University of
St Andrews

Risk Assessment No 5 - Risk assessment for the Consent for the Use of ELSEC Automatic Irradiators for Dosing Samples for TI and OSL Analysis.

Ionising Radiations Regulations 2017

Document type	**Procedure**
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RISK ASSESSMENT 5 – Use of ELSEC Automatic Irradiators for Dosing Samples for Tl and OSL Analysis - IRR 2017
Description of Work and Scope of the Assessment
Use of automatic irradiators for dosing samples for TL and OSL analysis
This risk assessment has been carried out in accordance with the Ionising Radiations Regulations 2017 (IRR17) Approved Code of Practice (ACoP). This risk assessment only addresses the radiological risks associated with the type of equipment detailed above.
Who is at risk?
The operator and other workers in the laboratory

ACoP Paragraph 70 - Matters to be considered in an assessment, where relevant
70(a) - Nature of the radiation sources likely to be present
ELSEC 1 (A Littlemore Scientific Engineering automatic irradiator): **$^{90}Sr/^{90}Y$, source strength 3.70GBq** ELSEC 2 (A Littlemore Scientific Engineering automatic irradiator): **^{241}Am, source strength 2mCi (0.074Gbq)**
70(b) - Estimated dose rates
External – external dose rate originates entirely from bremsstrahlung due to interaction of beta particles in the shielding materials.
70(c) - Likelihood of contamination arising and being spread
None
70(d) - Results of previous personal dosimetry and area monitoring
see appendix 1
70(e) - Advice from manufacturers or suppliers about safe use and maintenance of equipment
Only trained and experienced workers (or inexperienced workers under close personal supervision by an experienced trained worker) allowed into the area where this work is undertaken. The ELSEC irradiators should be positioned in such a way that the space underneath the reader is inaccessible.

All workers must wear a whole body dosimeter badge when entering this area.
70(f) - Engineering Controls, etc. In place or planned
The sources are contained within lead shielding. Samples are introduced for dosing via a sample tray. The sample door is narrow, so that fingers cannot accidently be placed under the source.
70(g) - Planned Systems of Work
Only trained and experienced workers (or inexperienced workers under close personal supervision by an experienced trained worker) allowed into the area where this work is undertaken. Local rules apply in the laboratory. See Appendix B In the event of malfunction of the irradiator, i.e. if the irradiator behaves unusually or there is any suggestion of improper operation, the user must stop using the equipment immediately, evacuate the immediate area and request the assistance of a qualified radiation expert with appropriate medical and dosimetric monitoring
70(h) - Estimated airborne and surface contamination levels
None
70(i) - Effectiveness and suitability of PPE
Laboratory coat
70(j) - Unrestricted access to high dose rates or significant contamination
Not allowed. Only trained and experienced workers (or inexperienced workers under close personal supervision by an experienced trained worker). All workers exit the room when ELSEC irradiators are running.
70(k) - Possible accident situations, their likelihood and severity
See Table 1
70(l) - Consequences of failure of Control Measures including Systems of Work
See Table 1
70(m) - Steps taken to prevent accidents, or limit their consequences
See Table 1.

TABLE 1: Personal

Step	Who is Affected	Hazard		Initial Risk			Controls	Residual Risk		
		Description	Effect	SF	FF	R	List of Controls Required	SF	FF	R
1	Instrument operator	External radiation dose from sealed 90Sr/90Y source within Elsec 1, or 241AM source within Elsec 2	Possibility of raising risk of some form of cancer.	2	2	4	The sources are well shielded within the Elsec irradiators. The Elsec irradiators have both hardware and software safety controls to prevent accidental activation of the source Strict adherence to Local Rules required to use Elsec irradiators Follow the ALARA-principle, which states that all doses shall be kept as low as reasonably achievable	2	1	2
2	Laboratory workers	External radiation dose from sealed 90Sr/90Y source within Elsec 1, or 241AM source	Possibility of raising risk of some form of cancer.	2	2	4	Only trained and experienced workers (or inexperienced workers under close personal supervision by an experienced trained worker)	2	1	2

		within Elsec 2								
3	Estates / Trades	External radiation dose from sealed 90Sr/90Y source within Elsec 1, or 241AM source within Elsec 2	Possibility of raising risk of some form of cancer.	2	2	4	Estates / Tradesmen only permitted access under close supervision by either the DRPS or LRPS	1	1	1
4	Administrative staff	External radiation dose from sealed 90Sr/90Y source within Elsec 1, or 241AM source	Possibility of raising risk of some form of cancer.	2	2	4	No need for administrative staff to access luminescence laboratories. Should access be required, it would only be permitted under close supervision by either the DRPS or LRPS	1	1	1

		within Elsec 2								
5	Cleaners	External radiation dose from sealed 90Sr/90Y source within Elsec 1, or 241AM source within Elsec 2	Possibility of raising risk of some form of cancer.	2	2	4	No cleaners are permitted access to the luminescence laboratories	1	1	1

Matrix of Risk Level					
Severity Factor (SF)					
Frequency Factor (FF)		Slightly Harmful (1)	Harmful (2)	Very Harmful (3)	Extremely Harmful (4)
	Very Unlikely (1)	1	2	3	4
	Unlikely (2)	2	4	6	8
	Possible (3)	3	6	9	12
	Probable (4)	4	8	12	16

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

<u>ACoP Paragraph 71 – Outcomes of the assessment</u>
71(a) - Actions taken to keep exposures ALARP
All users to be trained by DRPS and Lab-PI, Dr Tim Kinnaird or LPRS, Dr Aayush Srivastava
71(b) - What Engineering Controls, Warning Signals and other Safety Systems are necessary
Access to luminescence laboratories restricted to trained and experienced workers. The luminescence laboratories remained locked at all times: key holders are the DRPS and LPRS. A key is stored at reception for emergencies: either the DRPS or LPRS must be notified prior to access. All workers instructed on the Local Laboratory Rules.
71(c) - Whether PPE is appropriate and if so what type
Laboratory coat
71(d) - Dose Constraints
An investigation action level 0f 0.5 mSv/2 months has been adopted.
71(e) - Protection of female employees
No special protection required. A separate specialised risk assessment will be undertaken for each expectant mother who wishes to continue working with the Risø readers.
71(f) - Investigation levels
An investigation action level of 0.5 mSv/2 months has been adopted.
71(g) - Maintenance and testing schedules
There will be 2 yearly audit of premises

71(h) - Contingency Plans
As identified in Local Rules.
71(i) - Training needs
All workers must follow the Local Rules and have received specific induction training to the Elsec irradiators before use
71(j) - Designation of Controlled and Supervised Areas
The Risø Room (annex of room 207) is a Supervised Area
71(k) - Access restrictions and other precautions for designated areas
Access to the laboratories will be via a lock on the entrance to the room
71(l) - Designation of persons
Not required.
71(m) - Personal dosimetry
Whole body dosimeter badges issued to workers.

71(n) - Leak testing of radioactive sources
71(o) - Responsibilities of managers
Ensure that Local Rules are followed, and all staff are properly trained
71(p) – Monitoring / auditing program to ensure compliance with IRR77
URPA to audit operations every two years

Lead Assessor (sign): Tim Kinnaird, Lab PI and DRPS

Second Assessor (sign):

,
Dr Paul Szawlowski, University Radiation Protection Officer and Deputy Director of Environmental, Health and Safety Services (28/05/2021)

Date of Assessment: 12/07//2021

Appendix A: Elsec 1 wipe tests

A. Source Details		**C. Wipe Test Details**						
		Date	**Area Wipe Tested**	**Background Counts per Second**	**Counts per Second on wipe test**	**Monitor Used**	**Signs in place**	**Locking mechanism working (Y/N)**
Radionuclide	90Sr/90Y	**25/07/2008**	**Edge of source housing**	**10**	**10**	**L1210B**	**Yes**	**Yes**
Activity of Source on Arrival	3.7 GBq	**17/06/2010**	**Edge of Source Housing**	**10-12cps**	**10-12**	**Mini 900 44A Probe**	**Yes**	**Yes**
Source Serial Number		**30/07/2013**	**Edge of Source Housing**	**0.1 cps**	**0.1 cps**	**EP-15 Geiger Muller Probe- on a Mini 900**	**Yes**	**Yes**
Description of Equipment	Beta irradiator	**30/07/2013**	**Edge of Source Housing**	**10-15 cps**	**10-12 cps**	Mini monitor 900 with 44A Scintillation probe (Serial Number 3890)	**Yes**	**Yes**
Serial Number of Equipment	ELSEC 1	**17/11/2015**	**Edge of Source Housing**	**0.5 cps**	**0.5 cps**	Geiger Muller Probe- on a Mini 900 (serial number026998)	**Yes**	**Yes**
Location of Source	Room 207, Irvine Building	**17/11/2015**	**Edge of Source Housing**	**15 cps**	**15cps**	Mini monitor 900 with 44A Scintillation probe (Serial Number 3890)	**Yes**	**Yes**
Use	Luminesence measurement	**07/04/2021**	**Around source housing**	**3-4 cps**	**2 cps**	**Mini monitor with scintillation probe (serial number 027535**	**Yes**	**Yes**
Date of Arrival	31-01-1997	**07/04/2021**	**Around the Source Housing**	**0.5 cps**	**0.5 cps**	**Mini monitor with Geiger muller probe (serial number 040096)**	**Yes**	**Yes**
Vendor								
Risk Assessment details	GE 0701 & GE 0201							
B. Source Records								
RSA Registration Number	RSA/C/ 0070160							
First Wipe Test Date								
Vendor certificates Available								
Comments								

Appendix A contd: Elsec 2 wipe tests

A. Source Details		**C. Wipe Test Details**							
		Date	**Area Wipe Tested**	**Background Counts per minute**	**Counts per Minute on wipe test**	**Monitor Used**	**Signs in place**	**Locking mechanism working (Y/N)**
Radionuclide	241Am	**25/07/2008**	**Edge of source housing**	**10**	**12**	**L1210B**	**No**	**Yes**
Activity of Source on Arrival	6.734 MBq	**17/06/2010**	**Edge of Source housing**	**10-12**	**10-12**	**Mini 900 44A Probe**		**Yes**
Source Serial Number		**30/07/2013**	**Edge of Source Housing**	**0.1 cps**	**0.1 cps**	**EP-15 Geiger Muller Probe- on a Mini 900**	**No**	**Yes**
Description of Equipment	Alpha irradiator	**30/07/2013**	**Edge of Source Housing**	**8-15 cps**	**8-10 cps**	Mini monitor 900 with 44A Scintillation probe (Serial Number 3890)	**No**	**Yes**
Serial Number of Equipment	ELSEC 2	**17/11/2015**	**Edge of Source Housing**	**0.5 cps**	**0.5 cps**	EP-15 Geiger Muller Probe- on a Mini 900 (Serial Number 026998)	**No**	**Yes**
Location of Source	Room 207, Irvine Building	**17/11/2015**	**Edge of Source Housing**	**15 cps**	**15 cps**	Mini monitor 900 with 44A Scintillation probe (Serial Number 3890)	**Yes**	**Yes**
Use	Luminesence measurement	**07/04/2021**	**Around the source housing**	**2 cps**	**4 cps**	**Mini monitor scintillation probe (serial number 027535)**	**Yes**	**Yes**
Date of Arrival	31/1/1997	**07/04/2021**	**Around the source hosuing**	**0.5**	**0.5 cps**	**Mini monitor geiger muller probe (serial number 040096)**	**Yes**	**Yes**
Vendor								
Risk Assessment details	GE 0201							
B. Source Records								
RSA Registration Number	RSA/C/ 0070160							
First Wipe Test Date								
Vendor certificates Available								
Comments								

Appendix B: Use of automatic ELSEC irradiators for dosing samples for TL and OSL analysis.

This procedure describes use of automatic 241Am and 90Sr β-irradiators for dosing samples for thermoluminescence (TL) and optically stimulated luminescence analysis (OSL).

Irradiation of samples is necessary in luminescence dating. The luminescence behaviour of samples exposed to known doses can be compared to the initial behaviour of the same samples to obtain information about the original nature of the material in terms of stored dose, irradiation status, sensitivity etc. Irradiation can take place in either a β or a γ source to comply with validated and standard methods for luminescence dating.

Instrumentation. Two 9022 irradiator systems, manufactured by Littlemore Scientific Engineering (ELSEC), were commissioned in January 1997. Irradiator I is equipped with a 3.70GBq 90Sr β-source and Irradiator II with a 2miCi 241Am β-source. Decay corrections need to be applied regularly (e.g. every 6 months) using the 90Sr half-life of 29.12a.

Both irradiators are controlled by a single computer and interface unit, which can support up to 14 irradiators. Control software is supplied by the manufacturer. Samples are loaded on an aluminium tray with 64 (8x8) machined positions for 10mm sample discs, with a light tight screw down lid fitted with a rubber o-ring, for safe, dark transport. After irradiation, all samples should be handled under safelight conditions.

Methodology.

1.Control software. Control software has been loaded into the C:\IRRD directory on the control PC. Prior to starting a run, the computer time can be checked in the root directory. From within the IRRD directory, log files (see below) can be accessed and copied to disc. C:\IRRD\irrd starts the program.

2. Setup. After the program has been started, both irradiators automatically reset. This does not require the insertion of a sample tray to trigger the microswitches. They reset to the withdraw position (WD) which is between positions 4 and 5 on the tray and has been adjusted when the units were commissioned. Offsets to control the movement of the X-Y stage relative to the sample positions were checked in October 98. It should not be necessary to alter these.

Once both units have reset, it is possible to change the set-up; Alt-S accesses the set-up screens. The first screen details the number of irradiators installed, their source types, offsets etc. The only parameter on this screen which is likely to need alteration is the Jitter radius (see below). F3 leads to the second set-up screen, where the parameters likely to need alteration are the log file name (and path if desired) and the number of jitter steps. It is recommended that a unique log file name be generated for each irradiation. Ctrl-enter saves changes to the set-up.

3. Defining a run. Runs (saved as *.IRRD dose/time files) define the exposure received by each of the 64 positions on the plate. Runs can be defined either by dose (which requires a dose rate to have been entered at set-up) or by duration of exposure (any non-zero value overrides dose). Alt-E followed by paging down the list of existing runs to * NEW * prompts the user to create a name for a new run. The dose screen is then displayed; the user can enter a dose for each position required or press F3 for the duration of exposure screen where there are again 64 positions at which exposures can be entered. Exposures are timed to the nearest second up to a maximum of more than 1 year. Ctrl-

enter saves the new run. Existing runs can be edited with Alt-E. It should be noted that the layout of the screens (and the sample tray) is boustrophedon to reflect the motion of the X-Y stage.

4. Irradiating a sample tray. Once the control parameters have been set, irradiation can proceed. Discs should be loaded onto the tray to correspond with the run (or vice versa). If the timing of the irradiation is such that the plate is likely to remain in the unit for several hours before removal, it is best to avoid placing discs in positions 4 and 5, nearest to the WD position; there is some evidence of cross-talk. The tray should be inspected visually to ensure that all discs are well located in the recesses. Then the tray should be slid horizontally into the slot at the front of the unit, the flap should be closed and the clips secured.

The information screen, which displays information about irradiations in progress or recently completed, should be visible. If not, esc or ctrl-enter should return the user to this screen. Alt-N produces a query as to which irradiator is to start a new run; if one is already in use the other is chosen by default. When the irradiator has been chosen, a choice of starting sample is offered. When this has been selected, the list of runs is displayed and the appropriate one can be chosen. The information screen then indicates the name of the run, which irradiator is being used, and the total time to go for the run. This provides a useful check that the

durations have been entered correctly in the dose/time file. The screen also shows whether the stage is moving or whether it has reached the start position. The number and exposure time of the current sample are also displayed, together with status information. When the stage has reached the correct position for the start sample, the status line changes from MOVING to ARRIVED. An audible click indicates that the source has moved into position, the red light on the control unit is illuminated, and the status line changes to EXPOSING. Time to go for both the sample and the entire run can be seen to be counting down. At the end of exposure, there is another click, the red light is replaced by the amber MOVING light and the status line changes to MOVING. The cycle repeats itself the appropriate number of times.

At any time, a run can be aborted with Alt-A; this halts the irradiation immediately and returns the stage to the WD position. Alt-H halts the run at the end of the current exposure and returns to WD. After the last programmed exposure, the stage returns to WD. After any of these operations, the status line changes to FINISHED.

5. Jittering (Optional). The software incorporates a jittering function. Without jitter, dose at the centre of each disc is significantly greater than at the rim. Jittering aims to overcome this by positioning the source in a series of locations at the corners of polygons. The radius of the polygon and the number of sides can both be specified at set-up, subject to certain restrictions. The time spent at each vertex is equal to the total exposure time divided by the number of jitter steps. The quotient must be at least 10 seconds. Jitter radius must be less than the offsets. A jitter radius of 0 disables the function. If the number of steps is a factor of the total exposure, equal periods are spent at each position and the jittering functions as intended. If, however, there are surplus seconds, these are supposed to be added to the final period. It has been observed that this does not happen. The software is being edited by its author; in the interim it is probably best not to use jittering. If jittering is used, its progress can be monitored on the information screen.

Recording requirements. Use of the irradiations is automatically logged into log files, provided these are named at set-up. If no log file is named, the only information retained is the name of the run, number of the irradiator, time run started, its duration, and its FINISHED status. If a log file is named, that file contains information about the time of every operation except jittering; ie time set-up altered, time run started, time first sample started and finished, etc. Errors are also recorded. If a new log file is not specified for each run, the data are appended to the last named file, until this reaches the size specified at set-up. When this happens, the log file is renamed OLD.LOG, overwriting any existing file of that name and a new log file is started. Log files should be printed out for checking.

In addition to these log files, each irradiation should be documented in the irradiator day book. This should include the date, and the location of samples on the sample plate, as well as the exposure time and dose (calculated), whether there was jitter, and which unit was used, and by whom. Interruptions to runs should also be noted. The name of the log file used should also be documented. If the computer clock is checked, this should be noted.

Quality assurance considerations. Examination of the log files from each run, together with direct observation of the information screen if appropriate, provide some quality assurance. Calibration of the units was repeated in the summer of 1998 and could be repeated as needed. The use of standards is also being considered.

Safety assessments. The units contain radioactive sources. Standard practice should be followed at all times. The sources should not be tampered with. They should only be moved by a classified worker. It should not be necessary to move them during normal operation of the unit. Lead shielding is in place under the units. Any person using the irradiators should have only minimal exposure to radiation; nevertheless the use of a pocket dosimeter is recommended and finger dosimeters can also be worn during insertion and removal of the sample trays.

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