaruk	Issued on: 2019



Diamond Light Source

Local Rules for the Protection of Persons from Ionising Radiations

Accelerator

(Linac vault, Booster ring, Storage Ring and Zone 13 excluding RF test facility)

These Local Rules are important for your safety and well-being. All Diamond Light Source personnel, visitors, and contractors must follow these Local Rules whilst working in the Diamond accelerator Controlled and Supervised Radiation Areas.

Disciplinary action will be taken against anyone found tampering with the Personnel Safety System or deliberately failing to follow an effective search procedure.

These Local Rules will be reviewed biennially, or whenever any significant changes are made to the operation of the linac, booster and storage ring and associated RF equipment.

This issue of the Accelerator Local Rules supersedes all previous issues.

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Document Approval:

Health Physics holds the electronic master copy with digitally approval record on the SharePoint.

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1. Introduction

- 1.1 These local rules are a requirement of regulation 18(1) of the Ionising Radiations Regulations (IRR) and they set out the key arrangements for restricting radiation exposure in and around the Diamond Accelerators (Linac, Booster ring and the Storage ring and Zone 13 excluding RF test facility). They define the principles and working procedures to be adopted to ensure safe operation of the Diamond Light Source (DLS) accelerators. All Diamond Light Source staff/ contractors working in the Diamond Controlled or Supervised Radiation Areas must read these Local Rules as part of the Health Physics radiation safety training before entering those areas covered by these Rules. All persons supervising contractors or guiding visitors in the accelerator Controlled or Supervised Radiation Areas must ensure that they are familiar with and obey the access conditions described in section 7.
- 1.2 Separate Local Rules (list of other local rules in 10.3) are available for the DLS Controlled Radiation Areas not covered by this document, and links to these documents will be found on the Health Physics page of the Diamond Intranet. Written instructions are provided where appropriate for all Supervised Radiation Areas not covered by this document.
- 1.3 These rules cover the operation of the linear accelerator (Linac), Booster synchrotron, Storage ring and associated RF equipment and other Controlled/ Supervised areas in Zone 13 excluding RF test facility.
- 1.4 None of this work involves open sources. The risk of a radiation contamination accident during the operation of either the accelerators or the RF systems is negligible.
- 1.5 A glossary of Health Physics terms used in this document can be found on the Health Physics intranet page (FAQ section).

2. Radiation Safety Organisation and Responsibilities

- 2.1 The Chief Executive Officer (CEO) of DLS Ltd has overall responsibility for the health and safety of all staff, users, contractors and visitors at Diamond Light Source. The CEO may delegate authority for certain health and safety functions to other people, however, he may not delegate his responsibility. Safety responsibility then devolves down the management and supervisory chains. The name of the CEO is given in Appendix 1.
- 2.2 The Technical Director will authorise any change in operation of the accelerators, having received appropriate confirmation of the functioning of the Personnel Safety System(PSS), the integrity of the shielding, and that all associated procedures are in place. The name of the Technical Director is given in Appendix 1.
- 2.3 A Radiation Protection Adviser (RPA) has been appointed under Regulation 14 of the IRR. The RPA has been provided with appropriate terms of reference. DLS is obliged to consult

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the RPA on those matters which are specified in Regulation 14(1) and Schedule 4 of IRR. The RPA's name is listed in Appendix 1.

- 2.4 The Health Physics (HP) Team Leader has responsibility for overseeing all aspects of radiation safety. For those matters specified in Regulation 14(1) and Schedule 4 of IRR, the Health Physics Team Leader must consult with the RPA. The name of the Health Physics Team Leader is given in Appendix 1.
- 2.5 Radiation Protection Supervisors (RPSs) have been appointed by the Technical Director under Regulation 18(5) of the IRR. They are responsible for ensuring compliance with the Local Rules and have been given appropriate terms of reference. The names of the RPSs and their contact details are given in Appendix 1. Appendix 2 lists the RPSs and deputy RPSs for individual areas.
- 2.6 The Principal Personnel Safety Engineer (PPSE) is responsible for the design, commissioning, routine testing and modification of the accelerator's PSS, as described in Section 6 and [TDI-HP-GEN-REP-0013¹](#).
- 2.7 The Head of the Accelerator Operations Group has overall responsibility for the safe operation of the accelerators. His responsibilities include:
- Ensuring that the procedures defined in the appropriate Method Statements and in the Local Rules are followed.
 - Nominating an Operations Shift Leader who will be present and in charge of safety for each shift when the accelerators are operational.
 - Authorising suitably trained DLS personnel to search any or all of the zones in the three accelerator vaults.
- 2.8 The Head of the RF Group is specifically responsible for the safe operation of all Linac, Booster and Storage ring RF equipment, including amplifiers, cavities and management of the relevant Inductive Output Tubes (IOT) shielding and Supervised Radiation Area.

3. [Dose Investigation Level](#)

- 3.1 If the dose recorded by any DLS employee exceeds 0.8 milliSieverts (mSv) for the first time in any calendar year, the Health Physics Team Leader will initiate a formal investigation to make sure that exposure is being restricted as far as is reasonably practicable. The RPA must be consulted about this investigation.
- 3.2 If there is evidence to suggest that the dose received by any DLS employee may reach the investigation level before the end of the calendar year, the Health Physics Team

¹ [http://diamvdocs13.diamond.ac.uk/TECHNICAL_DIVISION_\(TEC\)/Health_Physics_HP/General_\(GEN\)/Reports_\(REP\)/TDI-HP-GEN-REP-0013.pdf](http://diamvdocs13.diamond.ac.uk/TECHNICAL_DIVISION_(TEC)/Health_Physics_HP/General_(GEN)/Reports_(REP)/TDI-HP-GEN-REP-0013.pdf)

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Leader will initiate a review of working conditions with the aim of restricting further exposure before the investigation level is reached.

4. Areas to which these rules apply

4.1 These Local Rules apply within all the Controlled and Supervised Radiation Areas in Zone 13 listed in Appendix 2. The designation of each area is shown at each entrance into the area.

5. Shielding

5.1 The accelerators and their RF cavities have been installed within interlocked shielded vaults. Much of the radiation shielding is concrete; however, some shielding will be of lead walls or, locally, blocks of lead. The Health Physics Team will verify that the shielding is adequate by performing frequent radiation surveys. Once the equipment is operating normally, surveys will be performed on a 6 monthly basis. This period will be subject to review.

5.2 All removable radiation shielding is subject to configuration control (Fig 1) using a radiation Permit to Work (PtW) based on the DLS PtW procedure [HAS-PRC-0021](#)². All such shielding and components (nuts, bolts etc.) or its covers will be painted yellow or provided with suitable signs and must be marked to indicate that it is subject to configuration control, and that a radiation PtW issued by the RPS is required to disassemble the shielding or change or remove the components. The PtW procedure will ensure safety while shielding is temporarily removed by locking away the relevant accelerator operational keys, or in the case of the RF amplifiers, by disabling amplifier operation. Work on some items, such as shutters, may require both PSS and Radiation PtW. The RPS for the area will keep a register of all shielding and components which are subject to configuration control within their designated area.



Fig 1 Sample of warning sign for PtW.

5.3 **Any changes to radiation shielding or radiation safety critical components**, whether intended to be permanent or temporary or any kind of safety/ contingency exercise (SHE, Radiation, PSS etc.), must be carried out under a radiation Permit to Work issued by the RPS.

² <http://diamvdocs13.diamond.ac.uk/HEALTH%20AND%20SAFETY/Procedures/HAS-PRC-0021.docx>

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- 5.4 ***For temporary changes to radiation shielding which has been designed and constructed to fit only in the correct manner***, the RPS will visually confirm that the shielding has been returned to its original configuration before cancelling the permit. All other shielding must be surveyed by the Health Physics Team before the permit can be cancelled.
- 5.5 ***Permanent changes to radiation shielding and radiation safety critical components, or installation of new shielding, must be approved in advance by the RPA***. The changes must be implemented under a radiation PtW issued by the RPS. The shielding or changed components must be surveyed by Health Physics Team before the permit can be cancelled.
- 5.6 Where a survey is mandatory before a radiation PtW can be cancelled, it is permitted to operate the accelerator(s) specifically for the survey whilst the RPS and a member of The Health Physics Team are present.

6. Personnel Safety System (PSS)

- 6.1 It is probable that any person left in a vault whilst the beam is energised would suffer serious detriment to their health. A PSS system is provided to ensure that people could use the safety features (annunciators, warning sound, lights, emergency beam off button etc.) to stay safe and cannot enter or could use them to prevent if stuck within:
- The Linac, Booster, and Storage ring accelerator vaults during electron beaming.
 - The Linac vault whilst the cavity is powered with RF.
 - The Booster vault whilst the cavity is powered with RF.
 - Zones 7 & 8 of the Storage ring whilst the RF cavities are being tested without an electron beam. The remaining zones of the storage ring may be open for general access during RF testing.

The procedures for design and modification of a PSS are described in [TDI-HP-GEN-REP-0013³](#). This document should be considered as part of the Local Rules.

- 6.2 ***Disciplinary action*** will be taken against any person:
- 6.2.1 Tampering (i.e. altering or interfering in an unauthorised or improper manner) with any part of the PSS.
- 6.2.2 Deliberately not performing a search of any accelerator vault in the correct manner.
- 6.2.3 Deliberately locking a person inside an interlocked accelerator vault is forbidden except for the purpose of health physics radiation safety contingency exercise or

³ [http://diamvdocs13.diamond.ac.uk/TECHNICAL_DIVISION_\(TEC\)/Health_Physics_HP/General_\(GEN\)/Reports_\(REP\)/TDI-HP-GEN-REP-0013.pdf](http://diamvdocs13.diamond.ac.uk/TECHNICAL_DIVISION_(TEC)/Health_Physics_HP/General_(GEN)/Reports_(REP)/TDI-HP-GEN-REP-0013.pdf)

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checking the crash out mechanisms and PSS (including emergency beam off buttons). These checks must be done under a radiation or PSS or both (radiation and PSS) Permit to Work defined by the Principal Personnel Safety Engineer (PPSE) (and radiation PtW for contingency plan rehearsal) who will specify adequate hardware precautions to ensure that the beam cannot be activated in that area during the work or exercise.

- 6.3 The local RPSs are responsible for ensuring that an effective search pattern is maintained for each PSS zone across all three accelerator vaults. Searchers must report to the RPS for the area any specific problems immediately for rectification.
- 6.4 Anybody noticing any fault or problem with the PSS for any vault must not enter the vault, and report to the Operations Shift Leader and PPSE as soon as possible.
- 6.5 The Operations Shift Leader must not operate any accelerator if he is aware of any fault or problem with the vault's PSS, which would compromise the effectiveness of the search in excluding people from the area and report to the PPSE as soon as possible.

7. [Access / Working Instructions](#)

- 7.1 All staff, Users and contractors entering the Controlled & Supervised Radiation Areas covered by these Local Rules are required to attend a Health Physics training session **or online refresher training every 2 years** dealing with the radiation hazards present around the accelerators and the contents of these Local Rules.
- 7.2 All staff, Users and contractors are required to obey all safety signs displayed at the doors of and inside the vaults.
- 7.3 General access to any vault or zone is only permitted when the annunciator outside the door reads "**OPEN.**" (Fig 2) Personnel not performing a search must not attempt to enter a vault or zone when it is in the process of being searched, shown as "**RESTRICTED**" on the annunciator. Only trained personnel who have been authorised by the Head of the Accelerator Operations Group may initiate an entry to the vault once it has been searched, a condition shown as "**STANDBY**" or "**BEAM ON**" on the annunciator. The equipment is deemed to be energised and generating radiation whenever the annunciator indicates "**BEAM ON**", whether or not the equipment is actually energised. Entries from "**STANDBY**" or "**BEAM ON**" conditions will 'break the search', returning the annunciator to "**OPEN**", and another search will be required before operation can resume.



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Fig 2 PSS annunciator displaying different stages in the vault.

7.4 A member of the Health Physics Team must survey a vault or zone before anyone enters that area for the first time after the relevant accelerator has been operational.

7.5 Where the entry is for escorted access to specific equipment only, the Operations Shift Leader or RPS can make the entry with a portable X-ray radiation monitor. It is located in the control room. Once the zone has been opened for entry to specific equipment, the **'ACTIVATION MONITORING'** sign (Fig 3) must be placed on the door to the vault to show that it is not open for general access. If the vault is to be left open with general access, a member of the Health Physics Team must do a full survey, the **'ACTIVATION MONITORING'** sign can then be removed.



Fig 3 Activation monitoring sign

7.6 The Linac klystron area and the Booster RF area are designated as **Supervised Radiation Areas** and are permanently fenced off. Only staff authorised by the Head of the Accelerator Operations Group or appropriate RPS are allowed to enter these areas during commissioning and operation.

7.7 Part of the Storage Ring RF Hall around the IOTs has been designated as a **Supervised Radiation Area**. Only staff authorised by the RF RPS are allowed to enter it during operation of any part of the storage ring RF equipment.

7.8 Once it has been demonstrated that an accelerator can operate safely at a given set of operating parameters then it should be possible for the equipment to be operated within those established parameters without Health Physics personnel being present. The Health Physics Team Leader will specify the maximum parameters up to which the accelerator may operate. If the accelerator is to be operated outside of these conditions, for example, at higher current or pulse rate, then Health Physics personnel must be present unless the work can be carried out in silent hours with the Synchrotron Building (excluding the main control room) cleared of all personnel. No visits to the building will be allowed even for short times.

7.9 The IRR only allows two methods for access to a Controlled Radiation Area. Personnel must either be classified radiation workers, or must enter the area under Written Arrangements (Appendix 3).

7.10 Classified Workers

7.10.1 All classified radiation workers employed by DLS are issued with personal dosimeters. These dosimeters should be worn for the period indicated on the dosimeter. Classified workers in the employment of another radiation employer

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who are visiting DLS (other than as outside workers) will have appropriate dosimetry issued by their employer. Classified workers must wear their dosimeters at any time that they enter any DLS Controlled or Supervised Radiation Areas. All classified workers employed by DLS will receive training in radiation safety before commencing work with radiation.

7.10.2 Classified workers have a duty of care to their dosimeter – information on use and care of dosimeters is provided to all workers when they become classified workers – see the DLS Health Physics leaflet “[Wear Your Dosimeter⁴](#)” available via the Health Physics pages of the Diamond Intranet.

7.11 Non-classified (Staff and Outside workers)

7.11.1 All non-classified Staff and Outside workers must enter the Controlled Radiation Areas under the Written Arrangements (Appendix 3). Some workers at Diamond have been chosen to be part of a ‘control group’. They are issued with personal dosimeters on a quarterly basis. The purpose of this practice is to ensure that Diamond’s working areas have been correctly designated for radiation protection purposes. All workers in the ‘control group’ must wear their dosimeters at any time that they enter any DLS Controlled or Supervised Radiation Areas. The Written Arrangements still apply to these persons.

7.12 Classified Outside Workers

7.12.1 Outside Workers are contractors providing services to DLS, in DLS Controlled Radiation Areas, who have been designated as classified radiation workers by an employer other than DLS and who have a **Radiation Passbook** in their possession.

7.12.2 DLS employees who supervise potential outside workers must inform the Health Physics Team before the Outside Worker arrives at Diamond.

7.12.3 The Outside Worker must report initially to the Health Physics Team and present their Radiation Passbook. The Health Physics Team will retain the passbook whilst the Outside Worker is at DLS. The Outside Worker will be provided with dosimetry for the purpose of dose assessment.

7.12.4 The DLS RPS and the contractor’s supervisor must ensure that the Outside Worker is wearing all appropriate dosimetry before permitting access to the Controlled Radiation Area. Written Arrangements are not needed and the Outside Worker is considered to have the same status in terms of access as a DLS Classified Worker to

⁴ <http://intranet.diamond.ac.uk/dms/DiamondDocs/HealthPhysics/Wear-your-dosimetry/Wear%20your%20dosimetry.pdf>

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those Controlled Radiation Areas agreed upon in writing between DLS and the Outside Worker's Employer.

7.12.5 At the end of the work, the Outside Worker must report to the Health Physics Team to allow a dose estimate to be entered into his or her Radiation Passbook. The Health Physics Team will forward the assessed dose to the Outside Worker's employer as soon as possible. If it is known that Outside Workers will arrive or depart outside of normal working hours, the Health Physics Team will make special arrangements for the issue of dosimeters and entry of the dose estimate into the Outside Worker's Radiation Passbook. These arrangements will be agreed with the Outside Worker's employer.

8. Use of Radioactive Sources and Samples

- 8.1 Detailed procedures covering the use of sources at DLS are given in the document "Use of Radioactive Sources at Diamond", [TDI-HP-PRC-0002⁵](#). This document should be considered part of the Local Rules.
- 8.2 All radioactive sources and materials required by DLS staff must be purchased by the Health Physics Team. This may require application for an amendment to the Environmental Permit, which can take several months to be granted.
- 8.3 All persons intending to use DLS owned radioactive sources on the Diamond premises must provide copies of the method statements and risk assessments to the Health Physics Team Leader or Health Physicist at least 5 working days before the work is intended to start.
- 8.4 No person may bring radioactive material to DLS without prior agreement from the Health Physics Team Leader or Health physicist. Radioactive material includes radioactive sources, experimental samples and Naturally Occurring Radioactive Materials (NORM). Copies of the risk assessments and method statements must be submitted to the Health Physics Team Leader or Health Physicist at least 1 month before the sources are required on site. The Health Physics Team Leader or Health Physicist may refuse permission for certain radioactive materials to be brought onto site. Outside workers wishing to work with any radioactive material on site, whether owned by their employer or by DLS, must provide a certificate from their employer indicating their competence to work with radioactive materials. Detailed procedures covering the use of user owned sources at DLS are given in the document "Procedures for the use of radioactive samples on the Diamond Beamlines", [TDI-HP-PRC-0006⁶](#).
- 8.5 No radioactive material or source, including activated accelerator components, may leave the DLS site without prior approval of the Health Physics Team Leader or Health Physicist.

⁵ [http://diamvdocs13.diamond.ac.uk/TECHNICAL DIVISION \(TEC\)/Health Physics HP/Procedures \(PRC\)/TDI-HP-PRC-0002.pdf](http://diamvdocs13.diamond.ac.uk/TECHNICAL DIVISION (TEC)/Health Physics HP/Procedures (PRC)/TDI-HP-PRC-0002.pdf)

⁶ [http://diamvdocs13.diamond.ac.uk/TECHNICAL DIVISION \(TEC\)/Health Physics HP/Procedures \(PRC\)/TDI-HP-PRC-0006.pdf](http://diamvdocs13.diamond.ac.uk/TECHNICAL DIVISION (TEC)/Health Physics HP/Procedures (PRC)/TDI-HP-PRC-0006.pdf)

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8.6 If the person responsible for a source knows or suspects it is missing or damaged, they should immediately inform the RPS, Experimental Hall Manager and the Health Physics Team.

9. Incidents, Accidents and Contingency Plans

9.1 The possibility of accidents and incidents involving ionising radiation or failure of the search system is small but cannot be eliminated totally.

9.2 Any person finding themselves locked in a searched area should walk towards the nearest door pressing the nearest emergency beam off button en route or pressing the emergency door release. They must then report to the Operations Shift Leader in the Control Room. The Operations Shift Leader will inform the Technical Director who will decide what form of investigation, if any, will be conducted.

9.3 A contingency plan (Appendix 4) has been written to cover reasonably foreseeable accidents involving persons being exposed to radiation. Health Physics will perform contingency plan rehearsal in suitable interval to comply with IRR [Reg-13(2)c] with coordinate support & response from PSS, SHE, EHC and OPS.

9.4 Any person hearing the fire alarm sounding must follow DLS FIRE AND EMERGENCY ARRANGEMENTS ([HAS-PRC-0011⁷](#)).

10. General

10.1 Induced activity

10.1.1 During electron beam operation, some components in the accelerator vaults will become slightly radioactive. A member of the Health Physics Team will monitor inside the vaults before general access is granted. A sign (Fig 3) will be displayed on the vault gate to restrict anyone's entry until the monitoring is complete by HP team. The dose rates and date will be displayed on a **white board** at the entrances to the vaults. If the dose rates for the current day or first day of a shutdown are not displayed, any person entering the vaults must contact the Main Control Room before commencing work. If white board displays contact dose rates in excess of 100 microSieverts per hour ($\mu\text{Sv/h}$), or 10 $\mu\text{Sv/h}$ at a distance of 30cm, then personnel must ring the Main Control Room to seek Health Physics support to make sure the work could be done safely. More restrictions in 10.1.2. It is not expected that operation of the cavities will cause components within the RF zones of the Linac, Booster, or Storage ring vaults to become radioactive.

⁷ <http://diamvdocs13.diamond.ac.uk/HEALTH%20AND%20SAFETY/Procedures/HAS-PRC-0011.docx>

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10.1.2 With the exception of items downstream of the first front end absorber on a Beamline, any component to be removed from the accelerator vaults which is:

- Part of the electron accelerating/storage vacuum vessel structure.
- Part of the machine in which electrons or radiation may be accidentally or deliberately absorbed.
- Metallic fixed equipment within 50 cm of the electron accelerating/storage vessel

Must be monitored by the Health Physics Team for induced radioactivity. Examples include, but are not limited to: vacuum vessels, magnets, absorbers, beam position monitors. If it is found to be radioactive, the item must remain within the vaults or other suitable secure area until the activity has decayed to background levels. Machining or any process which produces swarf or dust must not be carried out on any radioactive accelerator components without the written permission of the Health Physics Team and appropriate RPS. See Appendix 5 for further details on the monitoring and storage of radioactive materials.

10.2 Radiography.

All DLS staff who intend to bring radiography contractors onto the Diamond site must inform the Health Physics Team Leader or Health Physicist (who will inform the Experimental Hall Manager and the RPS) at least 5 working days before the work is intended to start.

10.3 Other Local rules –

- 10.3.1 Beamlines & Experimental Hall (TDI-HP-LR-0002)
- 10.3.2 RF Test Facility (TDI-HP-LR-0003)
- 10.3.3 Radio-chemical Laboratory (TDI-HP-LR-0006)
- 10.3.4 Detector Laboratory (Lab 29/ DR G43) (TDI-HP-LR-0004)

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Appendix 1 – Names of nominated people

Position	Name	Tel Ext.
Chief Executive Officer	Andrew Harrison	8811
Technical Director	Richard Walker	8484
Head of Accelerator Operations Group	Chris Bailey	8043
RPA & HP Team Leader Health Physicist	Richard Doull Sanjeev Faruk	8269 8875 8605 (HP Team)
Principal Personnel Safety Engineer	Martin Wilson	8049
**RPSs:		
Head of Accelerator Operations Group	Chris Bailey	8043
Operations Shift Team	Adrian Johnson	8615
Operations Shift Team	John Fox	8669
Operations Shift Team	Alan Gracey	8702
Operations Shift Team	Wayne Perkins	8521
Operations Shift Team	Vincent Winter	8638
Head of RF Group	Chris Christou	
Senior RF physicist	Pengda Gu	8862
Operations Shift Leader	Control Room	8899 (01235 778899 from a mobile phone)

****Note – At least one RPS required to be present/ available in the working hours on weekdays to fulfil the requirement of IRR, Reg – 18(5), ACOP para-350.****

Appendix 2 – Designation of areas and RPS responsible

Designation	Area	RPS	Deputy RPS
Controlled Radiation Area	Linac vault	C. Christou	Operations Shift Leader
	Booster vault	C. Christou	Operations Shift Leader
	Storage ring vault	C.P. Bailey	Operations Shift Leader
Supervised Radiation Area	Linac klystron area	C. Christou	Operations Shift Leader
	Booster RF amplifier area	C. Christou	Operations Shift Leader
	Storage ring RF amplifier area	C. Christou	Pengda Gu
	Storage ring roof	C.P. Bailey	Operations Shift Leader
	Ground floor inner circulation corridor and CIAs	C.P. Bailey	Operations Shift Leader
Not designated	All other areas in Zone 13		

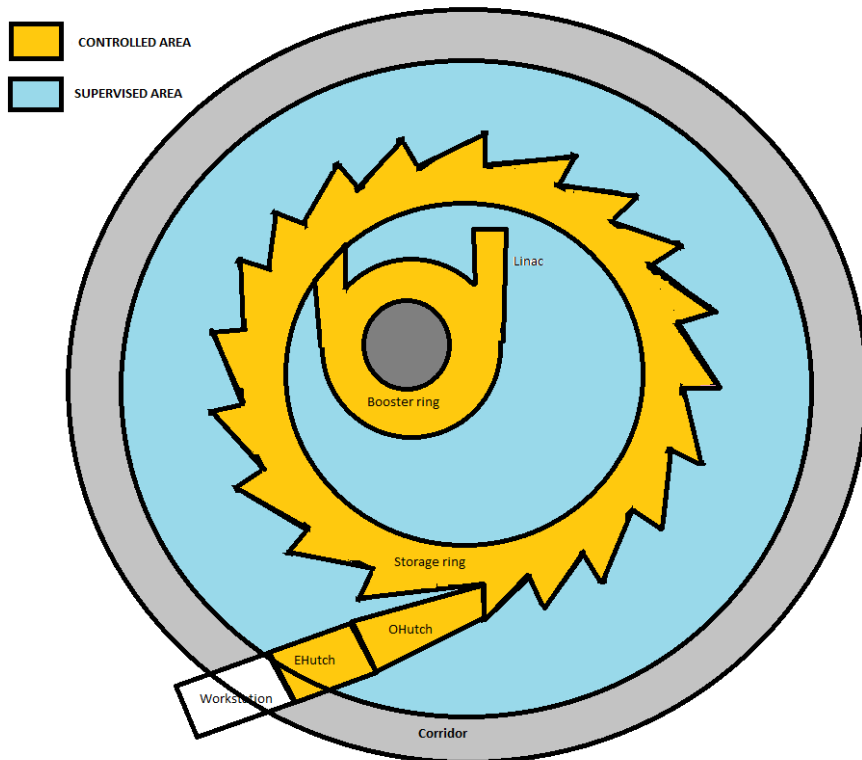


Fig 4: Layout of controlled and supervised area in synchrotron ring.

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Appendix 3 – Written Arrangements for access to the DLS Controlled Radiation Areas by Non-classified Persons

1. Area

Written Arrangements apply to work within the accelerator vaults and any other temporary Controlled Radiation Areas.

2. Application

Written Arrangements apply to ALL people entering the above areas who are not designated as Classified Workers under Regulation 19(3)c of the IRR.

3. Summary of Hazards

3.1 Accelerator vaults - Accelerators operational (Controlled Area):

Electron losses during operation give rise to high energy photon and neutron radiation within the vaults. These areas will be searched and locked by trained DLS staff. The vaults are shielded with concrete and lead. Sensitive radiation monitors which continuously monitor and record dose rate are installed on the outer wall of the vaults (Fig 5). In addition, there is extensive passive radiation monitoring around the Diamond site.



Fig 5 Installed Radiation monitor

3.2 Accelerator vaults - Accelerators not operational (Controlled Area):

Loss of high energy electrons within the accelerator vaults will lead to some parts of the structure becoming slightly radioactive. The contact dose rates are expected to be low, and most of the activity generated should be short lived. However, occasionally the dose rate could be significant. Access restrictions will be imposed if the dose rates exceed levels defined in section 4.1.2.

3.3 Linac vault, All booster zones and the Storage Ring zone 7 and 8 - Cavities operational:

The cavities are capable of generating adventitious radiation with energies up to 3 MeV within the vaults (i.e. they can generate radiation even without stored beam). The level of radiation generated by the cavities will depend upon their level of conditioning and internal cleanliness, and should reduce over time as the conditioning improves. These areas will be searched and locked by trained DLS staff. The vaults are shielded with concrete and lead. Sensitive radiation monitors which continuously monitor and record

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dose rate are installed on the outer walls of the vaults. In addition, there is extensive passive radiation monitoring around the Diamond site.

3.4 Linac vault, All booster zones and Storage Ring zone 7 & 8 - Cavities not operational:

As 3.2; there should be no activation radiation hazard from the cavities themselves when they are not operational.

3.5 Linac vault (Controlled Area),

Radiation hazards in the Linac vault also include the 90keV gun and acceleration of dark current from the powered accelerating structures even in the absence of beam. The power is disconnected by the PSS when the vault is opened.

4. [Access conditions](#)

4.1 General

4.1.1 The annunciator at each door of the vaults will read “**OPEN**” when the electron beam is off and/or when the Booster and Storage ring RF cavities are not powered. It is possible that an induced activity hazard will remain. The RPS will ensure that all persons entering the Controlled Radiation Areas covered by these Written Arrangements have undergone suitable training in radiation safety.

4.1.2 Accelerator vaults

Staff from The Health Physics Team will enter the vaults and monitor for induced radioactivity. A white board will display the dose rates at the entrance. Any areas where the contact dose rate exceeds 100 mSv/h, or the dose rate at 30 cm from the vacuum vessel exceeds 10 mSv/h will be marked by barriers, and appropriate dose restriction procedures implemented. If it is required that staff work within the barriers, the RPS will review and approve the risk assessments and method statements prepared by the supervisor of the work. Only personnel authorised by the RPS are allowed to work within the barriers.

If induced radioactivity is detected during monitoring, the gates at either end of the zone will remain closed and a sign will be in place instructing staff who wish to enter the adjacent zone that they should enter via the labyrinth. Staff who need to enter that zone should check the white board in the cage for any restrictions and enter through the labyrinth. Staff must not crash through gates, as monitoring may still be underway or they may be unaware of areas of high dose rate due to induced radioactivity. If no activation is detected Health Physics will open the gates to allow free access between zones.

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Induced activity will not be produced from operation of the cavities alone. People are free to enter the Booster zones and zones 7 and 8 of the Storage ring vault as soon as the door is opened after RF cavity operation without electron beaming. The PSS does not allow limited access for either of the RF zones for the period of the cavity operation.

4.2 DLS Employees

4.2.1 All DLS staff, Users or contractors who “work” or accompany visitors in the accelerator vaults are expected to attend a training course in Accelerator radiation safety. This will explain the requirement of:

- The Local Rules
- Permits to Work
- Shielding
- The meaning of any signs in use
- Emergency Procedures
- Access

4.3 Visitors

4.3.1 Visitors are defined in document ‘[HAS-PRC-0032 Access Management for Diamond Controlled Premises](#)’

4.3.2 All visitors must be accompanied at all times by a member of DLS staff who has; attended the Health Physics radiation safety training session, is fully aware of the work in progress in the area and the contingency plan detailed in Appendix 4 of this document.

4.3.3 In Supervised Radiation Areas the maximum number of visitors is 10 per Suitably Qualified and Experienced DLS staff. Maximum number of visitors in a tour group is 12 depending on the profile of the group, tour groups of more than 10 visitors must be accompanied by at least 2 Suitably Qualified and Experienced Persons. Authorisation must be obtained from the appropriate person in charge of that area. The host (DLS staff) is responsible for ensuring the evacuation of the visitors in the event of a fire.

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4.3.4 In Controlled Radiation Areas the maximum number of visitors is 6 per Suitably Qualified and Experienced DLS staff. Maximum number of visitors in a tour group is 12, tour groups of more than 6 visitors must be accompanied by at least 2 Suitably Qualified and Experienced Persons. Authorisation must be obtained from the appropriate person in charge of that area. The host (DLS staff) is responsible for ensuring the evacuation of the visitors in the event of a fire.

4.3.5 Visitors must obey all safety signs displayed at the door and inside the accelerator vaults and all instructions given by the guide.

4.4 Contractors

4.4.1 All contractors who “work” in the accelerator vaults are expected to attend Accelerator radiation safety training or receive instruction (Toolbox talk if working less than 5 days) in radiation safety. This will explain the requirement of:

- The Local Rules
- Permits to Work
- Shielding
- The meaning of any signs in use
- Emergency Procedures
- Access

4.5 Special Cases

4.5.1 Female employees and visitors: The external radiation hazards around the vaults are expected to be low (less than 0.03 $\mu\text{Sv/h}$), so it is not considered necessary to introduce further work restrictions for female workers and visitors who may be pregnant. This must however, be confirmed by risk assessment. Any female employee who declares herself to be pregnant will be offered a personal dosimeter on a monthly basis for the term of the pregnancy. There are no significant contamination hazards around the vaults, so it is not considered necessary to introduce additional restrictions for female workers or visitors who may be breastfeeding (although there could be other reasons). They are advised to–

- Wear Dosimeter (ask HP for the Dosimeter)
- Do not enter a vault first to do the radiation checks with radiation monitor. (ask another trained member of staff to do it)
- No work, manipulation or handling radioactive source or induced materials.

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4.5.2 Young Persons on work experience: Young people aged between the ages of 16 and 18 are allowed to work as trainees in radiation areas subject to a risk assessment being performed by the person responsible for the visit and an annual dose limit of 0.3 mSv.

5. Dose estimation

5.1 Dose estimation will be derived from:

- Diamond Synchrotron Light Source. Report of the Design Specification - chapter E6.
- [TDI-HP-GEN-PRO-0003⁸](http://diamdocs13.diamond.ac.uk/TECHNICAL_DIVISION_(TEC)/Health_Physics_HP/General_(GEN)/Proposals_(PRO)/TDI-HP-GEN-PRO-0003.pdf) Implementation of the Radiation Safety Legislation at Diamond
- Installed radiation monitoring
- Personal monitoring of classified workers and DLS control group
- Radiation Surveys
- Induced activity surveys.

5.2 The shielding around Diamond has been designed to ensure that no person working outside of the shielding at DLS should receive a dose in excess of 1 mSv in a 2000 hour working year.

6. Records

6.1 The Approved Dosimetry Service contracted by DLS keeps all dosimeter records.

7. Contingencies

7.1 All persons working in the accelerator vaults must be aware of the contingency plan for dealing with emergencies, detailed in Appendix 4 of this document.

⁸[http://diamdocs13.diamond.ac.uk/TECHNICAL_DIVISION_\(TEC\)/Health_Physics_HP/General_\(GEN\)/Proposals_\(PRO\)/TDI-HP-GEN-PRO-0003.pdf](http://diamdocs13.diamond.ac.uk/TECHNICAL_DIVISION_(TEC)/Health_Physics_HP/General_(GEN)/Proposals_(PRO)/TDI-HP-GEN-PRO-0003.pdf)

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Appendix 4 – Contingency Plan for Persons Exposed to Radiation within a Vault

The Operations Shift Leader on duty is responsible for activating and applying the emergency plan. This plan addresses the situation where someone has received, or it is thought possible to have received, an over-exposure to radiation by being within the vaults whilst the accelerators are beaming or in the RF zones whilst the cavities are powered. Any person who knows or suspects that they or another person has been over-exposed to radiation should contact the Operations Shift Leader (8899) in the Control Room immediately. A contingency flow chart (TDI-HP-LR-0008) is available in all vault entrances for a quick guide of the following actions.

1. Make the accelerator or RF cavities safe by pushing a **“Emergency Beam Off”** button (Fig 6) within the vault, or by switching off power via the control system. Switching off the machine power should remove the prompt radiation hazard. This should be confirmed with a switched on hand held radiation monitor stored in control room.
2. **Call** operation shift leader (8899) in the control room and explain the incident and ask for, if required, summon assistance, a Diamond First Aider or the Ambulance service.
3. **Disable** the beam by **removing** the machine control keys. Do not issue them again until authorised in writing by the Technical Director in conjunction with the RPA.
4. **Take whatever immediate action is needed to sustain life.** There should be no prompt radiation hazard within the vaults and the radiation levels due to activation will not be high enough to pose an immediate threat to the life of the rescuers, so it is not essential to remove the casualty from the vaults to avoid subsequent radiation exposure, although they should be moved elsewhere if possible.
5. **Do not leave** the casualty unattended unless it is absolutely necessary to do so.
6. **Collect** dosimeter, if wearing, and record as much information as possible about the incident from the person concerned, and anyone else present. Stay with the casualty and try to comfort until emergency responder arrives.



Fig 6 Emergency Beam off button

Following sections is for information only. Emergency controller and other responsible group dealing with the incident will take following actions accordingly –

7. If the emergency services have been called, ensure that the responders are met and escorted to the casualty.
8. A member of staff may accompany the casualty to hospital, during office hours this could be preferably be the RPS. JR is the nearest A&E and has radiation emergency procedure in place. Out of office hours the EHCs (who are all trained as RPSs) should ring JR via switch board (01865 741841) to alert emergency physicist/ RPA regarding the incident and seek their assistance.
9. Inform the Technical Director, Head of the Accelerator Operations, Human Resources (HR) and the Health Physics Team Leader, as soon as possible. HP team leader or RPA may communicate with Oxford University Hospitals (OUH) RPA or emergency physicist via switch board (01865 741841) if required.

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10. Collect any dosimeters worn by the affected persons.
11. If the injuries are serious, arrange for Human Resources Group to inform both the casualty's employer (if not a staff member) and the casualty's next of kin.

This contingency plan is intended to cover only the emergency phase of the incident. The plan will end when the Operations Shift Leader has formally declared the situation safe and is satisfied that in the short term a repetition of the incident is not possible. The Technical Director will then decide if an inquiry should be established to investigate the incident.

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[Appendix 5 – Recording and Storage of Irradiated Components.](#)

DLS has a statutory duty to account for all radioactive materials on site including those formed by induced activity. However, accelerator components will not be considered for the accounting procedures until disconnected from the accelerator.

Irradiated components will fall into one of three categories, and must be dealt with as follows:

1. **Out of scope.** Activity concentration less than stated in table 2.3 of SCOPE OF AND EXEMPTIONS FROM THE RADIOACTIVE SUBSTANCES LEGISLATION IN ENGLAND, WALES AND NORTHERN IRELAND⁹. No special procedures to be followed.
2. **Exempt.** Activity concentration greater than stated in table 2.3 of SCOPE OF AND EXEMPTIONS FROM THE RADIOACTIVE SUBSTANCES LEGISLATION IN ENGLAND, WALES AND NORTHERN IRELAND.
3. **Permitted.** Activity concentration greater than stated in table 3.1H of SCOPE OF AND EXEMPTIONS FROM THE RADIOACTIVE SUBSTANCES LEGISLATION IN ENGLAND, WALES AND NORTHERN IRELAND.

Components with contact dose rates between 0.1 and 20 µGy per hour above background must be stored or worked on in a Supervised or Controlled Radiation Area.

Components with contact dose rates above 20 µGy per hour above background must be stored or worked on in a Controlled Radiation Area.

The Health Physics Team Leader will decide suitable storage and shielding for components with measured contact dose rates greater than 100 µGy per hour above background.

The Health Physics Team Leader must be contacted before any component marked Active is disassembled, modified or machined in any way.

The Health Physics Team will keep records of all radioactive materials on site. All radioactive materials will be marked appropriately, and periodically monitored. Health Physics will arrange for ultimate disposal of any radioactive material. It should be noted that DLS is not currently authorised to accumulate or dispose of radioactive waste outside of the scope of the Exemptions Regime of the Environmental Permitting Regulations, but it will seek authority to do so when this becomes necessary.

⁹[SCOPE OF AND EXEMPTIONS FROM THE RADIOACTIVE SUBSTANCES LEGISLATION IN ENGLAND, WALES AND NORTHERN IRELAND](#)