



Radiation Safety Procedures for the Use of Sources of Ionising Radiation.

Dublin City University

Prepared by Mr. Michael Burke, Radiological Protection Officer, updated 10th Dec'2019

The President of Dublin City University, Prof. Brian MacCraith, is ultimately responsible for Radiation Safety.

SCOPE AND APPLICABILITY

These procedures apply to all Schools and Research Centres using sources of ionising radiation/ accelerators regulated under SI 30 of 2019.

The Environmental Protection Agency, in accordance with the terms of the Radiological Protection Act, 1991 (Ionising Radiation) Regulations 2019, hereby authorises the Undertaking to carry out the practice(s) listed in **Section 1**, using the Radiation Sources/Accelerators listed in Schedule 2 of the Authorisation for the purposes therein at the authorised premises listed in Schedule 4. These conditions may be amended at the discretion of the Environmental Protection Agency. Work cannot commence with a radiation source or a new source acquired until an "Application to Work with a Radiation Source" form is completed and submitted by following the link:

https://www.dcu.ie/science_and_health/FSH-Safety.shtml.

Contents

Section	Detail	Page
(i)	Radiation Safety Procedures - Revision History	3-4
1	Inventory of licensed radiation sources	5-8
2	Normal Operating Procedures	9-20
3	Radiation Emergency Procedures	21-27
4	Planned Maintenance	28
5	Radiological Protection Administration	29-32
6	Transporting Radiation Sources/ Materials	32-33
7	Radon Survey	34
Appendix 1	Records: Shared Google Drive Folder	35-36
Appendix 2	Purchasing a licensable radiation source	37-41
Appendix 3	Registration Form for work with Unsealed Radioisotopes	42-43
Appendix 4	Radioisotope Record Form	44
Appendix 5	Spills of Unsealed Sources	45
Appendix 6	Protocol for Radiation Source Wipe Test	46
Appendix 7	Survey of Leybold Didactic NG-24 <i>example</i>	47
Appendix 8	List of Transporters approved for Radioactive Sources	48-49
Appendix 9	Safety Protocol for Niton XL 900 XRF	50-55
Appendix 10	Risk Assessments	56-65
Appendix 11	Check list for sealed and irradiating Sources	66

(i) Revision History

Date: 11th February 2020

Page 34; Results from Radon Survey carried out Oct to Jan, included.

Page 19; Section 2.16 Included section on Radiation Protection Education, Training & Information

Page 20; Section 2.17 Included section on Protection of Exposed Workers, Apprentices and Students.

Date: 3rd Jan 2020:

Page 7; section 1.4. Approval for Bruker AXS

Page 29; update section 5.3, "responsible person for managing radiation source"

Date: 5th Nov 2019:

Page 64; Risk Assessment for Bruker AXS X-Ray included to support application to have instrument brought back into use.

Page 38; Updated SOP "Purchasing a licensable radioactive source", section 6.2 to include the use of a new google form application procedure.

Date: 20th Sept 2019:

Page 7; Malvern Epsilon XRF removed from inventory. No longer on license

Page 30; remove above from list of responsible staff

Page 61; remove corresponding RA from list

Date: 20th June 2019:

Page 65; Appendix 11 "Check list for Radiation sources"

Date: 8th May 2019

Application for addition of the Niton XRF back into operation as a licensable practice.

Previously, "custody only" on license.

Page 7; include Niton XRF on list of irradiating sources

Page 8; update campus map showing location of NRF building (new location for instrument)

Page 30; update list of responsible person for managing radiation source

Page 49; Appendix 9, additional Safety Protocols included

Page 64; Risk Assessment included

Date: 5th March 2019:

Application for addition of a new sealed source "Rutherford Scattering Apparatus".

Page 5; include Rutherford Scattering Apparatus in list of "Sealed Sources". Waiting approval.

Page 14; include in "Table of Sealed Sources in DCU (Licence L0169-02), (Activity kBq, External dose, ALI Ingestion/ Inhalation figures)".

Page 27; update Section 4, maintenance on sealed sources.

Page 29; Section 5.3, updated list of responsible person for managing radiation source.

Page 57; Appendix 9, risk assessment included

Date: 19th December 2018

Page 5; include Malvern Epsilon 4 XRF in list of irradiating equipment. Waiting approval for "custody and commissioning". RA on P.54.

Page 28; include responsible person's name for XRF listed above.

Date: 3rd December 2018

Page 5; Iodine-125, following measurements, the date for decay to background changed to April 2019. Reference to I-125 also changed on pages 16, 20 and 23, to reflect decay to background revised date.

Page 5; request Bruker Advance D8 for "custody only". Instrument is broken and it will take time to secure funding to return to full working condition. Reference also on P.28

Section 1

Inventory of licensed radioactive sources

1.1 Sealed Sources, Unsealed Sources and Irradiating Equipment are located in a number of buildings on the Glasnevin campus of DCU (see campus plan on P.4). The location and inventory are notified annually to the Chief Fire Officer, Dublin City Council.

1.2 Sealed Sources: NG-13, Marconi Building

No.	Serial Number	Radionuclide	Activity kBq	1/2 life	Principal Emissions
1	4468 BN	Ni 63	370,000	96 yrs	Beta
2	PH/P66300/7	Ra 226	185	1600 yrs	Alpha / Gamma
3	NG13 1/8	Ba-133	37	10.51 yrs	Gamma / Beta
4	NG13 2/8	Cd-109	37	453 days	Gamma
5	NG13 3/8	Cs-137	37	30.2 yrs	Gamma / Beta
6	NG13 4/8	Cs-137/ Zn-65	37	244.3 days	Gamma / Beta
7	NG13 5/8	Co-57	37	270 days	Gamma
8	NG13 6/8	Co-60	37	5.62 yrs	Gamma / Beta
9	NG13 7/8	Mn-54	37	312 days	Gamma
10	NG13 8/8	Na-22	37	2.62 yrs	Gamma / Beta
11	MC226	Cs-137/ Ba-137m	370	30.2 yrs	Gamma/ Beta
12	LC895	Sr-90	74	28.6 yrs	Beta
13	LX809	Na-22	74	2.6 yrs	Gamma / Beta
14	LF171	Am-241	74	432 yrs	Gamma/ Alpha
15	LC745/ LC720	Cs-137	333	30.2 yrs	Gamma / Beta
16	LC745/ LC720	Am-241	4.44	432 yrs	Gamma/ Alpha
17	LC745/ LC720	Sr-90	4.44	28.8 yrs	Beta
18	MT193	Co-60	74	5.62 yrs	Gamma / Beta
19	LC432	Cs 137	5	30.2 yrs	Gamma / Beta

Sealed Source: X-175B, Lonsdale Building (Custody only)

20	LS6500	Cs137	1110	30.2 yrs	Liq. Sc. Counter, Gamma
----	--------	-------	------	----------	----------------------------

Sealed Source: GB-01A, NICB Building (Custody only)

21	LS6500	Cs137	1110	30.2 yrs	Liq. Sc. Counter, Gamma
----	--------	-------	------	----------	----------------------------

Sealed Source: NG-03, Marconi Building

22	CO00174802- AN-1281	Am-241	330	432 yrs	Gamma, Alpha (used in Rutherford Scattering apparatus)
----	------------------------	--------	-----	---------	---

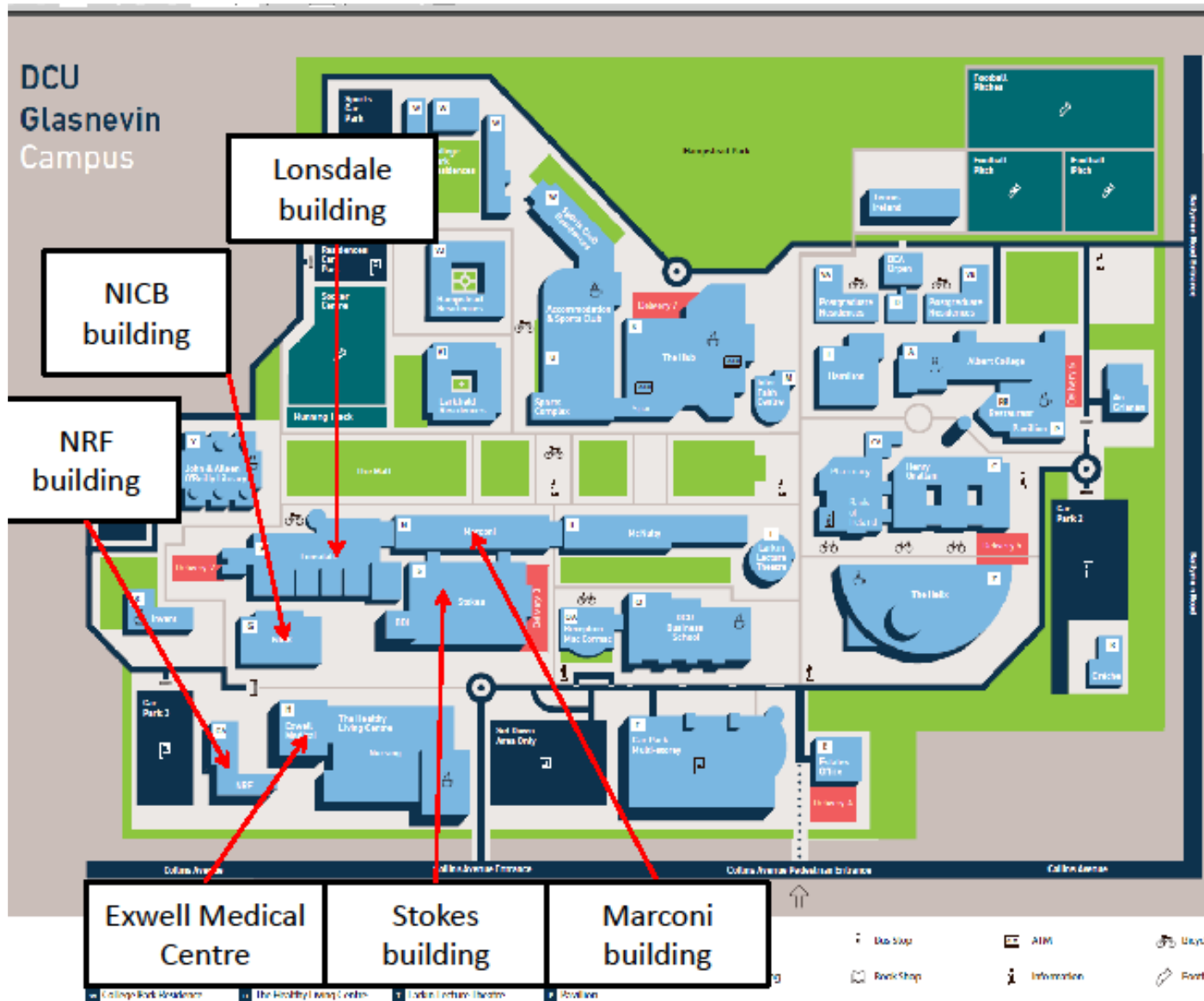
1.3 Unsealed Source: X-175b, Lonsdale building (Custody only)

Iodine-125 waste. Decayed to background in December 2019. Waiting approval from Irish Water to dispose to drain, following ORP approval.

1.4 Irradiating Equipment

Instrument	Location	Manufacturer	Model	Purpose	Comment
X-ray diffractometer	XB-12, Lonsdale building	Oxford Instruments	Gemini S Ultra	Research	Custody only
X-ray diffractometer	NG-11a, Marconi building	Jordan Valley	Bede D1	Research	Dosimetry, Yes
X-ray diffractometer	S-124, Stokes building	Bruker AXS	D8 Advance	Research	Dosimetry, Yes
X-Ray apparatus	NG-24, Marconi building	Leybold-Didactic	55481 Rontgengerat	Teaching	Dosimetry, Yes
X-Ray apparatus	NG-24, Marconi building	Leybold-Didactic	554800 Rontgengerat	Teaching	Dosimetry, Yes
Bone Densitometry	HG-34, Exwell, Nursing Building	DMS Group	Stratos	Research	Custody only. Waiting ORP approval to dispose.
X-Ray apparatus	GAG02C, NRF building	Thermo Scientific	Niton XL 3t 900	Research	Dosimetry, Yes

1.5 Campus Plan



Section 2

Normal Operating Procedures

2.1 Basic Principles of Control

There are three main principles of control against the internal radiation hazard:

- (a) containment;
- (b) cleanliness;
- (c) use of the least toxic radioactive material that is suitable, and the minimum quantities in all experiments.

The two methods of containment of operations most widely used are partial containment by means of fume cupboards, and complete containment by means of glove boxes.

2.2 General Procedures for Working with Radioactive Materials

The following working practices and procedures should be adopted:

- (a) the laboratory bench should be maintained in a tidy and orderly state;
- (b) there should be no unnecessary accumulation of radioactive materials;
- (c) any surface contamination arising during an operation should be cleaned-up immediately;

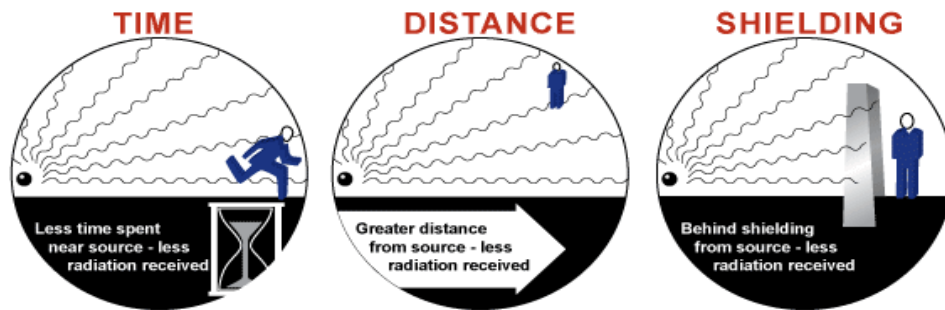
2.3 Methods of Protection

Every attempt must be made to limit the degree of exposure achieved through working with radioactive materials or radiation sources. Table 1 lists the types of radiation which may be encountered. Their range in air varies with their nature and energy and gives rise to two types of radiological hazard - internal and external.

Radiation type	Main hazard to personnel	Protection
Alpha particles	Internal	Containment
Beta particles	Internal and external skin dose	Containment, local shielding and exposure time
Gamma & X-rays	External	Distances, shielding and exposure time
Neutrons	External	Special shielding and exposure time

Table 1 Main types of ionising radiation's and their hazards

2.3.1 The External Radiation Hazard



The basic methods of protection against external radiation are:-

- restriction of the strength (activity) of every source to the minimum necessary for the task in hand;
- the use of the maximum amount of distance between the source and the operator, compatible with the satisfactory and safe performance of the work;
- restriction of the period of exposure to the minimum compatible with safe working;
- the use of suitable shielding.

The protection necessary in any particular situation to ensure that doses are kept below the relevant limit may be achieved by a combination of these methods as further detailed below:

The Use of Time

The acceptable dose must be kept both within statutory dose limits and **ALARA** - As Low as Reasonably Achievable. Exposure to high dose rates calls for careful pre-planning, and sometimes for 'dummy' runs. 'On the job' discussions in a radiation field should be avoided.

The Use of Distance

Inverse square Law – Applies to Gamma and X-Ray radiation

The intensity of the radiation (I) decreases in proportion to the square of the change in distance (D). The effect of a change in distance can be calculated using:

$$I_1 D_1^2 = I_2 D_2^2$$

Where I_1 and D_1 is the initial intensity and distance, and I_2 and D_2 is the final intensity and distance. The intensity of radiation from a radioactive source decreases with increasing distance. The dose rate is inversely proportional to the square of the distance, i.e., by doubling the distance the dose rate is reduced by a factor of 4 and so on. For example, the gamma dose rate from a 1 GBq cobalt-60 source decreases with increasing distance as follows.

$$\begin{aligned} \text{At } D_1 &= 1 \text{ cm, } I_1 = 3.5 \text{ Sv h}^{-1} \\ D_2 &= 10 \text{ cm, } I_2 = 0.035 \text{ Sv h}^{-1} = 35 \text{ mSv h}^{-1} \\ D_2 &= 100 \text{ cm, } I_2 = 0.35 \text{ mSv h}^{-1} = 350 \text{ uSv h}^{-1} \end{aligned}$$

Radioactive sources should therefore never be handled with bare hands or with gloved hands unless the thickness of the glove is sufficient to reduce the radiation to reasonable levels.

The Use of Shielding

Beta Radiation. The most suitable shielding materials for beta radiation are sheets of light metals such as aluminium or Perspex. The absorption of beta particles in matter gives rise to bremsstrahlung radiation (electromagnetic radiation resulting from the retardation of charged particles). For sources of energetic

beta radiation, a combination of Perspex and lead makes the best shielding material.

Gamma rays cannot be completely absorbed by a shield; they are only reduced in intensity. Of course, any degree of attenuation is possible if the shield is made thick enough. The approximate thicknesses of various materials required to attenuate 1 MeV gamma rays by a factor of 10 are (broad beam geometry):

LEAD	IRON	CONCRETE	WATER
3.5cm	6cm	20cm	40cm

2.3.2 The Internal Radiation Hazard

Routes of Entry:

- (a) *Ingestion.* Contamination on surfaces may lead to ingestion of activity through the mouth. Control is based on a combination of rules and procedures and strict laboratory discipline, e.g. in the correct use and removal of gloves, correct monitoring procedures after working in contaminated areas, and no eating, smoking, drinking, or applying make-up in contamination-controlled areas.

- (b) *Inhalation.* Work carried out in a laboratory or workshop can be accompanied by the formation of airborne contamination. The assessment of the significance of radioactive airborne contamination is a difficult problem due to the influence of many factors such as breathing characteristics (rate of breathing, whether the individual breathes through the nose or the mouth etc.), the size, shape and density and the chemical properties of the airborne particles (which will affect lung deposition and subsequent metabolism), and the ventilation pattern in the working area. Control is largely based on proper containment and ventilation coupled with correct working discipline. Before a job is carried out consideration must be given to the possibility of airborne contamination.

- (c) *Absorption.* Radioactive contamination may penetrate the skin by diffusion through the skin barrier or via cuts and wounds. Radioactive materials deposited on the skin and absorbed through the skin may subsequently disperse via the blood stream. Organic solvents are particularly dangerous in that they can penetrate the skin easily. In general, however, the skin forms an efficient barrier to contamination. Control is based largely on correct laboratory discipline and techniques, e.g. when using solvents suitable gloves should be worn.

2.4 Procedure for the Procurement of Radioactive Sources and Irradiating Equipment.

A Standard Operating Procedure for Purchasing a licensable radioactive source (sealed, unsealed, irradiating equipment) is available in **Appendix 2**. The ordering of all sources of ionising radiation, whether sealed, unsealed or irradiating equipment must be approved by the RPO. These safety procedures prevent radioactive sources which are not on the University licence being brought into DCU and also ensure that the quantities of materials ordered are within specified limits on our licence. These procedures also prevent unauthorised personnel from ordering and/or working with radioactive materials.

2.5 Sealed Sources

Section 1 details the inventory of sealed sources in DCU. The table below shows the activity of each source; external dose at 1m (mSv/hr); ALI ingestion/ inhalation and $\frac{1}{2}$ life.

Table of Sealed Sources in DCU (Licence L0169-02), (Activity kBq, External dose, ALI Ingestion/ Inhalation figures)

No.	Manufacturer/ Supplier	Serial Number	Radionuclide	Activity kBq	External Dose @ 1m in mSv/hr	Exposure time req'd to receive 1mSv @ 1 m in hrs	Annual Limit on Intake (ALI) Ingestion (20mSv)kBq	Dose if source ingested (mSv)	Annual Limit on Intake (ALI) Inhalation (20mSv)kBq	Dose if source inhaled (mSv)	1/2 life	Principal Emissions
1	The Radiochemical Centre Amersham, UK	4468 BN	Ni 63	370,000	2.4E-06	4.2E+05	130,000	56.923	38,000.00	194.737	96 yrs	Beta
2	Davidson & Hardy Lab Supplies 4 Clare St Dublin 2	PH/P66300/7	Ra 226	185	5.6E-07	1.8E+06	74	50.000	22.00	168.182	1600 yrs	Alpha,/ Gamma Set of 4 (185kBq ea)
3	The Nucleus Inc Oak Ridge TN USA	NG13 1/8 Ba- 133	Ba-133	37	4.5E-06	2.2E+05	29,600	0.025	10,360.00	0.071	10.51 yrs	Gamma / Beta
4	The Nucleus Inc Oak Ridge TN USA	NG13 2/8 Cd- 109	Cd-109	37	1.7E-06	6.0E+05	10,000	0.074	5,000.00	0.148	453 days	Gamma
5	The Nucleus Inc Oak Ridge TN USA	NG13 3/8 Cs- 137	Cs-137	37	3.8E-06	2.6E+05	1,000	0.740	2,000.00	0.370	30.2 yrs	Gamma / Beta
6	The Nucleus Inc Oak Ridge TN USA	NG13 4/8 Cs- 137, Zn-65	Cs-137/ Zn- 65	37	3.1E-06	3.2E+05	5,000	0.148	6,900.00	0.107	244.3 days	Gamma,/ Beta (value shown for Zn-65. Cs-137 values same as line above)

No.	Manufacturer/ Supplier	Serial Number	Radionuclide	Activity kBq	External Dose @ 1m in mSv/hr	Exposure time req'd to receive 1mSv @ 1 m in hrs	Annual Limit on Intake (ALI) Ingestion (20mSv)kBq	Dose if source ingested (mSv)	Annual Limit on Intake (ALI) Inhalation (20mSv)kBq	Dose if source inhaled (mSv)	1/2 life	Principal Emissions
7	The Nucleus Inc Oak Ridge TN USA	NG13 5/8 Co- 57	Co-57	37	1.5E-06	6.6E+05	1.00E+05	0.007	50,000.00	0.015	270 days	Gamma
8	The Nucleus Inc Oak Ridge TN USA	NG13 6/8 Co- 60	Co-60	37	1.4E-05	7.3E+04	6,000	0.123	3,000.00	0.247	5.62 yrs	Gamma / Beta
9	The Nucleus Inc Oak Ridge TN USA	NG13 7/8 Mn-54	Mn-54	37	4.8E-06	2.1E+05	28,000	0.026	13,000.00	0.057	312 days	Gamma
10	The Nucleus Inc Oak Ridge TN USA	NG13 8/8 Na-22	Na-22	37	3.9E-06	2.5E+05	11,100	0.067	5,700.00	0.130	2.62 yrs	Gamma / Beta
11	AEA Technology Germany	MC226	Cs137/ Ba- 137m	370	3.8E-05	2.6E+04	1,000	7.400	2,000.00	3.700	30.2 yrs	Gamma/ Beta
12	AEA Technology Germany	LC895	Sr-90	74	7.0E-04	1.4E+03	1,100	1.345	740.00	2.000	28.6 yrs	Beta
13	AEA Technology Germany	LX809	Na-22	74	1.2E-05	8.4E+04	11,100	0.133	5,700.00	0.260	2.6 yrs	Gamma / Beta
14	AEA Technology Germany	LF171	Am-241	74	6.3E-06	1.6E+05	500	2.960	0.50	2,960.000	432 yrs	Gamma/ Alpha
15	AEA Technology Germany	LC745/ LC720	Cs-137	333	3.42E-05	2.92E+04	1,000	6.660	2,000.00	3.330	30.2 yrs	Gamma / Beta
16	AEA Technology Germany	LC745/ LC720	Am-241	4.44	3.00E-07	3.33E+06	500	0.178	0.51	174.118	432 yrs	Gamma/ Alpha
17	AEA Technology Germany	LC745/ LC720	Sr-90	4.44	4.28E-05	2.34E+04	1,100	0.081	740.00	0.120	28.8 yrs	Beta
18	AEA Technology Germany	MT193	Co-60	74	3.70E-06	2.70E+05	6,000	0.247	3,000.00	0.493	5.62 yrs	Gamma / Beta
19	AEA Technology Germany	LC432	Cs 137	5	5.15E-07	1.94E+06	1,000	0.100	2,000.00	0.050	30.2 yrs	Gamma / Beta
20	Beckman Coulter	LS6500	Cs137	1110	1.14E-04	8.75E+3	1,000	22.200	2,000.00	11.100	30.2 yrs	Liquid Scintillator Counter (NICB)
21	Beckman Coulter	LS6500	Cs137	1110	1.14E-04	8.75E+3	1,000	22.200	2,000.00	11.100	30.2 yrs	Liquid Scintillator Counter (Biotech)
22	Eckert & Ziegler	CO00174802- AN-1281	Am-241	330	2.81E-05	3.6E+04	500	1.32E+01	0.51	12,941.18	432 yrs	Gamma/ Alpha

2.6 Registration Form for work with Unsealed Radioisotopes.

Refer to Appendix 3 for details on the form to be completed before working with unsealed sources.

2.7 Radioisotope Record Form.

Refer to Appendix 4 for details on the form to be completed when working with unsealed sources.

2.8 Dosimetry

If a possibility of exposure to significant levels (i.e., greater than 1 mSv yr⁻¹) of penetrating radiation exists, the RPO will arrange for the issue of personal dosimeters to each person who may be exposed. The RPO will ensure that a record is kept of the exposures recorded by such personal dosimeters. Such records must be kept for a period of at least 5 years, but it is recommended that they are kept indefinitely. Any dosimeter must never be used by more than one person. Currently, there are no unsealed sources on the DCU license, except Iodine-125 waste due to decay to background in approx. Dec'2019. DCU has an account with Landauer UK. Dosimetry badges currently placed in all XRD/ XRF rooms for area monitoring as an added measure to review exposure over time and to complement biannual surveys by the RPO and annual survey by the RPA. This will be reviewed after 12 months.

2.9 Records

A Google drive is shared with all relevant staff responsible for radiation sources, including DCU's RPA (Dr. Elaine Doorly), RPO (Michael Burke) and H&S Manager (Paula Kierans). A separate folder for each instrument, sealed source and unsealed source is accessible and responsible staff can upload information to their relevant folder. See **Appendix 1** for details of folders included. A record will be kept by each School/ Centre of the quantity and nature of each radionuclide present in the School/ Centre. Information relating to service reports, calibration of monitors, wipe test certificates, RAs, Training records, etc.

2.10 Signage

Each room in which radioactive materials or radiation sources are stored or used will have the internationally agreed black and yellow symbol for radiation prominently displayed at the entrance to the room. The radiation safety procedures must also be permanently mounted in a conspicuous position within the room. A copy of the front page of the current license must also be posted at the front entrance to the room.

2.13 Spills and Emergencies

All spills or other accidents involving radioactive materials must be reported to the relevant responsible person in the School/ Centre. The RPO should also be informed if the possibility of contamination or external exposure of workers or other persons exists as a result of the accident.

In the event of an emergency situation, the RPO should be contacted immediately to give advice and guidance on procedures to be followed. The RPO should be contacted at 01-7005110, or on the following mobile phone number: 085-7714045 (for use in emergencies only). The University security centre should also be contacted at ext. 5999 or (01-7005999) and advised of the situation. If the emergency services need to be contacted such as the fire brigade or ambulance, these should be contacted through the University security staff who can open gates for them and direct them into the appropriate area of DCU. Examples of emergency situations would include fire or explosion in a building/ room containing radioactive materials, loss or theft of any licensed item, damage to, leakage from or other incident/accident involving a licensed item. In the event of an emergency situation, the EPA should also be contacted and notified at +353 1 268 0100. They can also offer advice and guidance.

Each radiation worker must familiarise themselves with individual School/ Centre emergency procedures and must discuss this matter, and their role in implementing emergency procedures with the RPO before commencing work with sources of ionising radiation. More detailed emergency procedures are outlined in **Section 3 Radiation Emergency Procedures**. All users of ionising radiation in University should be familiar with these procedures.

2.13 Pregnant Workers

Pregnant workers should formally notify their supervisor or the RPO when they become pregnant or their intention to become pregnant so that dose reduction steps can be taken. The notification should include date of declaration, estimated date of conception and expected date of birth. The RPO will determine what steps are necessary to maintain all doses to the embryo/foetus below allowable limits. Appropriate personnel monitoring equipment must be provided to individuals who have declared a pregnancy or planned pregnancy. The recommendation of the Office of Radiological Protection is that the radiation dose to the foetus not exceeds 1mSv. (This would suggest, by a conservative measure a dose of <1 mSv for the abdomen of woman). Exposure during the first trimester is the most hazardous. If a pregnant woman or a nursing mother works with radioactive liquids or dusts, these can cause exposure of the foetus through ingestion or via contamination of the mother's skin and transfer across the placenta to the foetus or by breastfeeding, to the baby. Pregnant women should not be assigned to a radiation use area during pregnancy unless exposures potential is demonstrated to be below 1mSv/9months. Monthly TLD monitoring will be established during the pregnancy period.

2.14 Waste

Currently, the only radioactive waste stored in DCU is Iodine-125 (custody only) and is due to decay to background in approx. April 2019. Researchers who intend to work with unsealed sources **must** consult with their supervisor and RPO as there are no unsealed sources on our current license. A Risk Assessment must be prepared and approved before the RSP is updated to include relevant information on procedures, dosimetry, spills, waste management, etc. Also, the Liquid Scintillation Counter LS6500 in X-175a is custody only and cannot be used until it is serviced and amended for use on the DCU license. **No work with unsealed sources can commence until approved by the RPO, RPA and license amended accordingly.**

For general information:

Liquid waste: Liquid wastes, such as waste scintillation fluids etc. must be certified as being within the approved limits set by S.I. 125 of 2000, before being disposed of down approved drains. A log is maintained in the radiation facility (X-175). One copy of these certificates must be sent to the University RPO annually and one copy should be kept on Departmental files.

DCU license specifies that waste containing unsealed radioactive substances shall not be disposed of unless total activity of isotope to be disposed of per day is as follows:

³ H	Less than 10 ⁹ Bq or 10 ⁶ kBq/kg
¹⁴ C	Less than 10 ⁷ Bq or 10 ⁴ kBq/kg
³² P	Less than 10 ⁵ Bq or 10 ³ kBq/kg
³⁵ S	Less than 10 ⁸ Bq or 10 ⁵ kBq/kg
¹²⁵ I	Less than 10 ⁶ Bq or 10 ³ kBq/kg
⁴⁵ Ca	Less than 10 ⁷ Bq or 10 ⁴ kBq/kg

(Remember 10⁵Bq = 2.7 uCi, and 1 uCi = 37kBq)

Daily quantities disposed of should not exceed these limits. Date of disposal, isotope and activity must be recorded in the **Disposal log book** in the Waste room.

1. **Perspex waste boxes.** Each research group should have their own Perspex waste boxes for both liquid and solids clearly marked with the isotope. (e.g. ³²P, ³⁵S or ⁴⁵Ca). Do not mix isotopes. This waste must be stored in the Waste room until the Geiger counter shows it to be at background level. The waste can then be put into the waste bin in the lab.

2. **Radiation warning labels** and markings must be removed or defaced prior to disposal of waste material.
3. **Scintillation vials** are a major source of waste. Whether glass or disposable vials are used, they should be emptied of scintillant, steeped in Lipsol and rinsed thoroughly. Glass vials and caps may be reused.

2.15 Inspection, auditing and disciplinary action.

The University RPO will inspect each School/ Centre and facilities at intervals and will advise on any other precautions that may from time to time be required. The RPA will also inspect facilities annually and make recommendations.

In the event of non-compliance with the safety rules relating to radiological protection, any individual / group may be reported to the RPO, the Health & Safety Office. The RPO or H&S officer, in conjunction with the Head of School/ Centre may invoke disciplinary procedures which may include the suspension or cessation of work with ionising radiation.

All procedures involving the importation, transportation, custody and use of radionuclides and the disposal of associated waste are licensed by the EPA and these procedures are subject to their inspection. Licence applications are made by the responsible person through the University RPO, who submits them to the RPA for review and approval before submitting to the EPA for approval. The RPO will also periodically update the University Health & Safety Steering Committee (Chaired by the University Chief Operating Officer) of ongoing amendments to the DCU EPA licence. Any areas of non-compliance with licence conditions will be rigorously investigated by the ORP-EPA who has the power to revoke or suspend the University licence. It is therefore imperative that these University Radiation Safety Procedures and the University ORP-EPA licence conditions are complied with.

2.16 Radiation Protection Education, Training and Information

Regulation 35 (1) of S.I. No. 30 of 2019 refers to the responsibilities of the undertaking to exposed workers, apprentices and students. DCU does not have a category of exposed workers (as persons working with ionising radiation onsite are unlikely to receive a radiation dose in excess of 1mSv per year) or apprentices as defined in Regulation 2. The category of "student" encompasses undergraduate and postgraduate students. Undergraduates have limited exposure to radiation sources in the School of Physical Sciences as part of their practical coursework. The sources used in teaching include sealed sources and the Leybold Didactic X-Ray apparatus. Training is provided by

means of an induction for students, carried out by a trained technical officer. All students scheduled to take a radiation experiment e.g. Gamma ray spectroscopy, X-ray diffraction must log into loop (Loop is DCU's on line learning platform which allows students to connect with course content and manuals). Once logged in, they must read the radiation operating procedures for the physics laboratory prior to commencing the experiment. Students will be asked a short series of questions to make sure they understand the content. They will then sign a sheet which states that they are aware of radiation safety and agree to comply with all radiation safety regulations. The signed sheets are uploaded to the relevant folder in Google drive.

Training is offered every year to staff and researchers (post doctorate and post graduate students) by the RPO as part of Safelab Module 2 and a record maintained by the RPO. Staff responsible for radiation sources (see Section 5) will undergo additional training to familiarise all relevant staff to the changes in the Radiation Safety Procedures and Risk Assessments. This training will be carried out by the RPO and further training will be facilitated by the RPA, Dr. Elaine Doorly in Radiological Protection, as deemed necessary. An attendance record is maintained by the RPO. Individual researchers requiring access to irradiating sources must complete basic training with the RPO and specific training with a person responsible for a particular instrument. Records are maintained of all such training.

2.17 Protection of exposed workers, apprentices and students

Regulation 30 (1) S.I. 30 of 2019, stipulates the arrangements for all workplaces where workers are liable to receive an exposure greater than an effective dose of 1 mSv per year. Based on risk assessment and the knowledge of DCU's sealed and irradiating sources, and the measures in place to monitor and limit exposure, the undertaking is confident that no worker or student will be exposed to levels that exceed 1 mSv per year. There is no situation where a self-employed worker or a worker employed under an external employer, is exposed to radiation. As such, there is no category of "exposed worker" as defined in *regulation 2*. All sealed sources are maintained in a locked lead store when not in use and all irradiating equipment is monitored by area monitoring dosimetry and regular checks by the RPO. Commencing in March 2020, the technical officer charged with maintaining and controlling sealed sources in NG-13, will wear an Instadose radiation monitoring badge which will allow for improved dosimetry compliance, while simplifying dose reads via iPhone, iPad, or PC at any time.

Section 3

Radiation Emergency Procedures

The sources of ionising radiation in use in DCU include sealed sources, unsealed sources and irradiating apparatus.

Possible emergencies related to the use of these sources of ionising radiation can be broadly defined in five categories, as follows;

- A. Fire.**
- B. Loss or Theft of a licensed item.**
- C. Damage to Sealed Sources.**
- D. Faults in safety systems of irradiating apparatus.**
- E. Spills of unsealed sources.**

The following are the emergency procedures to be implemented in the event of each of the above categories of emergency:

A. Fire

Should a fire occur in a lab / room where sources of ionising radiation (sealed or unsealed) are stored / used, the following procedure should be implemented by the person becoming aware of the fire;

1. Raise the Alarm and Evacuate

- Raise the fire alarm, by breaking the glass at the nearest break glass unit.
- Ring DCU security at ext. 5999 internal (01-7005999 external), and advise of the location, and size of the fire, and that there are sources of ionising radiation in the room. If the emergency services need to be contacted such as the fire brigade or ambulance, this should be communicated to DCU security. They will liaise with the emergency services and direct them to the relevant building.
- Attempt to fight the fire with an appropriate fire extinguisher, only if you have been trained in the use of fire extinguishers, if the fire is small and manageable, you have raised the alarm first, and you have a clear escape route.

- If possible, before leaving the lab, remove any sources of ionising radiation within their shielded containers from the immediate danger area.
- Leave the building immediately by the nearest route, closing doors and windows in the lab if possible before leaving. In general, all lab services, except lighting, but including ventilation, should be switched off and all doors and windows should be closed.
- Go to the nearest assembly point for your building.

* Please note: Your personal safety is of paramount importance in the event of a fire. Do not attempt to fight the fire, remove materials, or close windows / doors if doing so would endanger your personal safety.

2. Notify the Proper Authorities.

After retreating to a safe area, you should then,

- Notify the Radiation Protection Officer (01-7005110; mobile: 085-7714045).
- The University Radiation Protection Officer will notify the EPA, Office of Radiological Protection immediately in the event of an emergency situation, and in particular if the fire is not brought immediately under control, or if there is a risk of exposure of persons to ionising radiation.

3. Sealed / Unsealed Sources: Determine the types and activities involved and likely consequences.

- There are no unsealed sources in DCU except for Iodine-125 waste, custody only and stored in X-175b, Lonsdale building (decay to background approx. Dec' 2019).
- All small sealed sources used for Teaching are stored in a lead safe in NG-13, Marconi building. Two Cs-137 sealed sources are located in Liquid Scintillator Counters (custody only) in X-175b, Lonsdale building and GB-01a, NICB building.
- Where sealed or unsealed sources are involved in a fire, the RPO should be consulted to determine from the inventory, the quantities, activities and types of sources that are stored/ used in that room, and from this information, determine the likely consequences resulting from the fire in terms of possible exposures. This information is detailed in **Section 1, page 5-6**. This information should be given to any emergency services personnel that attend the incident. A Campus plan showing the relevant buildings containing radiation sources (sealed, unsealed and irradiating) detailed in **Section 1, page 8**.

4. Irradiating Equipment: Unplug.

- Should a fire occur in a room where irradiating apparatus such as X- Ray machines are used, the machine should be switched off and unplugged where it is safe to do so, and the general procedures outlined above with regard to raising the alarm, attempting to extinguish the fire, and evacuating the building will also apply thereafter.
- Before reusing any irradiating apparatus after a fire in a room accommodating it (if indeed it is still operational), it should be subject to a full examination by a competent person including testing of safety systems, interlocks etc.

B. Loss or Theft

(Of any licensed item, i.e. sealed or unsealed sources or irradiating equipment)

1. Notify the Proper Authorities

- Notify the Radiation Protection Officer (01-7005110; mobile: 085-7714045).
- RPO to notify Gardaí, University Safety Officer, Security and ORP of the missing radioactive source along with details of quantity and activity.
- RPO to report to Head of School / Centre Director, School safety officers and to the Faculty of Science & Health Safety Committee
- Security system in the relevant lab to be reviewed.

The normal procedure should be that the person becoming aware of the loss / theft of the item should notify the RPO who will notify the EPA, office of radiological protection.

2. Provide Relevant Information

- Give details of the ionising radiation source, its form (sealed, unsealed, irradiating apparatus), and details of the quantity, activity and concentration where relevant.
- Provide as much detail as possible about the circumstances leading to the loss or theft of the item.
- Provide details regarding labelling or packaging of the item, as this will be of relevance if the source is found by or comes into contact with a member of the public. For instance, does it have a radiation trefoil sign, or a Transport Index indicating that it could be hazardous to be in close proximity to the original container?

3. Search for lost items

- Undertake an immediate search for the source if it is thought to be lost.
- While the search is underway, there should be no sweeping of floors, no removal of waste, and no disturbing of furniture etc.
- Examine all relevant records, storage inventories and usage records, speaking to all users, regarding when the material was used last, where it was stored etc.
- If there is any reason to suspect that a lost source might have become damaged, the possibility of contamination by spilled radioactive substance should be borne in mind, and procedure with regard to spillages and decontamination as outlined under section E below, may need to be applied.

The greatest danger with loss or theft of radioactive materials is the hazard presented to someone who comes into contact with radioactive materials and is unaware of the hazard. It is imperative therefore that action is taken immediately it is suspected that radioactive materials are missing. It would be unacceptable to wait days or weeks hoping that the missing materials will 'turn up'.

Note: The Niton XL 900 XRF is the only mobile irradiating source potentially susceptible to theft. The equipment is located in a secure room with restricted swipe access

C. Damage to Sealed Sources

1. Discontinue use of damaged source immediately.

- All sealed sources in DCU are subject to routine leak tests at least once every 2 years. If sources fail this leak test, they will not be licensed for use in DCU. Sealed sources are stored in a secure lead safe in NG-13 and removed by a responsible technical officer to be used under supervision in a teaching laboratory. As such, they are unlikely to be damaged; however, sealed sources may potentially become damaged due to for example, overt mechanical damage, chemical corrosion, or use in hostile conditions. It is important therefore that they are stored and used correctly, and in appropriate conditions.
- If a sealed source becomes damaged, there is a risk of contamination with the radioactive material contained in the sealed source.
- Use of the damaged source must discontinue immediately.

2. Seek advice and assistance from a competent person.

- The technical officer or lecturer licensed to use the sealed source may not necessarily have the expertise or equipment such as contamination monitors, decontamination kits, available to him / her to deal with such an event. The RPO should be contacted for advice.
- Potential contamination to personnel involved and equipment will be assessed by the University RPO.
- Procedures with regard to personnel and equipment decontamination as outlined in section E below with regard to spills of unsealed sources will then be applied.

D. Faults in safety systems of irradiating apparatus.

1. Isolate Equipment, Prevent Use and Report to the University RPO

All irradiating apparatus must be routinely and adequately serviced and maintained by a competent person, to ensure that it is in a serviceable condition, and that all safety devices, and interlocks etc. are operational. Irradiating apparatus that is operating incorrectly can be made safe by operating an emergency cut off switch and / or isolating the equipment from the mains supply. Any equipment indicating a fault in a safety system such as an interlock must not be used and must be reported at once to the technical officer in charge who should instigate the necessary repair / service. The RPO should also be contacted.

2. Investigate Overexposures.

Any case of overexposure or suspected overexposure must be reported to the University RPO for investigation and dosimeters (where applicable) must be sent for analysis immediately

E. Spills of unsealed sources

Note: There are no unsealed sources currently used in DCU. There is a custody only Iodine-125 waste stored in X-175b awaiting decay to background (Dec'19). Unsealed sources can only be used in the radiation facility in the Lonsdale building, X-175.

If unsealed sources are to be used in the future, the RAs and RSP will have to be amended and a detailed spills procedure included in the RSP. **Appendix 4** gives a detailed procedure for procedures regarding spills of unsealed sources.

Contact Details of Relevant Personnel:

University RPO

Mr. Michael Burke: 01- 7005110, Mobile: 085-7714045

University Safety Manager

Ms. Paula Kierans: 01- 7008896, Mobile: 086-1098097

EPA, OFFICE OF RADIOLOGICAL PROTECTION:

Office hours: Phone: +353 1 268 0100, Fax: +353 1 268 0199, email: radregulatory@epa.ie

Outside office hours: The EPA, OFFICE OF RADIOLOGICAL PROTECTION operates a 24-hour, 7 day a week on – call system to provide a response to any accident or emergency situation involving radiation. This service can be accessed by following the instructions given after ringing +353 1 268 0100.

University Radiation Protection Adviser (RPA)

Dr Elaine Doorly, Radiation Safety Ireland Ltd., 087-2644107

DCU Security (for Access to all Emergency Services or assistance after normal working hours):

01-7005999 (external) or internal ext. 5999

Contact Details of Emergency Medical Support

Fire, Gardai, Ambulance: Dial 5999 and ask for the service (s) you require. Tell them you are in Dublin City University. Make sure that you inform them radiation is involved. If using the **Safezone App**, activate the emergency button on your phone. This will be received by security and they will know your location. Be prepared to give the following information:

1. Information on the condition of the victim, if there is a casualty.
2. Details of any hazards (i.e. fire/ chemical/ radiation/ biohazard)
3. Exact location of the accident (room number and building)

Security staff will meet the service at the University entrance and escort them to the right location.

Nearest Hospital:

Medical Treatment	Beaumont Hospital <i>Phone</i> 8377755
Poison Information Service	Beaumont Hospital <i>Phone</i> 8092566
Toxicology	Beaumont Hospital <i>Phone</i> 8092673
Accident & Emergency	Beaumont Hospital <i>Phone</i> 8092720 / 8092714

Michael Burke Radiation Protection Officer	7005110
---	---------

Paula Kierans University Safety Manager	7008896
--	---------

Wendy Buckley Occupational Health Advisor	7007929
--	---------

Campus Health Centre	7005143
----------------------	---------

Buildings Office	7005142
------------------	---------

University Reception	ext. 9
----------------------	--------

Section 4

Planned Maintenance

4.1 Sealed Sources

All sealed sources are wipe tested every two years. See **Appendix 6** for EPA protocol for radioactive source wipe test. The sealed sources currently in use are due to be wipe tested in November 2019 (sources 1-21 on Pages 5-6). Am-241 the source for the Rutherford Scattering apparatus (source 22 on Page 6) due for wipe test in Feb 2021. Results are uploaded to the shared Google drive, as detailed in **Appendix 1**

4.2 Irradiating equipment

Irradiating equipment is checked biannually by the RPO and once by the RPA. An annual check is also carried out by an external service provider or by the supply company where applicable. The results are documented and uploaded to the relevant folder in Google drive. An example of an in-house check list used by the RPO to survey the Leybold Didactic in NG-24 is detailed in **Appendix 7**.

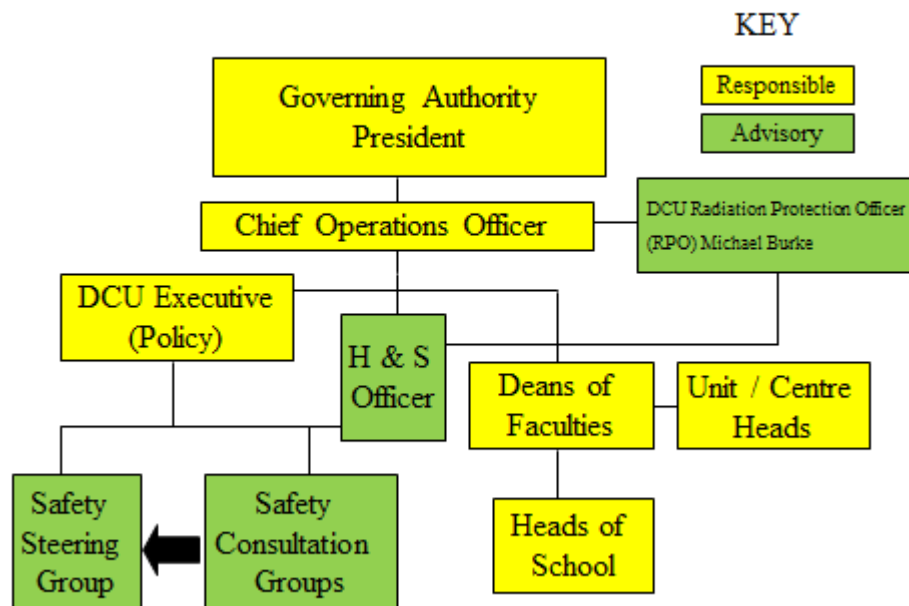
4.3 Portable Radiation Monitoring Equipment

DCU has two monitors in use. A Thermo Scientific Scintillation Mini-Monitor Series 900 with a type 44A probe attachment for surface contamination testing, and a Thermo Scientific RadEye B20 survey meter. The instruments' manuals should be operated as per the manufacturer's instructions. An electronic copy can be found in the relevant shared Google drive folder. The monitors are calibrated by the EPA or manufacturer and re-calibrated at least every 12 months. The Mini-Monitor calibrated on 20th Sept 2019 and the RadEye B20 was calibrated 16th April 2019. Calibration certificates are uploaded to Google drive. Date of last service is labelled on each Monitor.

Section 5

Radiation Protection Administration

5.1 Organisational Structure for Health & Safety in DCU



5.2 Heads of Schools/ Research Centres

Individual Heads of Schools/Centre Directors are responsible for the safe use of sources of ionising radiation within their areas. Each Head of a School which uses a source or sources of ionising radiation must nominate, for approval by the RPO and RPA, one member of staff who will be responsible for the keeping of records and the day to day management of radiological safety issues within the School/ Centre. This individual will be known as the School or Centre responsible person. From an operations perspective, the RPO will work and liaise with this person.

5.3 Responsible person for managing radiation source/ irradiating equipment

Source	Responsible Person	Comment
Sealed sources in NG-13	Mr. Henry Barry (henry.barry@dcu.ie)	Approved
X-175 Radiation facility	Dr. Rosaleen Devery (rosaleen.devery@dcu.ie)	Custody
Oxford X-Ray, XB-12	Dr. John Gallagher (john.gallagher@dcu.ie)	Custody
Bruker D8 X-Ray, S-124	Dr. Karsten Fleischer (karsten.fleischer@dcu.ie)	Approved
Jordan Valley X-Ray	Mr. Billy Roarty (billy.roarty@dcu.ie)	Approved
Leybold-didactic, NG-24, 2 instruments	Mr. Henry Barry (henry.barry@dcu.ie)	Approved - Registration
Stratos Bone Densitometry, Exwell Medical Centre	Dr. Brendan Egan (Brendan.egan@dcu.ie)	Custody, awaiting ORP approval to dispose
Niton XL 900 X-Ray, GAG02C	Dr. Una Prendergast (una.prendergast@dcu.ie)	Approved
LS6500 LSC, X-175	Dr. Rosaleen Devery (rosaleen.devery@dcu.ie)	Custody
LS6500 LSC, GB-01a	Not in use (RPO)	Custody
Rutherford Scattering apparatus	Mr. Alan Hughes (alan.hughes@dcu.ie)	Approved

5.4 University Radiation Protection Officer (RPO)

Overall supervision and advice on radiological safety is the responsibility of the RPO. The University RPO is Mr. Michael Burke 01-7005110 michael.burke@dcu.ie. The RPO must be consulted on certain issues but the ultimate responsibility for radiation safety in DCU rests with the University and with individuals within University Schools who are working with radiation.

The duties of the RPO include the following;

- a) To provide information and advice on all aspects of radiation protection in DCU.
- b) To aim to maintain radiation exposures at the lowest possible level by co-ordinating the radiation protection service in DCU.
- c) To ensure that accurate records are maintained of personnel exposure and of incidents involving contamination or of any radiological significance.
- d) To ensure that appropriate instruction is given in the proper procedures to be used and in the use of equipment necessary for safe working with ionising radiation.
- e) To ensure that monitoring equipment is regularly checked and calibrated.
- f) To ensure that records are maintained of importation, usage, storage and disposal of radioactive materials as may be required by the EPA.
- g) To ensure that all users of radioactive materials are informed of appropriate safety rules and national legislation as may be applicable.
- h) To carry out such other duties concerning radiation safety as may be required by the University.
- i) The RPO reports to the [University Safety Steering Committee](#) and is an ex-officio member of this committee and the Faculty Management Board.

The University RPO is authorised to refuse permission to undertake work with ionising radiation in any University School or research Centre if they are not satisfied that the necessary safety requirements can be met. The RPO is also authorised to require that a work activity with ionising radiation, which is deemed to be unsafe, or in contravention of the University licence requirements, or in contravention of the University Radiation Safety Procedures, cease or be suspended until appropriate control measures are implemented. The RPO has the authority to enforce a closure order on equipment/activity which does not comply with the terms of the License, after notification to the EPA and approval from the EPA.

5.4 Radiation Protection Advisor (RPA)

DCU is required to appoint a competent qualified expert, known as a 'Radiation Protection Adviser' from the list of EPA approved Radiation Protection Advisers, in accordance with Regulation 33 of the Radiological Protection Act 1991 (Ionising Radiation) Regulations 2019. The RPA is Dr Elaine Doorly, Radiation Safety Ireland Ltd. Her role does not include medical equipment. Currently, Mr. Ruairi O'Donnell is the RPA for the Stratos Bone Densitometer located in the Exwell Medical Centre. This instrument is "custody only", and an application has been made to dispose of the instrument through Healthcare Facilities Ltd.

The RPA must be consulted with regard to the following matters:

- (a) The examination and testing of protective devices and measuring instruments
- (b) The prior critical examination of plans for ionising installations from the point of view of radiation protection
- (c) The acceptance into service of new or modified sources from the point of view of radiation protection
- (d) The regular calibration of measuring instruments and the regular checking that they are correctly used
- (e) The designation of Controlled and Supervised areas
- (f) Appropriate quality assurance programmes including quality control measures to be taken for irradiating apparatus, nuclear devices and radioactive substances
- (g) The estimation of radiation doses

In the event of an emergency, the RPA will endeavour to attend at the earliest possible time to give on site advice and guidance.

Section 6

Transporting Radioactive Sources/ Materials

6.1 All licensed radioactive sources shall be shielded, packaged and transported in accordance with the International Atomic Energy Agency's Regulations for the safe transport of radioactive material, and in accordance with the conditions outlined in the University licence. The EPA is the competent authority for the transportation of Class 7 dangerous goods (radioactive material) within, to, or from Ireland. The regulations are designed to ensure that all such transportations comply with national, European and international legislation. See **Appendix 8** for a list of approved transporters of radiation sources in Ireland. The Irish legislation relevant to The Radiological Protection Act, amendments and statutory instruments are detailed in **Reference 1** page 32.

6.2 The RPO will ensure that users of radionuclides understand the international transport labels affixed to the packages in which isotopes are delivered and the relative hazards, which are indicated by such labelling, so that appropriate precautions can be taken. Please note that DCU is not licensed to transport radioactive substances. Any

courier or transport company used to transport radioactive materials in to DCU must have an EPA licence.

6.3 A licensee who intends to purchase a sealed source from another Member State of the European Union must first complete a standard declaration document, known as the [1493 form](#). The licensee is then required to submit this form to the EPA Office of Radiological Protection for approval and stamping. Once authorisation has been received from the EPA, the form should then be forwarded to the supplier. For sealed sources being sent to another Member State of the EU, the licensee must ensure that the Competent Authority in that State has approved and stamped the 1493 form prior to the shipment. A copy of the stamped form must be forwarded to the EPA Office of Radiological Protection. See **Appendix 2** for procedures to procure a radioactive source.

Sources imported from outside of the EU require an Import Licence from the EPA Office of Radiological Protection.

References:

1. Environmental Protection Agency

<http://www.epa.ie/radiation/lic/needtoknow/transport/>

2. International Atomic Energy Agency

<http://www-ns.iaea.org/standards/documents/default.asp?s=11&l=90&sub=70&vw=1#sf>

Section 7

Radon Survey

Radon in workplaces (Part 8, SI No. 30 of 2019)

The national reference level for indoor radon concentrations in workplaces is hereby established as an annual average activity concentration in air of **300Bq/m³**. The Agency shall prepare guidelines for employers on the application of this reference level.

An employer or self-employed person who is responsible for a workplace shall measure the indoor radon concentrations where the workplace is: -

- (a) underground, including mines and show caves;
- (b) on ground floor or basement level in high radon areas; or
- (c) identified by the agency as being liable to have radon concentrations in excess of the national reference level.

Referring to the EPA Radon map, DCU is in a low risk area; however, a minor survey was carried out (completed in Jan'20), with detectors installed in a number of buildings across all four campuses. The results from the survey below show that the concentrations are considerably less than the action level, and therefore, no remedial action is required. This survey will be repeated during summer'20 with a different set of buildings chosen across all four campuses.

DCU Radon Survey Oct'19 to Jan'20

Date (install)	Campus	Building	Room	Results Bq/m3
02/10/19	Glasnevin	Bea Orpen	Basement	14
02/10/19	Glasnevin	College Pk Apart.	W-11,12,13	4
02/10/19	All Hallows	Purcell hse	Lift shaft	25
02/10/19	All Hallows	O'Donnell hse	ODG03	10
02/10/19	Alpha	TAG	Gnd fl. East (stairwell)	62
02/10/19	Alpha	Materials building	Gnd fl (stairwell)	19
02/10/19	St Pats	Bangor hse	House 1 (SR)	43
02/10/19	St Pats	Clonmacnoise hse	House 4 (SR)	47
May 2018	Alpha Campus	Main building	Siemens offices	27

Appendix 1.

Records: Shared Google Drive Folder

Primary Folder: DCU Radiation License

https://drive.google.com/drive/u/0/folders/0B2Tfdo08zo7_N0F5ZDRCUnNtT00?ogsrc=32

Access: Michael Burke RPO
Elaine Doorly RPA
Paula Kierans University H&S Manager
Rosaleen Devery Biological Safety Adviser

Secondary Folders:

(RPO, RPA and H&S Officer have access to all folders below)

Restricted Access permitted to responsible staff:


DXA Scanner (custody only)
Niton XL 900 (custody only)
Ng-13 Sealed sources
NG-11a Bede
S-124 Bruker D8 (custody only)
Xb-12 X-Ray (custody only)
NG-24 Leybold didactic
X-175 Radiation Lab (custody only)
SOPs
Training Records
Radiation Monitors
General Information
Comms to Agencies

Mr. Enda Murphy
Dr. Una Prendergast
Mr. Henry Barry
Mr. Billy Roarty
tbc
Dr. John Gallagher
Mr. Henry Barry
Dr. Rosaleen Devery

Information included in Folders

- A folder is in place for each irradiating source on the DCU license. Information includes, service reports, RPO radiation checks.
- NG-13 sealed sources. Information on biannual wipe test results, Protocol for radioactive source wipe test, MSDS for each source, Risk Assessments, information on supplier, electronic log of use, Table of Sealed Sources - Activity (kBq, External dose, ALI Ingestion/ Inhalation figures).
- Radiation Monitors. Information includes, annual calibration certificates, manuals, repair certificates

Appendix 2

	<p style="text-align: center;">Standard Operating Procedure</p> <p style="text-align: center;">Purchasing a licensable radioactive source (sealed, unsealed, irradiating apparatus)</p>	<p>OP: DCU/RPO/SOP/001 Rev : 01 Approved by: MB Page : 37 of 66 Revision date: 27/03/2018 Review Date: 26/03/2021</p>
---	---	---

1.0 Purpose

The Radiological Protection Act 1991 (Ionising Radiation) Regulations 2019 - SI 30 of 2019 and the EPA licence conditions specify the legislative requirements for organisation relating to the purchase of radioactive sources. The procedure outlines how DCU will comply with these requirements.

2.0 Scope

This Procedure applies to all units of the university, both academic and support, including the campus companies and research centres. These are all hereinafter collectively referred to as the 'university'.

The scope of the procedure includes:

- Responsibilities
- Procedure
- Records

3.0 Definitions

ORP-EPA:	Office of Radiological Protection - Environmental Protection Agency
RPO:	Radiation Protection Officer, Michael Burke
RPA:	Radiation Protection Adviser, Dr. Elaine Doorly
EDEN:	Online gateway for organisations to communicate with the EPA
RA:	Risk Assessment
RSP:	Radiation Safety Procedures
REM:	Radiation Emergency Procedures

4.0 References

- EPA Licence Register number **L0169-04, 01/04/19 to 31/03/29**
- Radiological Protection Act 1991 (Ionising Radiation) Regulations 2019 - SI 30 of 2019
- Council Regulation (Euratom) No. 1493/93
- *European Communities (Carriage of Dangerous Goods by Road and Use of Transportable Pressure Equipment) Regulations 2011-2017*

5.0 Responsibilities

5.1 Purchaser is responsible for:

- Ensuring the need for purchasing a radioactive source is justified and due consideration given to how it will be used, where it will be stored, and all aspects discussed with the RPO in advance of a purchase order being generated.

5.2 Radiological Protection Officer (RPO) is responsible for:

- Ensuring all aspects of section 6.0 are complied with and the relevant import documents, RA, leakage test certificate, take back agreement, etc, are completed satisfactorily.
- Approval. A Purchase Order cannot be issued to the supplier until approved by the RPO, following approval from the RPA Dr. Elaine Doorly and the ORP-EPA. The license must first be amended

5.3 Radiological protection Advisor (RPA) Dr. Elaine Doorly is responsible for reviewing all the relevant documents necessary before a submission can be made to the ORP-EPA to amend the license.

6.0 Procedure

- 6.1 All radioactive sources (sealed, unsealed, irradiating apparatus) can only be acquired with the authorisation of the ORP-EPA, the RPA and the RPO.
- 6.2 Before acquiring any radioactive source, refer to Radiation Safety in DCU https://www.dcu.ie/science_and_health/FSH-Safety.shtml. An application process using google form will automatically submit to the RPO when completed. Only trained personnel can acquire radioactive sources.
- 6.3 For all radioactive sources, a RA must be prepared of the risks of exposure to ionising radiation for staff/ researcher/ student or any worker in DCU, and the corresponding protection measures for that item. RPO to approve. The RSP must also be updated to take account of any new source.
- 6.4 Unsealed sources require a Registration Form (**Appendix 2**) to be completed and e-mailed to the RPO and approval sought before acquiring the source. An Isotope Record Form (**Appendix 3**) must be completed after Step 10, and receipt of source, and a dosimetry programme implemented. DCU has an account with Landauer UK.
- 6.5 For sealed sources, in addition to a RA, the following information is required. Before a license change request is submitted to the EPA, via EDEN, the purchaser must (i) obtain written agreement from the supplier that the radioactive source will be accepted back by the supplier when no longer required, (ii) obtain a traceable leakage test certificate and quality certificate from the supplier, (iii) complete the Application Form for Shipment of Sealed Sources between Member states of the EU, Council Regulation No. 1493/93 (<http://www.epa.ie/radiation/regulation/export/>). This completed form is submitted to the EPA for approval and returned to DCU, whereupon the form is then sent to the supplier. Only then can the source be shipped.
- 6.7 Where a sealed radioactive source is being acquired to replace an existing one, the licensee shall arrange to return the sealed source being replaced to the manufacturer, or a successor, in accordance with the conditions of DCU's license.
- 6.8 Irradiating apparatus can only be purchased from a supplier holding a valid license with the EPA or alternatively from another source with the prior approval of the Agency.

6.9 In the case of new DXA Scanners, the Principal Investigator should include the following wording in their tender document, "Tenderers must include an appropriate Quality Assurance device/s (phantom) for the purpose of measuring performance across the range of intended subject matter (bone, fat mass and fat-free mass), to include the relevant manuals". All newly installed equipment will be subject to an agreed Quality Assurance programme, drawn up by DCU's RPA and will form part of the commissioning procedure. No plan to replace the existing instrument.

6.10 RPO to consult with RPA and apply via EDEN for addition of radioactive source to the License. RPO to update RSP and RA to include new source.

6.11 ORP-EPA approves and amends DCU License to include new source. Permission to purchase granted.

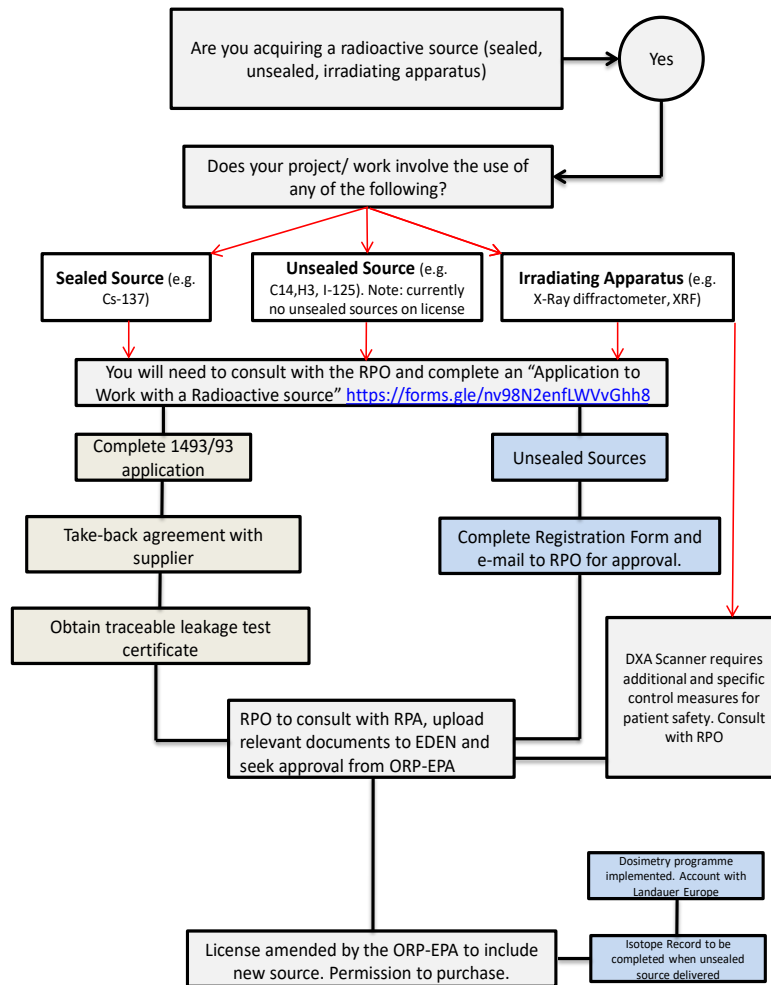
7.0 Records

All records will be stored electronically using a shared google drive folder. Only trained users have access to this folder.

(https://drive.google.com/drive/u/0/folders/0B2Tfdo08zo7_NVMyM3RURmpvRGc?ogsrc=32)

- Approved Risk Assessment documents will be held by the RPO and updated in the Appendix section of the Radiation Safety Procedures document.
- Take back agreement with supplier and wipe test certificate (sealed sources) will be filed and a hard copy retained by the School/ Research Centre. An electronic copy will be uploaded to the relevant google drive folder. This applies to all documentation outlined in 6.0 above.
- Completed registration form for unsealed sources will be filed by the RPO and stored on the shared drive.
- EPA approval communicated through EDEN
- Permission to purchase will be communicated by e-mail by the RPO to the relevant purchaser in the School/ research centre. PO and delivery dockets also uploaded to the shared google drive folder.

Flow Chart for Acquiring a *new* radioactive Source



Appendix 3

Registration Form for work with Unsealed Radioisotopes

Note 1: Work with radioisotopes can only be carried out in X-175, Lonsdale building.

Note 2: There are currently no unsealed sources on the DCU license. See Appendix 2 for procedure to acquire a new unsealed source

1. Name:

2. Position:

3. Name of Research Supervisor:

4. Project Title:

5. Estimated completion date:

6. Brief description of the experiment(s) you propose to carry out in Radiation Facility (X-175). Outline purpose and/or objectives.

7. Radionuclides you propose to work with: (Specify isotope and the quantity).

8. Specify where radioisotope/s is to be stored.

9. If a stock solution of a radioisotope is to be diluted or separated into aliquots, describe

10. Outline handling procedures to be used to minimise personnel exposure and lab contamination.

11. What instruments will you use for checking lab equipment, glassware and personnel during experiment:

12. Describe nature of hazardous materials that may be in radioactive wastes of which waste handlers should be aware (e.g. pathogens, carcinogens, toxic chemicals):

13. Specify the liquid scintillation counting fluid (brand name) you plan to use

14. Specify any solvents that may be used in processes which include radioactive materials

15. Procedures to be followed in the event of a spill:

16. No. of TLD's required for year:

17. Have you completed a Risk Assessment?

18. I acknowledge that I have reviewed the regulations pertaining to the ordering, use, and disposal of radioactive materials and agree to adhere to the University requirements:

Signature:

Please submit **Registration Form** and **Risk Assessment** electronically to RPO
michael.burke@dcu.ie

Appendix 4

Radioisotope Record Form

Isotope:

Radioactive concentration:

Quantity:

½ life:

Type of decay:

Usage

Researcher/ Lecturer:

Date ordered:

Date received:

How/ where is the isotope stored:

State room number where the isotope is to be used:

Waste disposal:

Submit electronically to RPO michael.burke@dcu.ie

Appendix 5

Spills of Unsealed Sources

The general priorities in dealing with spills are as follows:

- Deal with any personal injury or administer any first aid necessary first.
- Alert people in the area to the spill.
- Limit access to the area.
- Take all reasonable precautions to limit the spread of radioactive contamination.
- Put on protective clothing, lab coat, disposable gloves and overshoes.
- Cover a liquid spill with absorbent paper or pads.
- Confine the movement of people until they have been monitored and found free of contamination.
- Monitor personnel and remove any contaminated clothing.
- Notify the RPO and if unavailable, contact the University Safety Manager ext. 8896
- If outside of working hours, ring DCU Security at ext.5999 internal (01-7005999 external) and ask for radiation safety assistance.
- Initiate clean up and decontamination operations under RPO supervision.

Appendix 6

Protocol for Radioactive Source Wipe Test

A wipe test is carried out to check the integrity of the sealed source. Ideally a wipe test should be taken of the actual source, however sometimes this is not practical and a wipe of the nearest accessible surface should be taken. The wipe should be taken by trained personnel. The wipe should be placed at the end of a forceps and while wearing disposable gloves the housing should be wiped. The wipe test should then be surveyed with a hand held meter to check for gross contamination. If contamination is found then the EPA should be contacted immediately. Otherwise the preference for packaging the wipe test is as follows:

- Wipe test should be carried out using alcohol (isopropyl) moistened filter paper or 'medi-swabs' found in pharmacies.
- Dimensions of the wipe need to be approximately **2cm x 2cm**, anything larger may impair the efficiency of the measurement.
- The wipe should be placed at the end of a forceps and then rubbed lightly over the area.
- **Allow the wipe to evaporate to dryness.**
- Place in a zip-lock plastic bag or similar.
- Please supply the following information with each wipe test.

Radioactive Source Wipe Test		Source Details	
Company		Source Type:	
Contact		Model No:	
Telephone		Manufacturer:	
Email:		Serial Number:	
		Nuclide:	
		Activity:	
		Date:	

- Enclose PO with wipe test and forward to: EPA-ORP, 3 Clonskeagh Sq., Clonskeagh Road, D14

Appendix 7

Survey of Leybold Didactic Room NG-24, Marconi Building

Date:

Location	Reading ($\mu\text{Sv/hr}$)
Background reading in Lab	
X-Ray on. 35Kv, emission 1mA. Reading directly in front of tube	
Reading directly in front of sample change door (lead window)	
Interlock activated: scan stops. Reading directly in front of tube	
Sample change door closed: in standby mode	
Activate scan	

Signed by RPO

Michael Burke

Appendix 8

List of Transporters approved for Radioactive Sources

1. Agility Logistics Ltd.

Address: M1 Furry Park Industrial Estate, Santry, Dublin 9

Phone: 01-8667400/ 0872348126

E-mail: vvargas@agility.com

Contact: Mr Victor Vargas

2. DHL Global Forwarding (Ireland) Limited

Address: Unit F & G, Furry Park Industrial Estate, Santry, Dublin 9

Phone: 01-8161275

E-mail: Sharon.Hayden@dhl.com

Contact: Ms Sharon Hayden

3. Geodis (Ireland) Ltd.

Address: Damastown Industrial Park, Mulhuddart, Dublin 15

<http://www.geodis.ie/contact-@/en/view-10296-article.html/6303>

or P.O Box 92, Coronation Road, High Wycombe, Bucks, HP12 3TW, Eng

4. Hazmat Logistics Ltd.

Address: The Black Church, St. Mary's Place, Dublin 7

Phone:

E-mail: brendan.boucher@hazmatlogistics.co.uk

Contact: Mr Brendan Boucher

5. High Technology Sources Limited.

Address: C/O Casey & McGrath, 6 Northbrook Road, Dublin 6 and Unit 6 Moorbrook,
Southmead Industrial Estate, Didcot, Oxfordshire, OX 11 7HP, UK.

Phone: 0044 1235 514 202

E-mail: Jon@hightechsource.co.uk

Contact: Mr Jon Benn

6. Montgomery Transport (Ireland) Limited

Address: Bond Road, Dublin 3

Phone:

E-mail: naylward@montgomery-transport.com

Contact: Mr Neil Aylward

7. Mr Joe McMahon t/a J&A Transport

Address: Eagles Rest, Crunkill, Roosky, Co Roscommon

Phone: 087-2873388

E-mail: j.mcmahon@ymail.com

Contact: Mr Joe McMahon

8. Perlamar Limited

Address: Unit 43, Newtown Business Enterprise Centre, Newtownmountkenny, Co.
Wicklow

Phone: 01-2853659

E-mail: andy@perlamar.ie Contact: Mr Andrew Martindale

Appendix 9

Radiation Safety Protocol

Niton XL3t-900

X-Ray Fluorescence Analyser

Radiation Protection Officer:

Michael Burke Ext. 5110 michael.burke@dcu.ie

Technical Officer:

Úna Prendergast Ext. 6296 una.prendergast@dcu.ie

PURPOSE

The purpose of this protocol is to define the requirements and standards for the safe use of the Niton XRF hand held instrument. This safety procedure is provided in accordance with the requirements of the Radiological Protection Act 1991 (Ionising Radiation) Regulations 2019, SI.30 of 2019 and strict adherence to the rules is a legal requirement.

This safety protocol should be read in conjunction with the relevant licence conditions in the Authorisation issued by the Environmental Protection Agency – Office of Radiological Protection (EPA-ORP).

The main purpose of this Radiation Safety Protocol is to ensure the protection of workers and the public against the danger of radiation associated with the storage, transport and use of the Niton XRF equipment.

GLOSSARY

RPO - Radiation Protection Officer

TLD - Thermoluminescent Dosimeter (measures ionizing radiation exposure)

XRF - X-Ray Fluorescence Spectrometer

TECHNICAL DESCRIPTION OF THE LICENCED ITEM

Equipment Type: Niton XL3t-900 XRF analyser. The Niton XL3t X-Ray Inspection system is a portable, hand held XRF analyser (which will only be used in the test stand).

Equipment Location: The equipment will be stored in a locked transport case, in an interlocked room (GAG 02C – NRF Building) when it is not in use. It will not be taken off site.

TRAINING

X-ray equipment may only be used by those authorised employees who have received appropriate training and evaluation and are familiar with these Radiation Safety Procedures. The responsible person (Technical Officer – Úna Prendergast) and users of the Niton X-ray equipment are required to attend relevant training and refresher training every 3 to 5 years. A record will be maintained of training provided.

DUTIES OF ALL PERSONS USING THE EQUIPMENT

The duties of all users of the Niton XL3 XRF equipment are as follows:

- Examine the general condition of the x-ray unit and its transport case.
- Ensure that all interlocks and warning lights function correctly.
- If any remedial action is necessary; contact a technical officer (Úna Prendergast).
- To immediately report any radiation safety incidents to the technical officer who will then report to the RPO (Michael Burke ext: 5110 email: michael.burke@dcu.ie)

The duties of the Responsible Person (Technical Officer) in charge of the Niton XL3 XRF are as follows:

- Ensure that appropriate warning signage is displayed on the instrument and that this Radiation Safety Procedure is available in GAG02C.
- Take any remedial action that is necessary; and keep a record of all checks and remedial action taken. Records are kept in folder shared with RPO (Michael Burke)
- To immediately report any radiation safety incidents to the RPO (Michael Burke).
- Ensure that any maintenance or servicing necessary to ensure the safe operation of the hand held XRF under his supervision is undertaken as required and that a record of all such servicing / maintenance is kept. Records are kept in folder shared with RPO.
- That all the operators of the XRF equipment have been correctly trained in the safe use of the equipment, to record same to the shared folder with RPO.
- Ensure that a register is kept of authorised and trained users of the equipment and that only authorised users use the equipment.
- Ensure that the radiation safety procedures and EPA-ORP licence conditions are complied with.

SAFETY PROCEDURES FOR THE USE OF THE NITON XRF EQUIPMENT

- The XRF equipment may only be used by those authorised employees who have received appropriate training and evaluation and are familiar with this Radiation Safety Procedure.
- Under no circumstances is the XRF equipment to be loaned, hired or permitted to be operated by any other organisation, employer or person without the prior approval of the Radiological Protection Officer (RPO), the Radiation Protection Advisor (RPA) and the Environmental Protection Agency - Office of Radiological Protection (EPA-ORP).
- The XRF equipment should never be taken off site or removed from its current location in GAG02C.

- The XRF equipment should only be used in the test stand.
- As an added precaution, a room TLD badge will be used to monitor radiation doses. The RPO will maintain dosimetry records for a minimum of 5 years where such dosimetry is undertaken.

Radiation Dose & Designated Areas

- If used correctly the effective whole-body radiation dose from scattered X-rays will not exceed background radiation levels. There is therefore no need to designate work areas as 'Controlled' or 'Supervised' areas.
- The operator must ensure that the XRF equipment is always attended when in use and that other persons are kept away from the equipment when in use.

Storage & Transport of the Hand Held XRF Equipment

- When not in use, the XRF unit will be stored in its locked transport case in an interlocked room (GAG02C) on site.
- The door of GAG02C will have a radiation trefoil sign affixed to it. The transport case will have a notice stating: "This contains portable X-Ray equipment for use by authorised personnel only. It must not be moved from this area without the prior permission of the RPO. Instrument may only be used by the listed authorised personnel."
- The XRF equipment must be stored and transported with the battery pack removed from it.
- It is extremely important to avoid the possibility of theft of the XRF unit or of an on-site vehicle containing it. The vehicle should never be left unattended or out of sight except for short periods in cases of genuine necessity, in which case the driver must check that all doors are locked, and windows shut.
- In the event of a minor accident it may be obvious that the unit is undamaged. However, if the probe unit is damaged the emergency procedures detailed below must be implemented.

Safe Use of the handheld XRF Equipment

- Only authorised persons working in compliance with this Radiation Safety Procedure may use the XRF equipment.
- The Pin Number required to operate the equipment must not be 4 consecutive numbers and must not be similar to any other pin number used universally on site. The pin number must not be written on the instrument or case or on any documentation within the storage area. The pin number must not be given to unauthorised users.
- The battery pack should be removed from the unit when it is not in use.
- The unit must not be used if any of the safety features are not working (e.g. warning lights, password protection or any selected interlock settings). The Technical Officer and RPO must be informed if the unit is faulty to ensure the unit is repaired before being used again.
- When out of its carrying case, the unit must always be carried carefully. If dropped the probe unit containing the x-ray tube may be damaged. It is strongly recommended that the holster provided is used for carrying this equipment.
- When XRF analysis work is undertaken, the work area must be under constant visual supervision by the operator. If any unauthorised persons enter the work area, the operator should stop the measurement and ensure the unit x-rays are not on. If this is not possible then remove the battery pack.
- The probe unit must only be used in the test stand. NEVER be pointed at or held up against any person. KEEP YOUR FINGERS OR ANY PART OF YOUR BODY WELL AWAY FROM THE FRONT OF THE UNIT WHILST THE UNIT IS BEING USED. The dose rates in contact with the aperture at the front of the unit may exceed 1000 mSv per hour when the x-rays are on.
- The X-Ray test stand must always be used to ensure radiation safety.
- A TLD badge will be used to monitor radiation doses in the room. The RPO will maintain dosimetry records for a minimum of 5 years where such dosimetry is undertaken.

Maintenance of the XRF Equipment

- Maintenance will be carried out as necessary and as required (once annually) by the manufacturers.
- A record will be kept by the Technical officer and the RPO (in a shared folder) of all maintenance and servicing operations undertaken on the XRF Equipment.

Contingency Plans for Accidents or Incidents

The following procedures must be initiated by the unit operator in the event of the following accidents:

- **Exposure not terminating:**
 - Should the x-rays not turn off when the trigger is released then immediately remove the battery pack.
 - Do not use the XRF unit until it has undergone a full safety check, a cause has been found and rectified.

- **Theft or loss of the equipment:**
 - The RPO must be consulted as soon as it is suspected that the unit has been lost or stolen and an immediate search must be started.
 - The RPA and the EPA-ORP should also be notified, and if theft is suspected the Gardai must be notified.

- **Any damage to the XRF unit, including fire or mechanical damage:**
 - In the event of physical damage to the unit, leakage of x-rays may occur, even if no damage is apparent on visual inspection.
 - If mechanical damage is suspected, or the equipment has been involved in a fire, it should not be used until a safety check has confirmed that it is safe for use.

- **Over exposures:**
 - If the TLD return shows an over exposure or it is suspected or known that an employee has received an overexposure to ionising radiation, then they must immediately inform the RPO who will carry out an investigation to ascertain whether an overexposure has occurred.
 - If it is confirmed that an overexposure has occurred, the RPO will make a detailed record of that investigation, must notify the EPA-ORP and should contact the Radiation Protection Advisor for further advice.

- **Formal investigation level:**
 - If it is believed that any employee may have received an effective dose of ionising radiation that exceeds 1 mSv within a calendar year, the RPO shall carry out a formal investigation, in consultation with the RPA.

Appendix 10

Risk Assessments

Page	Content
56	Risk Matrix Applied in preparation of Risk Assessments
57	Training
58	Acquiring a new Radioactive Source
59	Jordan Valley Bede D1 X-Ray, S-124
60	Sealed Radioactive Sources, NG-13
61	Leybold Didactic X-Ray, NG-24
62	Leybold Didactic Rutherford Scattering apparatus, NG-03
63	Niton XL 900 XRF
64	Bruker AXS D8 X-Ray, S-124

Risk Matrix Applied in preparation of Risk Assessments

		Severity of the potential injury or damage								
		1 Minor First Aid, insignificant damage to property and or equipment	2 Minor Injury (< 3 days), slight damage to property and or equipment	3 Serious Injury/ ill health (>3 days), limited damage to property and or equipment	4 Major injury/ ill health, critical damage to property and or equipment	5 Fatal, catastrophic loss of business				
0-3 Low risk 4-12 Medium risk 13-25 High risk							Likelihood		Severity	
Likelihood of the hazard occurring	5 Certain	5	10	15	20	25	5	Certain it will happen	5	Fatal: work related death. Loss of business.
	4 very likely	4	8	12	16	20	4	Very likely to occur in normal conditions	4	Major injury/ill health: including fractures, amputations, loss of sight, a burn or penetrating injury to the eye, any injury or acute illness resulting in unconsciousness, requiring resuscitation or requiring admittance to hospital for more than 24 hrs. Critical damage to property and or equipment.
	3 Likely	3	6	9	12	15	3	Likely to occur if individual is inattentive, untrained or if equipment is not maintained	3	Serious Injury/ill health: where the person affected is unfit to carry out his or her normal work for more than 3 consecutive days. Limited damage to property and or equipment.
	2 Abnormal conditions	2	4	6	8	10	2	Only Likely in abnormal conditions	2	Minor injury: all other injuries, where the injured person is unfit for his or her normal work for less than 3 days. Slight damage to property and or equipment.
	1 Very unlikely	1	2	3	4	5	1	Very unlikely, only in extreme conditions	1	Minor First Aid event: eg. Minor abrasions/cuts/bumps. Insignificant damage to property and or equipment.
Risk Level		recommended action								
Low		Maintain existing control measures, managed by documented routine procedures								
Medium		The proposed activity can only proceed provided that: (i) the risk level has been reduced to ALARP/ALARA using the hierarchy of risk controls; (ii) the risk controls must include those identified in legislation, standards, Codes of Practice etc. (iii) the risk assessment has been reviewed and approved by the supervisor and (iv) a safe working procedure or Safe Work Method has been prepared (v) the supervisor must review and document the effectiveness of the implemented risk control measures								
High		The proposed task or process activity must not proceed. Steps must be taken to lower the risk level to ALARP/ALARA using the hierarchy of risk controls.								

DCU Health and Safety Office													
Hazard Identification and Risk Assessment Template Rev 01 Rev date 05012018													
										Prepared by:	M. Burke RPO	Date:	27th March 2018
Training												Review date:	27th Sept 2019
Who is affected by the Hazard: Staff, Research Student, Visitor													
Hazards	Is the Hazard present? Y/N	What is the risk?	Risk Rating -prior to having controls in place H= high M=Medium L= Low	Controls - Controls in place to reduce risks	Is the control in place? Y/N	Likelihood	Severity	Risk Rating (L x S)	L/M/H	Control measure implementation - Person/Office/Unit/D ept. responsible?	Approved by RPO		
Use of Radiation sources	Y	Untrained Person - risk of exposure	H	Radiation Safety carried out by RPO to all researchers during Safelab Module 2	Y	1	3	3	L	Mr. Michael Burke	Mr. Michael Burke		
			H	Records of training maintained	Y					Mr. Michael Burke	Mr. Michael Burke		
			H	RPA appointed and appropriately trained	Y					Mr. Michael Burke	Mr. Michael Burke		
			H	Only trained personel permitted to create procedures.	Y					Mr. Michael Burke	Mr. Michael Burke		
			H	All Radiation safety procedures approved by the Radiation Protection Officer	Y					Mr. Michael Burke	Mr. Michael Burke		
			H	Training for responsible persons (responsible for irradiating and sealed sources) carried out by RPA, Dr. Elaine Doorly and records maintained	Y					Mr. Michael Burke	Mr. Michael Burke		

DCU Health and Safety Office												
Hazard Identification and Risk Assessment Template Rev 01												
Purchasing Control												
						Prepared by:		M. Burke RPO		Date:		27th March 2018
										Review date:		27th Sept 2019
Who is affected by the Hazard: Staff, Research Student												
Hazards	Is the Hazard present? Y/N	What is the risk?	Risk Rating -prior to having controls in place H= high M=Medium L= Low	Controls - Controls in place to reduce risks	Is the control in place? Y/N	Likelihood	Severity	Risk Rating (L x S)	L/M/H	Control measure implementation - Person/Office/Unit/D ept. responsible?	Approved by RPO	
Acquiring a new Radioactive Source	Y	Uncontrolled source in Use	H	Procedure for acquiring new sources in place which clearly defines responsibilities and flows (Standard Operating Procedure for acquiring a new radioactive source SOP_01). On shared Google drive	Y	1	2	2	L	Mr. Michael Burke	Mr. Michael Burke	
			H	System in place to ensure all requests for purchase approved by Radiation Protection Officer	Y					Mr. Michael Burke	Mr. Michael Burke	
			H	Procedure clearly identifies process for notification and approval by the Office of Radiological Protection - Environmental Protection Agency	Y					Mr. Michael Burke	Mr. Michael Burke	
			H	Checks are in place to ensure Irradiating apparatus is only acquired from a supplier who holds a valid licence from the Agency for the distribution of such irradiating apparatus, or alternatively from another source with the prior approval of the Agency.	Y					Mr. Michael Burke	Mr. Michael Burke	
			H	The procedure clearly defines that in the case of licensed items intended for medical radiological procedures, the licensee shall ensure that the RPA has commissioned, and is satisfied with the performance of the equipment and that written evidence of this has been forwarded to the Agency prior to it being used on patients.	Y					Mr. Michael Burke	Mr. Michael Burke	
			H	For Irradiating apparatus, imaging devices, counting equipment and any other equipment, the performance of which may influence doses, shall be subject to appropriate quality assurance as drawn up by the RPA. This testing will form part of the commissioning procedure for all newly installed equipment.	Y					Mr. Michael Burke	Mr. Michael Burke	
			H	Prior to the acquisition of sealed radioactive sources, the procedure clearly states that written agreement should be obtained from the supplier that each radioactive source will be accepted back by the supplier when no longer required.	Y					Mr. Michael Burke	Mr. Michael Burke	
			H	Only trained personnel permitted to purchase radiation sources	Y					Mr. Michael Burke	Mr. Michael Burke	
			H	Up to date MSDS available and reviewed prior to purchase	Y					Mr. Michael Burke	Mr. Michael Burke	
			H	All Radiation safety procedures for new source documented and approved by the Radiation Protection Advisor	Y					Mr. Michael Burke	Mr. Michael Burke	
			H	Emergency intervention plan in place prior to use of source and approved by the Radiation Protection Officer	Y					Mr. Michael Burke	Mr. Michael Burke	

DCU Health and Safety Office											
Hazard Identification and Risk Assessment Template Rev 01 Rev date 05012018						Prepared by:		Date:			
Jordan Valley Bede D1 High Resolution X-Ray Diffractometer						M. Burke RPA		27th March 2018			
								Review date: 27th Sept 2019			
Who is affected by the Hazard: Staff, Research Students, Visitor											
Hazards	Is the Hazard present? Y/N	What is the risk?	Risk Rating -prior to having controls in place H= high M=Medium L= Low	Controls - Controls in place to reduce risks	Is the control in place? Y/N	Likelihood	Severity	Risk Rating (L x S)	L/M/H	Control measure implementation - Person/Office/Unit/ Dept. responsible?	Approved by RPO
Exposure to ionising radiation from X-Ray source.	Y	Unauthorised access to the room	M	Access to the front-lab only by authorized swipe card. S124 has a swipe card access system restricted to users and technical staff.	Y	1	3	3	L	Mr. Billy Roarty	Mr. Michael Burke
			M	Instrument time is booked by an on-line booking system.	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	A Log Book is maintained in the vicinity of the instrument and users are asked to note the time spent using the instrument and any issues that arise.	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	The tool undergoes annual routine maintenance, including a certified radiation check. The last such check was completed on 7-8/2/2017. The instrument is also inspected annually by DCU's RPA.	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	Equipment operated by trained personnel only.	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	Radiation warning sign on the door of S124 and a copy of the EPA Licence is present at the lab entrance door	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	A sign shall be displayed at appropriate locations advising female patients, prior to undergoing radiological examination, to declare their known or suspected pregnancy.	Y					Mr. Billy Roarty	Mr. Michael Burke
Exposure to ionising radiation from X-Ray source.	Y	Risk of fire	L	List of sealed sources and location sent to Chief Fire Officer.	Y	1	2	2	L	Mr. Michael Burke	Mr. Michael Burke
				Building has designated fire wardens	Y					Mr. Philip Daughen Fire Safety Officer	Mr. Michael Burke
				Annual fire drills carried out to ensure an efficient evacuation of the building	Y					Ms. Paula Kierans H&S Manager	Mr. Michael Burke

DCU Health and Safety Office											
Hazard Identification and Risk Assessment Template Rev 01 Rev date 05012018						Prepared by: M. Burke RPA		Date: 27th March 2018			
Sealed Radioactive Sources in NG-13 Physics Teaching Laboratory								Review date: 27th Sept 2019			
Who is affected by the Hazard: Staff, Student, Visitor											
Hazards	Is the Hazard present? Y/N	What is the risk?	Risk Rating -prior to having controls in place H= high M=Medium L= Low	Controls - Controls in place to reduce risks	Is the control in place? Y/N	Likelihood	Severity	Risk Rating (L x S)	I/M/H	Control measure implementation - Person/Office/Unit/ Dept. responsible?	Approved by RPO
Exposure to Ionising radiation (external and internal). Radioactive sources comprising of activity sealed in plastic disks or in steel cups: Barium-133, Cadmium-109, Caesium-137, Caesium-137/ Zinc-65, Cobalt-57, Cobalt-60, Manganese-54, Sodium-22 (37kBq each) Nickel-63 (370MBq) Radium-226 (185kBq) Caesium-137/ Ba-137m (370kBq) Strontium-90, Sodium-22, Americium-241, Cobalt-60 (74kBq ea) Caesium-137, Strontium-90, Americium-241 (342kBq) Note: The exposure time req'd to receive 1mSv @ 1m for Radionuclide with highest external dose rate (mSv/h), Sr-90, is 1400 hours. Example: Sr-90 (Activity = 74 kBq) From Safety Data Sheet, dose rate @1m (mSv/h/GBq) = 9.65 therefore, (9.65 x 74)/1 x 10 ⁶ = 7.141 x 10 ⁻⁴ mSv/h therefore, in order to receive a dose of 1mSv would require 1400 hours exposure @ 1m (1/7.141 x 10 ⁻⁴) (See "Table of Activities, dose rates, etc" in next worksheet)	Y	Risk of External exposure from sources.	M	Sources stored at all times in a lead lined secure store in NG-13, Marconi building. Only removed when required by Senior Technical Officer so minimal amount of handling by students.	Y					Mr. Henry Barry	Mr. Michael Burke
			M	Sources wipe tested for leakage every 2 years. Certificate uploaded to shared Google drive and EDEN.	Y	1	2	2	L	Mr. Henry Barry	Mr. Michael Burke
			M	Sources handled with a tongs and gloves worn to maintain a safe distance from user.	Y					Mr. Henry Barry	Mr. Michael Burke
As above	Y	Risk of Internal (ingestion/ inhalation) exposure from sources	L	Sources are only removed from the store in advance of a practical and students have supervised access to sources	Y	1	2	2	L	Mr. Henry Barry	Mr. Michael Burke
As above	Y	Theft or loss of sources which could put the public at risk.	L	All sealed sources stored in a locked lead lined safe in NG-13. Students do not have access to this store. Key held by a member of technical staff.	Y	1	2	2	L	Mr. Henry Barry	Mr. Michael Burke
				A record, both electronic and hard copy are maintained everytime a sealed source is removed and returned to the store.	Y					Mr. Henry Barry	Mr. Michael Burke
As above	Y	Risk of fire	L	List of sealed sources and location sent to Chief Fire Officer.	Y	1	3	3	L	Mr. Michael Burke	Mr. Michael Burke
				Building has designated fire wardens	Y					Mr. Philip Daughen Fire Safety Officer	Mr. Michael Burke
				Annual fire drills carried out to ensure an efficient evacuation of the building	Y					Ms. Paula Kierans H&S Officer	Mr. Michael Burke

DCU Health and Safety Office											
Hazard Identification and Risk Assessment Template Rev 01 Rev date 05012018						Prepared by: M.Burke RPO		Date: 27th March 2018			
Leibold Didactic Model 55481								Review date: 27th Sept 2019			
Who is affected by the Hazard: Staff, Students											
Hazards	Is the Hazard present? Y/N	What is the risk?	Risk Rating - prior to having controls in place H= high M=Medium L= Low	Controls - Controls in place to reduce risks	Is the control in place? Y/N	Likelihood	Severity	Risk Rating (L x S)	L/M/H	Control measure implementation - Person/Office/Unit/Dept. responsible?	Approved by RPO
Exposure to ionising radiation from X-Ray source.	Y	Risk of exposure to students	L	Instrument checked in advance of experiment by technical officer	Y	1	2	2	L	Mr Henry Barry	Mr. Michael Burke
		Risk of safety features not working	L	Yearly audit carried out by RPA	Y					Mr Henry Barry	Mr. Michael Burke
		Risk of safety features not working	L	Yearly check carried out by RPO. Readings taken directly in front of tube (35Kv @ 1mA= 0.14uS/hr); interlocks checked to ensure scan stops when activated.	Y					Mr Henry Barry	Mr. Michael Burke
		Risk of unauthorised access by students	L	Students can only operate instrument under the guidance of a staff member	Y					Mr Henry Barry	Mr. Michael Burke
		Risk of safety features not working	L	Instrument is fully protected with interlocks and leaded glass windows	Y					Mr Henry Barry	Mr. Michael Burke
		Risk of safety features not working	L	Radiation warning sign on the door of NG-24: Copy of the EPA Licence is present inside the laboratory entrance	Y					Mr Henry Barry	Mr. Michael Burke
Exposure to ionising radiation from X-Ray source.	Y	Risk of fire	L	List of sealed sources and location sent to Chief Fire Officer.	Y	1	2	2	L	Mr. Michael Burke	Mr. Michael Burke
				Building has designated fire wardens	Y					Mr. Philip Daughen Fire Safety Officer	Mr. Michael Burke
				Annual fire drills carried out to ensure an efficient evacuation of the building	Y					Ms. Paula Kierans H&S Manager	Mr. Michael Burke

DCU Health and Safety Office											
Hazard Identification and Risk Assessment Template Rev 01 Rev date 05012018						Prepared by: M. Burke RPA		Date: 5th March 2019			
Leybold Didactic: Rutherford Scattering Apparatus - (Am-241 source)						Review date:5/3/20					
Who is affected by the Hazard: Staff, Student, Visitor											
Hazards	Is the Hazard present? Y/N	What is the risk?	Risk Rating -prior to having controls in place H= high M=Medium L= Low	Controls - Controls in place to reduce risks	Is the control in place? Y/N	Likelihood	Severity	Risk Rating (L x S)	L/M/H	Control measure implementation - Person/Office/Unit/ Dept. responsible?	Approved by RPO
Exposure to Ionising radiation (external and internal). Am-241 (330kBq) Note: The exposure time req'd to receive 1mSv @ 1m for external dose rate (mSv/h), Am-241 330kBq, is 3.6 x 10 ⁴ hours. Example:Am-241 (Activity = 330 kBq) From Safety Data Sheet, dose rate @1m (mSv/h/GBq) = 0.085; therefore, (0.085 x 330)/1 x 10 ⁶ = 2.81 x 10 ⁻⁵ mSv/h therefore, in order to receive a dose of 1mSv would require 3.6 x 10 ⁴ hours exposure @ 1m (1/2.81 x 10 ⁻⁵)	Y	Risk of External exposure from sources.	M	Source contained within equipment and located in NG-03, Marconi building. Experiment setup by experienced technical officer and students provided with training and SOP for experiment. Student DO NOT handle the source	Y	1	2	2	L	Mr. Alan Hughes	Mr. Michael Burke
			M	Sources wipe tested for leakage every 2 years. Certificate uploaded to shared Google drive and EDEN.	Y					Mr. Alan Hughes	Mr. Michael Burke
			M	The equipment will be included as part of DCU dosimetry service (area monitor) with Landauer Europe on a monthly basis initially and reviewed after 12 months.	N					Mr. Alan Hughes	Mr. Michael Burke
			M	Source will be transferred to lead safe in NG-13 when apparatus not in use.	Y					Mr. Alan Hughes	Mr. Michael Burke
Exposure to Ionising radiation	Y	Risk of Internal (ingestion/ inhalation) exposure from sources	L	Sources are only removed from the store in advance of a practical and students have supervised access to the apparatus	Y	1	2	2	L	Mr. Alan Hughes	Mr. Michael Burke
Exposure to Ionising radiation	Y	Theft or loss of sources which could put the public at risk.	L	All sealed sources stored in a locked lead lined safe in NG-13. Students do not have access to this store. Key held by a member of technical staff.	Y	1	2	2	L	Mr. Alan Hughes	Mr. Michael Burke
				A record, both electronic and hard copy are maintained everytime a sealed source is removed and returned to the store.	Y					Mr. Alan Hughes	Mr. Michael Burke
Exposure to Ionising radiation	Y	Risk of fire	L	List of sealed sources and location sent to Chief Fire Officer.	Y	1	3	3	L	Mr. Michael Burke	Mr. Michael Burke
				Building has designated fire wardens	Y					Mr. Philip Daughen Fire Safety Officer	Mr. Michael Burke
				Annual fire drills carried out to ensure an efficient evacuation of the building	Y					Ms. Paula Kierans H&S Officer	Mr. Michael Burke

DCU Health and Safety Office											
Hazard Identification and Risk Assessment Template Rev 01 Rev date 05012018						Prepared by: M.Burke RPO		Date: 8th May 2019			
Niton XL 900 XRF						Review date:					
Who is affected by the Hazard: Staff, Students											
Hazards	Is the Hazard present? Y/N	What is the risk?	Risk Rating -prior to having controls in place H= high M=Medium L= Low	Controls - Controls in place to reduce risks	Is the control in place? Y/N	Likelihood	Severity	Risk Rating (L x S)	L/M/H	Control measure implementation - Person/Office/Unit /Dept. responsible?	Approved by RPO
Exposure to ionising radiation from X-Ray source.	Y	Risk of exposure to users	M	Instrument is only used by trained and approved users. Copy of the RSP provided to the user in advance of operation Experimental setup is checked by the technical officer prior to use Instrument has automatic shutoff if improper or no sample present and this minimises exposure. Close supervision of the work area in front of x-ray aperture when in use Warning lights are in place on the instrument indicating when X-rays are being generated. During use of the XRF device a controlled area shall be set up such that persons in the working area are kept at a minimum of 1 metre from the equipment. On no occasion shall anyone enter the area in front of the analyser (within 1m to either side) whilst it is in use. The unit can only be used when mounted and must never be used in the hand-held mode. This controlled area will continue to exist until the unit is disconnected from the battery pack. The controlled area must be under constant visual supervision by the operator. If any un-authorised persons enter the controlled area, the operator should stop the measurement and ensure the unit x-rays are not on. Instrument is used in accordance with radiation safety procedures. Additional Safety Protocols provided in the RSP	Y	1	3	3	L	Dr. Una Prendergast	Mr. Michael Burke
		Risk of safety features not working	L	Yearly audit carried out by RPA/RPO. Annual Niton service contract. Multiple interlock systems built into the instrument. Dosimetry TLD badge to remain in the lab at all times and checked monthly	Y					Dr. Una Prendergast	Mr. Michael Burke
		Risk of unauthorised access	L	Building access is controlled. Room has keypad entry which is only given to approved users. Instrument is kept in a locked case. Instrument is password protected.	Y					Dr. Una Prendergast	Mr. Michael Burke
		Risk of safety features not working	L	Radiation warning sign on the door of GAG02C. Copy of the EPA Licence is present inside the laboratory entrance	Y					Dr. Una Prendergast	Mr. Michael Burke
Exposure to ionising radiation from X-Ray source.	Y	Risk of fire	L	Building has designated fire wardens	Y	1	3	3	L	Mr. Philip Daughen Fire Safety Officer	Mr. Michael Burke
				Annual fire drills carried out to ensure an efficient evacuation of the building	Y					Ms. Paula Kierans H&S Manager	Mr. Michael Burke

DCU Health and Safety Office											
Hazard Identification and Risk Assessment Template Rev 01 Rev date 05012018						Prepared by: M. Burke RPO		Date: 5th Nov 2019			
Bruker D8-Advance X-ray Diffractometer						Review date: 5th Nov 2020					
Who is affected by the Hazard: Staff, Research students, visitors											
Hazards	Is the Hazard present? Y/N	What is the risk?	Risk Rating -prior to having controls in place H= high M=Medium L= Low	Controls - Controls in place to reduce risks	Is the control in place? Y/N	Likelihood	Severity	Risk Rating (L x S)	L/M/H	Control measure implementation - Person/Office/Unit /Dept. responsible?	Approved by RPO
Risk of Exposure to ionising radiation	Y	Minor risk of X-Ray exposure if tool is being serviced and safety interlocks are disabled. Unauthorised access.	M	Access to the front-lab only by authorized swipe card. S124 has a swipe card access system restricted to users and technical staff. Instrument time is booked by an on-line booking system.	Y	1	3	3	L	Mr. Billy Roarty	Mr. Michael Burke
			M	A Log Book is maintained in the vicinity of the instrument and users are asked to note the time spent using the instrument and any issues that arise.	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	The tool undergoes annual routine maintenance, including a certified radiation check. The last such check was completed on 30/10/2019. The instrument is also inspected annually by an external radiation adviser.	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	Warning signs about 'radiation' on the door of S124 and a copy of the EPA Licence is present on the lab entrance door. Equipment operated by trained personnel only. Radiation Badge monitoring in place.	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	Equipment The tool undergoes annual routine maintenance, including a certified radiation check. The last such check was completed on 29-30/10/2019. The instrument is also inspected annually by an external radiation adviser.	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	The entire enclosure is interlocked so that the X-ray shutter cannot be opened with the chamber open. In emergency use the 'STOP' button.	Y					Mr. Billy Roarty	Mr. Michael Burke
			M	Before first use, all users of the D8 Diffractometer should be instructed in its use by an authorized trainer and/or mentor. Training is currently conducted by Dr. Barry O'Connell. All users must undertake training before getting access.	Y					Mr. Billy Roarty	Mr. Michael Burke
Risk of Exposure to ionising radiation	Y	Risk of fire	L	Building has designated fire wardens	Y	1	2	2	L	Ms. Paula Kierans H&S Manager	Mr. Michael Burke
				Annual fire drills carried out to ensure an efficient evacuation of the building	Y					1	2

Appendix 11

Check list for Radiation Sources

Sealed Sources

- Copy of Licence on public display (main door of lab on the outside)
- Copy of Radiation Safety Procedures available in hard copy in the lab
- Annual checks by RPO and RPA
- All sources stored in NG-13 safe when not in use.
- Log all entries of sources in log book.
- Induction for students before labs commence
- Wipe test all sources every 2 years (due Nov'19)
- Forceps used to handle sources (distance)
- Minimise the source contact time with staff/students (time)
- If acquiring new source:
 - Risk Assessment
 - Update RSP
 - Plan of the facility (check with RPO)
 - Take-back agreement with supplier
 - Valid wipe test certificate from supplier
 - Council regulation Euratom No. 1493/93 completed and stamped by EPA (check with RPO)

Irradiating Sources

(Applies to sources operating >30kV)

- Copy of Licence on public display (main door of lab on the outside)
- Copy of Radiation Safety Procedures available in hard copy in the lab
- Annual measurement checks by RPO and RPA
- Annual service where applicable and advised by supplier
- Maintain service history
- SOPs provided for users
- User log in place, preferably electronic
- Training records maintained
- If acquiring a new instrument:
 - Risk Assessment
 - Update RSP
 - Plan of the facility (check with RPO)
 - Training record of new users
 - Commissioning/ Installation report must be supplied to EPA before full approval issued (check with RPO)