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## **Risø High Dose Reference Laboratory**

### **Note on NPL comparison 2014 – Revised**

This document was originally issued 2014.08.28. The document describes the outcome of a comparison between HDRL and NPL carried out in a 10 MeV electron beam. The document originally concluded that the failure of the comparison was likely to be caused by differences in irradiation geometry. After the original document was issued we have found that the failure of the comparison can be attributed to the use of a noncompliant alanine holder. For this reason the conclusion of this document has been revised.

The revision of this document is a corrective action from the non-conformance report “HDRL-F-01 (4) 2014-13 NPL comparison 2014”.

### Irradiation of NPL dosimeters and Risø HDRL dosimeters at a 10 MeV electron accelerator

#### First comparison:

Irradiation at Sterigenics, Espergærde 2014.06.04. The comparison failed and no NPL certificate was issued. It was decided to repeat the comparison. The results described in this note come from this repeat comparison.

#### Repeat comparison:

Irradiation at Sterigenics, Espergørde 2014.07.29.

NPL alanine reference dosimeters: Batch 70, 2182-2187, in standard holder.

HDRL dosimeters: Harwell alanine pellets, batch AT608, 560-565, in standard holder.

Kodak alanine films, batch 312.

Geometry: Risø HDRL standard absorber for irradiation of dosimeters at electron accelerators. Absorbers were placed in aluminum trays for irradiation at conveyor.

**Irradiation data:**

Phantom	NPL dosim.	HDRL pellets	HDRL films	Req. dose	Temp. (start)	Temp. (end)
#	70	AT608	312	[kGy]	[°C]	[°C]
10A	2182	560	363-332-222	10	26.5	34.0
10B	2183	561	441-362-399	10	27.1	34.5
20A	2184	562	230-375-583	20	27.4	42.3
20B	2185	563	230-375-583	20	27.0	41.8
40A	2186	564	186-562-409	40	26.9	55.9
40B	2187	565	577-627-511	40	27.2	56.1

**Measurements:**

Pellets, AT608:

- 1 Measured: 2014.07.31  
Instrument: Bruker EMX

Results from pellets measured on EMX were reported to NPL in certificate 14C-77 (2014.07.31). NPL certificate and report: 2014050170/3 received 2014.08.21.

The pellets were also measured on the e-scan spectrometer:

- 2 Measured: 2014.08.13  
Instrument: Bruker e-scan

Films, batch 312:

- 3 Measured: 2014.07.31  
Instrument: Bruker EMS 104

**Results:**

**1 Pellets measured on EMX**

Uncertainty associated with NPL transfer dosimeter readings:

$$U(\text{NPL}) = 2.6\% \text{ (k=2)}$$

Uncertainty associated with HDRL dosimeter readings (EMX). Excluding NPL transfer dosimeter uncertainty:

$$U(\text{HDRL}) = 1.81\%.$$

<b>Phantom</b>	<b>NPL Dose</b>	<b>HDRL dose (EMX)</b>	<b>%Difference</b>	<b>E-value</b>
#	[kGy]	[kGy]	[%]	k=2
10A	9.93	10.0	0.7	0.3
10B	10.01	9.96	-0.5	0.2
20A	19.91	20.6	3.5	1.1
20B	19.67	20.0	1.7	0.5
40A	39.7	40.6	2.3	0.7
40B	39.5	40.1	1.5	0.5
		<b>Average</b>	1.5	0.5

## 2 Pellets measured on e-scan

Uncertainty associated with HDRL dosimeter readings (e-scan). Excluding NPL transfer dosimeter uncertainty:

$$U(\text{HDRL}) = 1.88\%.$$

Phantom	NPL Dose	HDRL dose (e-scan)	%Difference	E-value
#	[kGy]	[kGy]	[%]	k=2
10A	9.93	9.98	0.5	0.1
10B	10.01	9.96	-0.5	0.2
20A	19.91	20.4	2.5	0.8
20B	19.67	19.7	0.2	0.1
40A	39.7	39.6	-0.3	0.1
40B	39.5	39.5	0.1	0.0
		<b>Average</b>	0.4	0.3

## 3 Films measured on EMS 104

Uncertainty associated with HDRL film dosimeter readings (EMS). Excluding NPL transfer dosimeter uncertainty:

$$U(\text{HDRL}) = 1.97\%.$$

Phantom	NPL Dose	HDRL dose (EMS)	%Difference	E-value
#	[kGy]	[kGy]	[%]	k=2
10A	9.93	9.85	-0.8	0.2
10B	10.01	9.83	-1.8	0.6
20A	19.91	19.6	-1.5	0.4
20B	19.67	19.5	-0.9	0.3
40A	39.7	39.8	0.3	0.1
40B	39.5	39.5	-0.1	0.0
		<b>Average</b>	-0.8	0.3

## Comments

For pellets measured on EMX, the E-value for the phantom 20A dose point exceeds 1. Risø HDRL measures 3.5% higher dose than NPL.

Measured on e-scan the same dosimeter results in a 2.5% higher dose than the NPL dose. For both spectrometers these deviations from NPL are remarkably higher, than for all other dosimeters, while the standard deviation of the measured dose for the 4 individual pellets of the dosimeter is not higher than for other dosimeters.

## Noncompliant alanine holders

In the early 2014 HDRL started to use new alanine holders. The holders were specified to be made of ABS (cf. HDRL-I-15) but were made from a different polymer (POM, Delrin or similar) which had a 25% higher density but the same look as the original ABS holders. In October 2014 it was found that the noncompliant alanine holders caused a  $3.6 \pm 0.1$  % overestimation of the measured dose when irradiated with 10 MeV electrons and a  $1.2 \pm 0.1$  % overestimation when irradiated in a Co-60 gamma beam.

## Conclusion

After a thorough investigation we attribute the failure of the E-test for one dose point in the second comparison to the use of a noncompliant alanine holder. The E-test passes if the measured dose for data point 20A is corrected by -3.6%. On this basis we grade the comparison as successful.



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The failure of the first comparison can also be explained by the use of noncompliant alanine holders in conjunction with an erroneous temperature coefficient (cf. HDRL-F-01 (4) 2014-13 NPL comparison 2014).

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