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Radiation Survey of Lonestar Unit
for
Owlstone Limited

May 2008

Report Title: Radiation Survey of Lonestar Unit

Customer Contact: Max Allsworth
NPI Manager

Address: Owlstone Ltd
St John's Innovation Centre
Cowley Road
Cambridge
CB4 0WS
United Kingdom

Telephone: + 44 1223 422415

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Please Contact: Paddy Copeland
Telephone: +44 1235 838622
Fax: +44 1235 838623
Mobile: +44 7917 804466
Email: paddy.copeland@aurorahp.co.uk

	Name	Position	Date	Signature
Author	Paddy Copeland	Radiation Protection Adviser	30 May 2008	
Reviewer	Glenn Hardcastle	Radiation Protection Adviser	2 June 2008	

CONTENTS

1. INTRODUCTION

This report relates to a radiation survey of the external surface of one of Owlstone Limited's Lonestar units (serial number 00018) carried out by Aurora Health Physics Services Ltd. Owlstone is planning to sell Lonestar units commercially and asked Aurora to carry out an independent survey prior to bringing the unit to market.

The Lonestar unit contains a single 555 MBq nickel-63 source. Nickel-63 emits beta radiation with a maximum energy of 66 keV.

2. RADIATION SURVEY

2.1 Survey Methodology

The radiation survey undertaken comprised of direct monitoring, in contact with, and at a number of fixed distances from all external surfaces of the Lonestar unit using the following instruments:

Table 1: Instruments used.

Instrument	Serial No(s)	Calibration Date	Background (on site)
Mini Instruments 900 D	AHP0041 (4368)	29/05/07	<0.1 µSv/h
Mini Instruments 900 EP15	AHP0077 (2269)	16/11/07	1 - 2 counts per second (cps)
Thermo Electron Electra/BP19DD	AHP0101 (3803/386)	24/12/07	10 - 15 cps
Automess 6150 AD2	AHP0061 (73796)	3/07/07	0.05 µSv/h

Instrument calibration certificates are appended to this report (see Appendix 1).

2.2 Survey Results

The direct radiation monitoring of all external surfaces of the Lonestar unit detected localised elevated radiation readings over a small area on the rear of the unit. The maximum observed contact dose rate was 0.8 µSv/h. Radiation readings over all other surfaces of the unit were at background levels. Radiation readings at 5cm from the unit were all at background levels

(less than 0.1 μSv/h). Figure 1 below shows the measured dose-rate profile around the unit. Dose rates in the vertical plane follow the same profile.

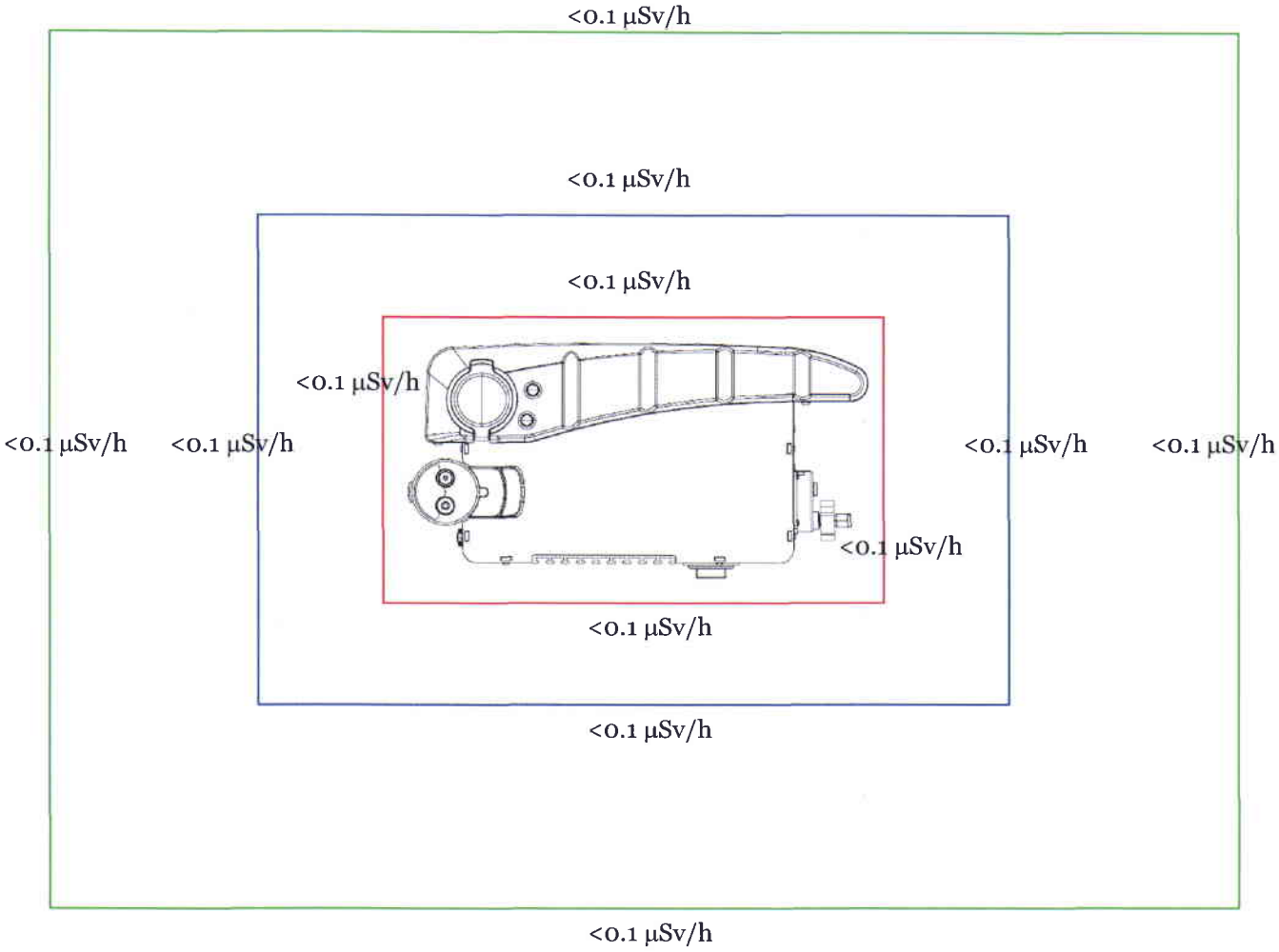

Figure 1. Dose rate profile around Lonestar Unit.

3. CONCLUSIONS

A dose rate survey has been carried out around a Lonestar Unit (serial number 00018). The maximum measured dose rate in contact with the unit was 0.8 μSv/h. Dose rates at 5cm were all at background levels (less than 0.1 μSv/h).

APPENDIX 1 CALIBRATION CERTIFICATES

ThermoFisher SCIENTIFIC

The world leader in serving science

CERTIFICATE OF CALIBRATION

ISSUED BY: **Thermo Fisher Scientific RM&SI**
Beenham Radiation Calibration Laboratory

DATE OF ISSUE: 29 May 2007 CERTIFICATE No: 9125

APPROVED SIGNATORY: J.Lowe

This certificate details the calibration results obtained for the instrument named below when calibrated in conjunction with calibration procedure RCS 028

The procedures used for the measurements are consistent with GPG14 (1999).
All measurements are checked by a designated 'Qualified Person' as defined by regulation 19(3) of the Ionising Radiation Regulations 1999.

Instrument Type:	Mini 900 D AMB
Instrument Manufacturer:	Thermo Fisher Scientific
Instrument Serial Number:	4368
Radiation Type Measured:	Gamma Dose Rate (Sv/h)
Customer:	Thermo Fisher Scientific

TRACEABILITY

All measurements were performed with a gamma source system which has been calibrated with cross referenced ionisation chambers and electrometers in accordance to BS 5869 (1980), ISO 4037 (1979), implying traceability to National Standards.

UNCERTAINTIES

System Dose

^{137}Cs and ^{60}Co: For air kerma rates above 1 $\mu Gy.h^{-1}$, the uncertainty in the system dose rate is ± 3%.

^{241}Am: For air kerma rates above 20 $\mu Gy.h^{-1}$, the uncertainty in the system dose rate is ± 4%.

Indicated Dose Rate

All indicated dose rates quoted, except the background response, have an uncertainty of ±10%.

INTRINSIC ERROR

The intrinsic error is calculated by $\frac{\text{indicated dose rate - system dose rate}}{\text{system dose rate}} \times 100\%$

NOTE: This calibration is not automatically valid for conditions of use different to those of calibration as given upon this certificate.

The uncertainties are for a confidence probability of not less than 95%. **P.T.O.**

CERTIFICATE OF CALIBRATION

DATE OF ISSUE: 29 May 2007 CERTIFICATE No: 9125

Measurement Results

The Probe was mounted horizontally, facing the gamma radiation beam.

Date of Measurements:	29 May 2007
Instrument Type:	Mini 900 D AMB
Instrument Serial Number:	4368
Test Type:	Initial
Temperature (°C):	21°C
Background Response ($\mu Sv.h^{-1}$):	<0.3µSv/h
Pressure (mbar):	1004mbar

Linearity Response ^{137}Cs

Source Number	System Dose Rate	Indicated Dose Rate	Intrinsic Error
4291GR	300µSv/h	295µSv/h	-1.67%
7581GR	20µSv/h	20µSv/h	0.00%
7581GR	2µSv/h	2.2µSv/h	10.00%

Overload Response

Off scale for 10 secs: Satisfactory

Energy and Polar Response ^{241}Am

Source Number	Orientation	System Dose Rate	Indicated Dose Rate	Intrinsic Error
1498LX	0°	100µSv/h	90µSv/h	-10.00%
1498LX	-90°	100µSv/h	62µSv/h	-38.00%

Remarks: [1] All system dose and dose rates are ambient dose equivalent rates, H*(10).

Measurements Performed By: J.W.V.Coles

The uncertainties are for a confidence probability of not less than 95%.

CALIBRATION CERTIFICATE

Radiation Metrology Group, Radiation Protection Division
Health Protection Agency, Chilton, Didcot, Oxfordshire, OX11 0RQ
E-mail: rad.met@hpa.org.uk Web: www.hpa.org.uk/radiation
Tel: +44(0)1235 831 600 Fax: +44(0)1235 822 818

Health Protection Agency

Radiological Protection Instrument
Certificate of Calibration
No. 49024

A. Name and address of user:

Aurora Health Physics Ltd
Harwell Innovation Centre
Curie Avenue
DIDCOT
Oxfordshire
OX11 0QG

B. Details of instrument and use:

Description:	**Thermo 900** with type **EP15** probe
Serial No:	**2269** and -- respectively
Use:	Monitoring of surfaces contaminated with beta emitting nuclides.

C. Details of calibration:

Date:	**16 November 2007**
Type of calibration:	Annual calibration
Calibration conditions:	The instrument's linearity was determined using a range of $^{90}Sr + ^{90}Y$ ISO extended area contamination plaque sources. The response to a variety of other nuclides was also measured.
Source to detector separation:	3 mm from the front of the detector
Orientation:	Radiation beam perpendicular to detector window
Uncertainties:	The uncertainties stated in this certificate are expressed at the 95% confidence level.
Traceability:	All source activities quoted in this certificate were derived from emission rate measurements using a P factor of 2. All emission rate measurements are directly traceable to national standards via UKAS accredited calibration facilities.

D. Results of calibration: Satisfactory for measurements performed
See over

E. Compliance with the Ionising Radiations Regulations 1999:

These results are typical of type and the instrument is suitable for the use described in section B, under the terms of the Regulations and the associated Approved Code of Practice.

Calibration performed by:	Miss C S Beswick	**Signature:** C S Beswick
Approved by (Qualified Person):	Mr T J Daniels	**Signature:** T J Daniels
Date of issue:	13 November 2007	

CALIBRATION

Certificate of calibration No. 49024

Results of calibration:

F. Physical inspection:

Battery test:	Satisfactory
Condition of Instrument:	Satisfactory
Audio:	Satisfactory

G. Linearity:

Source Activity ($^{90}Sr + ^{90}Y$)	Instrument Range	Instrument Reading (inc BG)	Response Factor	Estimated Uncertainty
Background	0 - 2000 Counts s^{-1}	0	-----	±50%
3.2 Bq cm^{-2}	0 - 2000 Counts s^{-1}	14	4.4	±20%
16.4 Bq cm^{-2}	0 - 2000 Counts s^{-1}	70	4.3	±20%
54.7 Bq cm^{-2}	0 - 2000 Counts s^{-1}	240	4.4	±20%

H. Other radiation responses:

Nuclide	Instrument Range	Instrument Reading (inc BG)	Response Factor	Estimated Uncertainty
Background	0 - 2000 Counts s^{-1}	0	-----	±50%
^{36}Cl	0 - 2000 Counts s^{-1}	140	3.8	±20%
^{60}Co	0 - 2000 Counts s^{-1}	55	2.4	±20%
^{147}Pm	0 - 2000 Counts s^{-1}	13	1.6	±20%
^{14}C	0 - 2000 Counts s^{-1}	240	1.7	±20%
^{241}Am	0 - 2000 Counts s^{-1}	50	2.3	±20%

Response factor is defined as the factor by which the indication of the instrument has to be divided by to give the units as defined below.

$$\text{Response factor} = \frac{\text{Indicated reading - BG, counts } s^{-1}}{\text{Estimated source activity - BG, Bq } cm^{-2}}$$

It is estimated that for monitoring of surfaces uniformly contaminated with:

^{32}P	4.4 cps above background = 1 Bqcm^{-2}
^{33}P	1.6 cps above background = 1 Bqcm^{-2}
^{35}S	1.7 cps above background = 1 Bqcm^{-2}
^{45}Ca	1.6 cps above background = 1 Bqcm^{-2}
^{204}Tl	3.8 cps above background = 1 Bqcm^{-2}

END OF DATA

CALIBRATION CERTIFICATE

Radiation Metrology Group, Radiation Protection Division
Health Protection Agency, Chilton, Didcot, Oxfordshire, OX11 0RQ
E-mail: rad.met@hpa.org.uk Web: www.hpa.org.uk/radiation
Tel: +44(0)1235 831 600 Fax: +44(0)1235 822 818

Radiological Protection Instrument
Certificate of Calibration
No. 49498

A. Name and address of user:

Aurora Health Physics Ltd
Harwell Innovation Centre
Curie Avenue
Didcot
Oxfordshire
OX11 0QG

B. Details of instrument and use:

Description:	**NE Electra 1A** with type **BP19DD** probe
Serial No:	**3803** and **386** respectively
Use:	Monitoring of surfaces contaminated with beta emitting radionuclides.

C. Details of calibration:

Date:	**24 December 2007**
Type of calibration:	Annual calibration
Calibration conditions:	The instrument's linearity was determined using a range of ^{90}Sr + ^{90}Y ISO extended area contamination plaque sources. The response to a variety of other nuclides was also measured.
Source to detector separation:	3 mm from the front of the detector
Orientation:	Radiation beam perpendicular to detector window
Uncertainties:	The uncertainties stated in this certificate are expressed at the 95% confidence level.
Traceability:	All source activities quoted in this certificate were derived from emission rate measurements using a P factor of 2. All emission rate measurements are directly traceable to national standards via UKAS accredited calibration facilities.

D. Results of calibration: Satisfactory for measurements performed
See over

E. Compliance with the Ionising Radiations Regulations 1999:

These results are typical of type and the instrument is suitable for the use described in section B, under the terms of the Regulations and the associated Approved Code of Practice.

Calibration performed by:	Mr D E Payne	**Signature:**	
Approved by (Qualified Person):	Mr D R Bungay	**Signature:**	
Date of Issue:	24 December 2007		

CALIBRATION

Certificate of calibration No. 49498

Results of calibration:

F. Physical inspection:

Battery test:	Satisfactory
Condition of Instrument:	Satisfactory
Audio:	Satisfactory
E.H.T.:	980V

G. Linearity:

Source Activity ($^{90}Sr + ^{90}Y$)	Instrument Range	Instrument Reading (inc BG)	Response Factor	Estimated Uncertainty
Background	Digital Counts s^{-1}	6.83	----	±50%
3.2 Bq cm^{-2}	Digital Counts s^{-1}	89	25.90	±20%
16.5 Bq cm^{-2}	Digital Counts s^{-1}	451	27.15	±20%
54.9 Bq cm^{-2}	Digital Counts s^{-1}	1540	28.12	±20%

H. Other radiation responses:

Nuclide	Instrument Range	Instrument Reading (inc BG)	Response Factor	Estimated Uncertainty
Background	Digital Counts s^{-1}	6.83	----	±50%
^{36}Cl	Digital Counts s^{-1}	955	25.97	±20%
^{60}Co	Digital Counts s^{-1}	430	18.71	±20%
^{147}Pm	Digital Counts s^{-1}	115	13.59	±20%
^{14}C	Digital Counts s^{-1}	1931	13.49	±20%
^{241}Am	Digital Counts s^{-1}	484	22.22	±20%

Response factor is defined as the factor by which the indication of the instrument has to be divided by to give the units as defined below.

$$\text{Response factor} = \frac{\text{Indicated reading - BG, counts s}^{-1}}{\text{Estimated source activity - BG, Bq cm}^{-2}}$$

It is estimated that for monitoring of surfaces uniformly contaminated with:

^{32}P	29.2 cps above background = 1 Bqcm^{-2}
^{33}P	12.6 cps above background = 1 Bqcm^{-2}
^{35}S	11.4 cps above background = 1 Bqcm^{-2}
^{45}Ca	12.6 cps above background = 1 Bqcm^{-2}
^{204}Tl	2.9 cps above background = 1 Bqcm^{-2}

END OF DATA

CALIBRATION CERTIFICATE

Radiation Metrology Group
National Radiological Protection Board, Chilton, Didcot, Oxon, OX11 0RQ
E-mail: rad.met@nrpb.org Web: www.nrpb.org
Tel: (01235) 831600 Fax (01235) 822818

Health Protection Agency

Radiological Protection Instrument
Certificate of Calibration
No. 47551

A. Name and address of user:

Aurora Health Physics Ltd
Harwell Innovation Centre
Curie Avenue
Chilton
Oxfordshire
OX11 0QG

B. Details of instrument and use:

Description:	**Automess 6150 AD**
Serial No:	**73796**
Use:	x and γ radiation above 60 keV

C. Details of calibration:

Date:	**3 July 2007**
Type of calibration:	Annual calibration
Calibration conditions:	The instrument's linearity was tested over a range of ambient dose equivalent rates using ^{137}Cs. The instrument's response to ^{241}Am and ^{60}Co was also measured and the overload and dose range performance were confirmed.
Calibration reference point:	As marked
Orientation:	Radiation beam normal to front face of instrument
Uncertainties:	The uncertainties stated in this certificate are expressed at the 95% confidence level.
Traceability:	All the equipment associated with the measurements performed in this certificate have calibrations directly traceable to national standards via the National Physical Laboratory or UKAS accredited calibration facilities.

D. Results of calibration: Satisfactory for measurement performed.
See over.

This instrument is designed to measure the quantity photon dose equivalent, H_x. The calibration was performed using the quantity ambient dose equivalent and therefore the responses obtained for ^{241}Am and ^{60}Co are as anticipated.

E. Compliance with the Ionising Radiations Regulations 1999:

These results are typical of type and the instrument is suitable for the use described in section B, under the terms of the Regulations and the associated Approved Code of Practice.

Calibration performed by: Mr D E Payne **Signature:**

Approved by (Qualified Person): Mr D R Bungay **Signature:**

Date of issue: 3 July 2007

CALIBRATION

Certificate of calibration No. 47551

Results of calibration:

F. Physical inspection:

Instrument condition:	Satisfactory
Battery test:	Satisfactory
Audio:	Satisfactory

G. Instrument settings: Alarm operation: Satisfactory

H. Dose Rate linearity;

Radiation Quality	Instrument Range	Instrument Reading	Response Factor	Estimated Uncertainty
Background	0-10 μSv h^{-1}	0.04	--	±10%
^{137}Cs (662 keV)	0-10 μSv h^{-1}	2.4	1.12	±10%
^{137}Cs (662 keV)	0-10 μSv h^{-1}	5.69	0.98	±10%
^{137}Cs (662 keV)	0-100 μSv h^{-1}	18.4	1.00	±10%
^{137}Cs (662 keV)	0-100 μSv h^{-1}	62.4	1.02	±10%
^{137}Cs (662 keV)	0-1000 μSv h^{-1}	197	1.00	±10%
^{137}Cs (662 keV)	0-1000 μSv h^{-1}	572	1.01	±10%
^{137}Cs (662 keV)	0-10 mSv h^{-1}	2.19	0.99	±10%
^{137}Cs (662 keV)	0-10 mSv h^{-1}	6.62	0.98	±10%

I. Dose Response:

^{137}Cs (662 keV)	μSv	50	1.00	±10%

J. Other nuclide responses:

^{241}Am (60 keV)	0-1000 μSv h^{-1}	94.5	0.37	±10%
^{60}Co (1.25 MeV)	0-1000 μSv h^{-1}	528	1.35	±10%

K. Overload:

^{137}Cs (662 keV)	0-10 mSv h^{-1}	Overload satisfactory at > 63 mSv h^{-1}

Response factor is defined as the factor by which the indication of the instrument has to be divided by to give the units as defined below. These factors are referred where applicable to a temperature and pressure of 20°C and 1013 mbar.

$$\text{Response factor} = \frac{\text{Indicated reading - BG, μSv h}^{-1}\text{, mSv h}^{-1}\text{, μSv}}{\text{True ambient dose equivalent rate - BG, μSv h}^{-1}\text{, mSv h}^{-1}\text{, μSv}}$$

END OF DATA