University of
St Andrews

Risk Assessment No 4 -
Risk Assessment for the Use of RISO DA-15 and DA-20 OSL

Ionising Radiations Regulations 2017

Document type	**Procedure**
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RISK ASSESSMENT 4 - Use of RISO DA-15 and DA-20 – IRR17
Location of Equipment (Building and Room Number)
Irvine Building - Room Number
Description of Work and Scope of the Assessment
Use of Risø DA-15 and DA-20 OSL/TL readers for luminescence measurements
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
Risø 1 (A Risø OSL/TL-DA-15 system (instrument no. 63), connected to a controller model DA-20): **^{90}Sr/^{90}Y, source strength 1.48GBq** Risø 2 (A Risø TL/OSL-DA-20 system (instrument no. 219), connected to a controller model DA-20): **^{90}Sr/^{90}Y, source strength 1.48GBq** Risø 3 (A Risø TL/OSL-DA-15 system (instrument no. 116), connected to a controller model DA-20): **^{90}Sr/^{90}Y, source strength 1.48GBq**
70(b) - Estimated dose rates
External – external dose rate originates entirely from bremsstrahlung due to interaction of beta particles in the shielding materials. When source is not activated, dose rate at distance of 1 m from the front of the Risø reader is <0.2µSv/h; when source is activated, dose rate is <0.3µSv/h. The dose rate directly on the surface of the irradiator is < 5µSv/h both when the source is activated and not activated. Further details in Appendix 1 Internal - dose rate to quartz at sample position is approximately 0.1 Gy/s.
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 Risø reader should be positioned in such a way that the space underneath the reader is inaccessible, and that the worker is prevented from using the space to the left of the reader.

All workers must wear a whole body dosimeter badge when entering this area.

70(f) - Engineering Controls, etc. In place or planned

The Risø irradiator is made of brass (outer diameter 10cm, height 9.5cm) and is surrounded by 20 mm of lead on the sides, and 40 mm on the top. An aluminium safety helmet (outer diameter 222 mm) covers the entire irradiator and lead shielding. The source is securely placed inside the irradiator, and backed by a 20 mm thick aluminium spacer, a 20 mm thick lead spacer, a spring washer, and final, 25 mm thick aluminium spacer (see Figure 8). The source is mounted inside a rotating aluminium wheel which is pneumatically activated. When the source is 'off' - the default position - it points directly upwards directly at a 10 mm thick carbon absorber (diameter 18.3 mm) completely covering the emitting surface. When the source is 'on' – the activated position - it points downwards towards the measurement chamber. A 0.125 mm beryllium window is located between the irradiator and the measurement chamber to act as vacuum interface for the measurement chamber.

Further safety controls:

Hardware: 1.) lid operation not possible when source is activated; 2.) source will not activate if lid is open, or partly open; 3.) if compressed air is not present, no software controlled irradiations are allowed

Software: 1.) disables irradiation if not gas supplied: this prevents the accidental activation of the source by a failed gas supply; 2.) if air supply valve fails such that compressed air is delivered directly to the actuator, the Controller recognises no request for irradiation was sent and sends deactivation command. In the second scenario the lid locks, and there is no danger to the operator.

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.

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 Risø readers 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 Appendix 2
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 Risø reader	Possibility of raising risk of some form of cancer.	2	2	4	The 90Sr/90Y sources are well shielded within the Risø readers The Risø readers have both hardware and software safety controls to prevent accidental activation of the source Strict adherence to Local Rules required use of Risø readers 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 Risø reader	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
3	Estates / Trades	External radiation dose from sealed 90Sr/90Y source within Risø reader	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 Risø reader	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

5	Cleaners	External radiation dose from sealed 90Sr/90Y source within Risø reader	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

ACoP Paragraph 71 – Outcomes of the assessment
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 Risø readers 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
The sources are leak tested at least every 2 years.
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

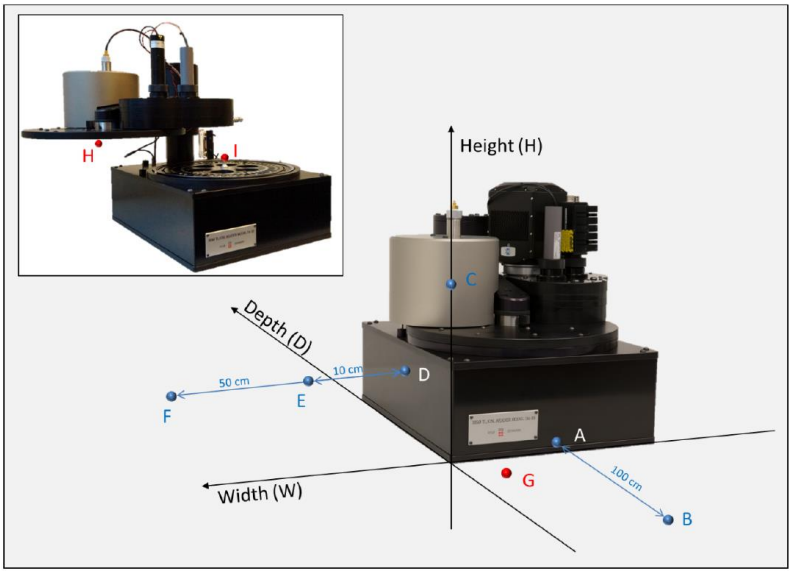
Lead Assessor (sign): Tim Kinnaird, Lab PI and DRPS

Second Assessor (sign):

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

Date of Assessment:

Appendix A: The Risø DA-15 and DA-20 OSL/TL reader



The Risø DA-15 and DA-20 OSL/TL reader, shown with the lid both open and closed. The figure shows the co-ordinates and positions of the external dose rate measurements listed below

1.48 GBq	(W , D , H)	On	Off		(W , D , H)	On	Off		(W , D , H)	On	Off
On/above safety helmet	(-13 , 19 , 22)	13	2	Left side	(0 , 35 , 18.5)	34	-	Left side	(25 , 25 , 0)	8	1
	(-13 , 19 , 26)	**4**	**2**		(0 , 40 , 18.5)	19	-		(30 , 25 , 0)	6	1
	(-13 , 19 , 29)	2	-		(0 , 45 , 18.5)	9	-		(35 , 25 , 0)	4	1
	(-13 , 19 , 33)	1	-		(0 , 5 , 6.5)	14	-		(40 , 25 , 0)	4	-
	(-13 , 22 , 34)	0.3	0.8		(0 , 10 , 6.5)	25	-		(60 , 25 , 0)	2	-
	(-13 , 22 , 39)	0.3	0.6		(0 , 15 , 6.5)	40	-		(80 , 25 , 0)	1	-
	(-13 , 22 , 44)	0.3	0.5		(0 , 20 , 6.5)	53	-		(5 , 25 , 12.5)	34	-
	(-13 , 22 , 54)	0.3	0.4		(0 , 25 , 6.5)	57	-		**(10 , 25 , 12.5)**	**17**	**3**
	(-13 , 22 , 61)	0.3	0.3		(0 , 30 , 6.5)	53	-		(15 , 25 , 12.5)	13	-
					(0 , 35 , 6.5)	40	-		(20 , 25 , 12.5)	10	-
Left side	(0 , 5 , 0)	16	-		(0 , 40 , 6.5)	27	-		(25 , 25 , 12.5)	7	-
	(0 , 10 , 0)	23	-		(0 , 45 , 6.5)	15	-		(30 , 25 , 12.5)	5	-
	(0 , 15 , 0)	32	-		(0 , 5 , 22)	4	-		(35 , 25 , 12.5)	4	-
	(0 , 20 , 0)	40	-		(0 , 10 , 22)	6	-		(40 , 25 , 12.5)	4	-
	(0 , 25 , 0)	43	2		(0 , 15 , 22)	9	-		**(50 , 25 , 12.5)**	**2**	**1**
	(0 , 30 , 0)	41	-		(0 , 20 , 22)	12	-		(60 , 25 , 12.5)	2	-
	(0 , 35 , 0)	30	-		(0 , 25 , 22)	17	-		(70 , 25 , 12.5)	1	-
	(0 , 40 , 0)	20	-		(0 , 30 , 22)	15	-		(80 , 25 , 12.5)	1	-
	(0 , 45 , 0)	13	-		(0 , 35 , 22)	12	-				
	(0 , 50 , 0)	9	-		(0 , 40 , 22)	10	-	Right side	(-39 , 25 , 0)	2	0.3
	(0 , 25 , 6.5)	57	3		(0 , 45 , 22)	6	-		(-44 , 25 , 0)	1.1	-
	(0 , 25 , 9.5)	76	4		(0 , 50 , 22)	5	-		(-49 , 25 , 0)	1.3	-
	(0 , 25 , 12.5)	**97**	**4**		(0 , 5 , 27)	3	-		(-59 , 25 , 0)	0.6	-
	(0 , 25 , 14)	84	-		(0 , 10 , 27)	3	-		(-69 , 25 , 0)	0.5	-
	(0 , 25 , 19)	71	-		(0 , 15 , 27)	4	-		(-79 , 25 , 0)	0.3	-
	(0 , 25 , 22)	17	-		(0 , 20 , 27)	4	-		(-89 , 25 , 0)	0.3	-
	(0 , 25 , 25)	7	2		(0 , 25 , 27)	4	-		(-99 , 25 , 0)	0.3	-
	(0 , 25 , 27)	4	-		(0 , 30 , 27)	5	-		(-139 , 25 , 0)	0.3	0.1
	(0 , 25 , 30)	3	2		(0 , 35 , 27)	5	-		(-39 , 25 , 8.3)	1.5	0.2
	(0 , 25 , 40)	0.6	0.3		(0 , 40 , 27)	4	-		(-89 , 25 , 8.3)	0.4	0.1
	(0 , 25 , 50)	0.5	0.3		(0 , 45 , 27)	3	-		(-139 , 25 , 8.3)	0.3	0.2
	(0 , 25 , 60)	0.5	0.3		(0 , 50 , 27)	3	-				
	(0 , 25 , 70)	0.5	0.3		(0 , 25 , 14)	84	-	Front side	**(-19 , 0 , 0)**	**9**	**0.3**
	(0 , 25 , 78)	0.4	0.3		(6.5 , 25 , 14)	28	-		(-19 , -25 , 0)	1.1	-
	(0 , 5 , 12.5)	9	-		(13 , 25 , 14)	14	-		(-19 , -50 , 0)	0.5	-
	(0 , 10 , 12.5)	20	-		(20 , 25 , 14)	9	-		(-19 , -75 , 0)	0.5	-
	(0 , 15 , 12.5)	40	-		(25 , 25 , 14)	6	-		**(-19 , -100 , 8.3)**	**0.3**	**0.1**
	(0 , 20 , 12.5)	73	-		(30 , 25 , 14)	5	-		(-19 , 0 , 8.3)	3	0.2
	(0 , 25 , 12.5)	97	4		(35 , 25 , 14)	4	-		(-19 , -25 , 8.3)	0.9	-
	(0 , 30 , 12.5)	74	-		(40 , 25 , 14)	3	-		(-19 , -50 , 8.3)	0.2	0.1
	(0 , 35 , 12.5)	29	-		(45 , 25 , 14)	3	-				
	(0 , 40 , 12.5)	20	-		(50 , 25 , 14)	2	-	Back side	(0 , -52 , 0)	7	-
	(0 , 45 , 12.5)	9	-		(55 , 25 , 14)	2	-		(-38 , -52 , 0)	3	-
	(0 , 5 , 18.5)	4	-		(60 , 25 , 14)	2	-				
	(0 , 10 , 18.5)	6	-		(70 , 25 , 14)	1	-	Under Table	**(-13 , 25 , -2.5)**	**40**	**3**
	(0 , 15 , 18.5)	15	-		(80 , 25 , 14)	1	-				
	(0 , 20 , 18.5)	50	-		(5 , 25 , 0)	31	2	Under Source*	**(4 , 50 , 27)**	**N/A**	**40**
	(0 , 25 , 18.5)	71	-		(10 , 25 , 0)	24	1				
	(0 , 30 , 18.5)	57	-		(15 , 25 , 0)	18	1	Hand position**	**(-20 , 20 , 20)**	**N/A**	**0.5**
					(20 , 25 , 0)	12	1				

External dose rate measurements in μSv/h for a 1.48Gbq $^{90}Sr/^{90}Y$ beta source loaded in the Risø beta irradiator. The position of each measurement is given in cm relative to the coordinate system shown above. 'On': the source is activated; 'Off' the source is inactivated (in safe position)

Appendix B:

Failures related to malfunctions and their consequences. Below, is a list of different failures related to possible malfunctions, the consequence, and solution.

1. The user attempts to open the lid during an irradiation

Consequence: The lid cannot open while an irradiation is in progress. When the irradiation command has been completed AND the source is in safe position, the lid will open. *Solution: Close the lid and restart the sequence*

2. The lid has not been closed completely

Consequence: An irradiation cannot be initiated unless the lid is completely closed. *Solution: Close the lid*

3. Loss of pneumatic air supply to the irradiator not during irradiation

Consequence: Next time the irradiation command is issued there will be insucient pressure to rotate the source. An error message will appear on the PC screen and the sequence stopped. *Solution: Restore the pneumatic air supply*

4. Loss of pneumatic air supply to the irradiator during irradiation

Consequence: The irradiator will automatically and immediately return to the 'off' (default) position. An error message will appear on the PC screen and the sequence stopped. *Solution: Restore the pneumatic air supply*

5. Loss of power to the Reader during irradiation

Consequence: The irradiator will automatically and immediately return to the 'off' (default) position. *Solution: Restore power to the Reader*

6. Loss of power to the Controller during irradiation

Consequence: The irradiator will automatically close and immediately return to the 'off' (default) position. *Solution: Restore power to the Controller*

7. Loss of power to the user PC during irradiation

Consequence: The irradiator will automatically terminate after 20 s (USB connection) or 5 min (RS-232 connection) since the power loss occurred. *Solution: Restore power to the user PC*

8. The status LED is not on (i.e. neither green nor red)

Consequence: The user cannot check if an irradiation is in progress via the status LED (but can do so on the irradiation indicator on the front display of the Controller or by the white mark on the visible face of the eccentric wheel). *Solution: Contact DTU Physics*

9. The status LED is continuously red

Consequence: The user cannot check if an irradiation is in progress via the status LED (but can do so on the irradiation indicator on the front display of the Controller or by the white mark on the visible face of the eccentric wheel. The system cannot be operated. *Solution: Contact DTU Physics*

10. The status LED is continuously green

Consequence: The user cannot check if an irradiation is in progress via the status LED (but can do so on the irradiation indicator on the front display of the Controller or by the white mark on the visible face of the eccentric wheel. *Solution: Contact DTU Physics*

11. Mechanical failure (e.g. of the rack gear) during irradiation

Consequence: The source cannot return to safe position. The status LED is continuously red and the white mark on the face of the eccentric wheel is visible. *Solution: Contact DTU Physics immediately. Do NOT attempt to open the lid of the Reader.*

Emergency situations

In the event of fire the source would automatically return to its safe position when the plastic tubes providing the pressure to activate the source melts. The source is encased in an aluminium support, which is in turn enclosed in a brass casing. The aluminium support will oxidize between 500 and 650 °C, but the brass casing will not become unstable until >900 °C. The source is constructed to ISO standard 2919 - Classication C.43342, which species a minimum temperature of 400 °C, before the source encapsulation becomes unstable. In summary, it is very likely that the source will remainin the housing for all fire temperatures up to 900 °C.

Appendix B

RADIATION CONTROLLED AREA AND EQUIPMENT HANDOVER FORM

Part 1: School/unit – Handover of Controlled Area and Equipment to Company Representative			
SITE:		CONTROLLED AREA / ROOM:	
COMPANY CARRYING OUT WORK:			
REASON FOR HANDOVER:			
IDENTIFY KNOWN HAZARDS WITH CONTROLLED ARE OR EQUIPMENT:			
As an authorised representative of the School/Unit I hereby hand over the controlled area and equipment as above. Information has been exchanged to enable appropriate risk assessment to be made.		**Company:** As an authorised, and suitably trained, representative of the company, I accept responsibility for the controlled area and equipment. I will work in compliance with my employer's procedures and Local Rules.	
School/Unit Representative:	**Signature:**	**Company Representative:**	**Signature:**
Date:	Time:	Date:	Time:

Part 2: COMPANY REPRESENTATIVE – Handover of Controlled Area and Equipment to School/Unit **Please tick all applicable categories of work carried out. See visit / service report for full details.**	
Category of Work	**Details**
☐ Routine Service	
☐ Fault Diagnosis / Repair	
☐ Installation of Part(s)	
☐ Upgrade / Modification	☐ Hardware / ☐ Software
☐ Incident Response	
☐ RPA Inspection	
☐ Exposure Protocol Changes	
☐ Other	
Could this work have implications for radiation safety of image quality?	**☐ NO / ☐ YES**

If "**Yes**", tick one or more boxes below that apply. Please refer to the visit / service report for full details.		
☐ Shielding	☐ Interlocks / Exposure termination	☐ Safety features / warning devices
☐ Beam quality / filtration / grid	☐ Collimation / alignment / field sizes	☐ Detector dose / input dose

☐ 1. Equipment is **OPERATIONAL** following work as indicated above and detailed on the visit / service report.
☐ 2. Equipment is **PARTIALLY OPERATIONAL**, but limitations may exist, please refer to visit / service report.
☐ 3. Equipment is **NOT OPERATIONAL** and **MUST NOT BE USED**.
Part 3: School/Unit – Returning Equipment to Use **I confirm that I have been authorised as a competent practice representative ☐**
I confirm that the above Company has provided information and that I have reviewed the associated service report (if applicable) and appropriate checks have been carried out in accordance with my employer's procedures ☐
☐ 1. I am satisfied that the equipment is in a satisfactory condition for use.
☐ 2. I am **NOT** satisfied that the equipment is satisfactory for use. Reason: Actions taken:

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

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