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Characterisation of Contamination Reference Sources

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Characterisation of Contamination Reference Sources - Background

- Part of Facility Development Programme - to include possible extension of UKAS accreditation
- Ordered a large number (24) ISO Class 2 extended area reference sources
- Nuclides ^{241}Am, $^{90}Sr/^{90}Y$, ^{129}I and ^{55}Fe
- Sources for use at 3 NRPB sites

  - a number of each nuclide are same nominal activity

Characterisation of Contamination Reference Sources - Background

- Sources Ordered from HTSL / AEA Technology QSA/Isotrak
- Order placed October 03 for advertised delivery in December 03
- First source wasn't delivered until February 04
- Still awaiting the last one !

Characterisation of Contamination Reference Sources

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Characterisation of Contamination Reference Sources - Measurements

- Sources ordered with PTB/DKD or AWE calibration as appropriate
- Prepared measurement programme for acceptance testing
- Measurements focussed on:-

  Approximate output

  Source Uniformity

Characterisation of Contamination Reference Sources - Measurements

- Approximate output important
  - varying activities of same nuclide to provides linearity measurements
  - previously experienced source outside the quoted activity tolerance of ± 30%
- Based output on known sensitivity of a large number of the same detector

Characterisation of Contamination Reference Sources - Measurements

- Essentially used sources to perform linearity measurements on a large number of identical, well characterised instruments
- Significant body of historical data !
- Everything fine for ^{241}Am and ^{129}I

Characterisation of Contamination Reference Sources - Measurements

- However, one $^{90}Sr/^{90}Y$ source consistently produced answers that differed by approximately 20% compared to others !

- Direct comparison possible with another $^{90}Sr/^{90}Y$ source of same nominal activity

Characterisation of Contamination Reference Sources - Measurements

- Comparison produced answer consistent with all other $^{90}Sr/^{90}Y$ sources

- Looked closely at certificates
  - Quoted measured emission rates for two sources is identical
  - Same nominal activity so possible, but most unlikely !

Characterisation of Contamination Reference Sources - Measurements

- Uniformity - determined from a series of measurements over the area of the source
- ISO 8769 states uniformity should be -
  - measured over whole surface
  - Individual areas of $10cm^2$ or less
  - Individual readings compared to the mean value

Characterisation of Contamination Reference Sources Measurements

For uniformity we used:-

- ZP 1490 (Mini E) for ^{241}Am & $^{90}Sr/^{90}Y$
- Mini 42B Scint. probe for ^{129}I

- ZP 1490 sensitive area of approximately 7 cm^2
- Mini 42B sensitive area of approximately 5 cm^2

Characterisation of Contamination Reference Sources Measurements

- These permitted measurements at:-
  - 5 positions on 10 x 10 cm sources
  - 8 positions on 10 x 15 cm sources

Strictly this doesn't comply with ISO 8769

- mean value doesn't represent the whole surface

Characterisation of Contamination Reference Sources Measurements

Rationale:-

- Simple, practical measurements
- No concerns regarding uniformity of probe
- Representative of a large number of common instruments
- ISO method dependant on averaging area, no minimum specified

Characterisation of Contamination Reference Sources Measurements

- Masking jigs used to mount the probes accurately
- All measurements made with probes connected to laboratory scaler timer
- Minimum of 10k counts accumulated for each measurement

Characterisation of Contamination Reference Sources Measurements

Uniformity results:-

- All ^{129}I sources < $\pm$ 3%

- 3 out of 9 $^{90}Sr/^{90}Y$ > $\pm$ 10%

- 6 out of 8 ^{241}Am > $\pm$ 10%
  and 2 of these were > $\pm$ 20% !

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Characterisation of Contamination Reference Sources Measurements

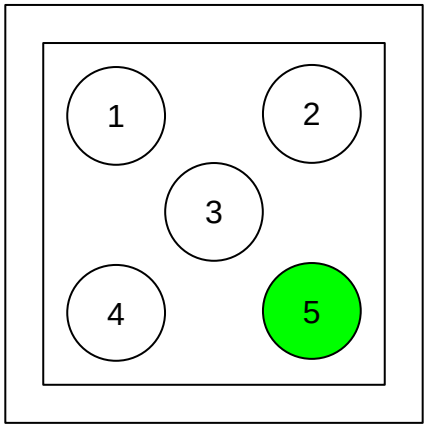
Results:-

- For ^{241}Am non - uniformity appears to increase with increasing activity

- The manufacturer has accepted that worst 2 ^{241}Am sources do not meet the ISO uniformity specification

MF159

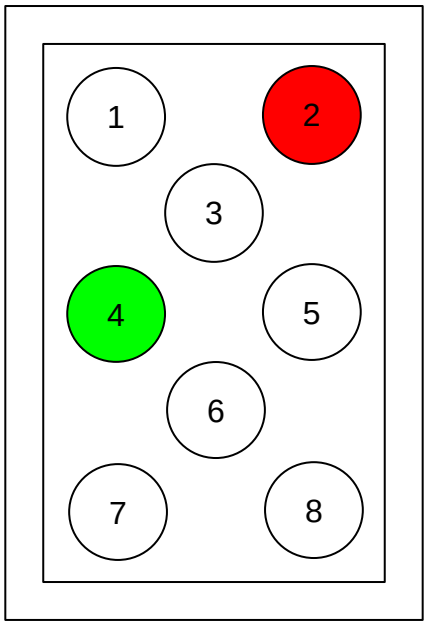
Nuclide: ^{241}Am Activity: 1.78 Bq/cm^2



Detector Position	Time (s)	Number of Counts	% Deviation from ξ
Position 1	5000	10811	7.53
Position 2	5000	10690	6.33
Position 3	5000	9968	-0.86
Position 4	5000	9937	-1.16
Position 5	5000	8862	-11.9
	ξ of Counts	10054	
	σ_{n-1}		

MF160

Nuclide: ^{241}Am Activity: 6.01 Bq/cm^2



Detector Position	Time (s)	Number of Counts	% Deviation from ξ
Position 1	2000	15004	6.65
Position 2	2000	16252	15.52
Position 3	2000	13828	-1.71
Position 4	2000	12681	-9.86
Position 5	2000	13300	-5.46
Position 6	2000	13172	-6.37
Position 7	2000	13340	-5.17
Position 8	2000	14966	6.38
	ξ of Counts	14068	
	σ_{n-1}		

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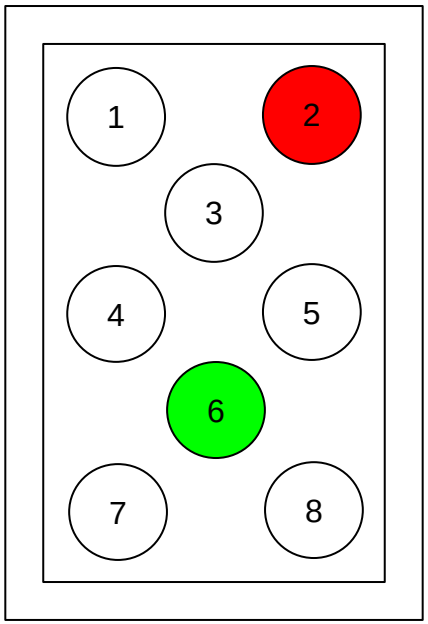
MF161

Nuclide: ^{241}Am Activity: 6.61 Bq/cm^2



Detector Position	Time (s)	Number of Counts	% Deviation from ξ
Position 1	2000	15630	2.52
Position 2	2000	17515	14.88
Position 3	2000	15253	0.05
Position 4	2000	14440	-5.29
Position 5	2000	15855	3.99
Position 6	2000	13694	-10.18
Position 7	2000	14299	-6.21
Position 8	2000	15282	-0.24
	ξ of Counts	15246	
	σ_{n-1}		

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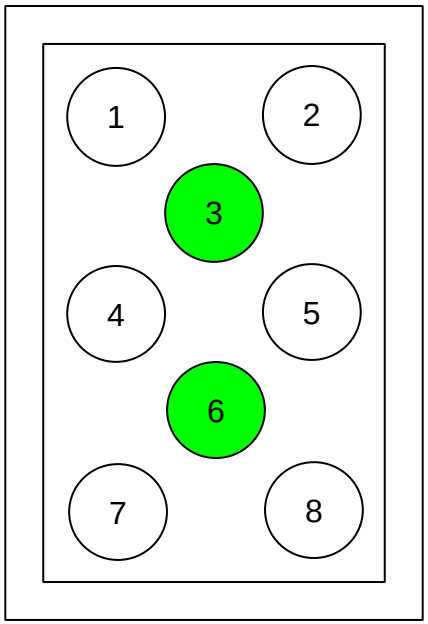
MF162

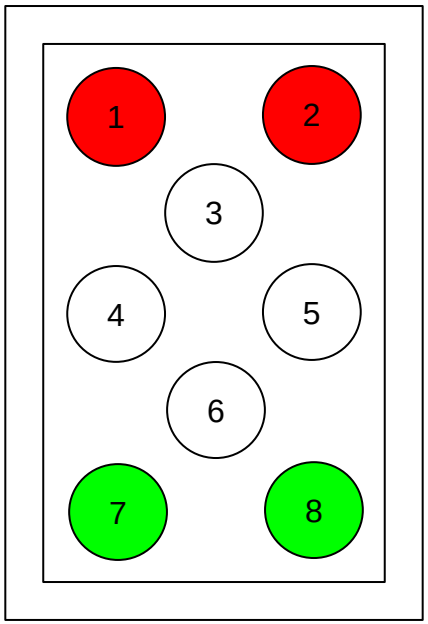
Nuclide: ^{241}Am Activity: 5.93 Bq/cm^2



Detector Position	Time (s)	Number of Counts	% Deviation from ξ
Position 1	2000	16136	6.80
Position 2	2000	16110	6.63
Position 3	2000	13489	-10.72
Position 4	2000	15180	0.48
Position 5	2000	15112	0.03
Position 6	2000	13267	-12.19
Position 7	2000	15621	3.40
Position 8	2000	15947	5.55
	ξ of Counts	15108	
	σ_{n-1}		

MF163

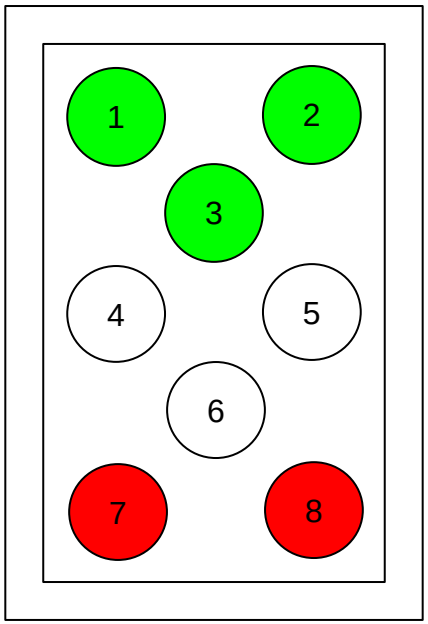
Nuclide: ^{241}Am Activity: 23.1 Bq/cm^2



Detector Position	Time (s)	Number of Counts	% Deviation from ξ
Position 1	400	12991	19.5
Position 2	400	12345	13.6
Position 3	400	10742	-1.18
Position 4	400	10928	0.53
Position 5	400	10694	-1.62
Position 6	400	10128	-6.83
Position 7	400	9370	-13.8
Position 8	400	9759	-10.2
	ξ of Counts	10870	
	σ_{n-1}		

MF164

Nuclide: ^{241}Am Activity: 21.6 Bq/cm^2



Detector Position	Time (s)	Number of Counts	% Deviation from ξ
Position 1	500	11395	-11.34
Position 2	500	11229	-12.64
Position 3	500	11973	-6.85
Position 4	500	12748	-0.82
Position 5	500	11692	-9.03
Position 6	500	14003	8.95
Position 7	500	15586	21.26
Position 8	500	14199	10.47
	ξ of Counts	12853	
	σ_{n-1}		

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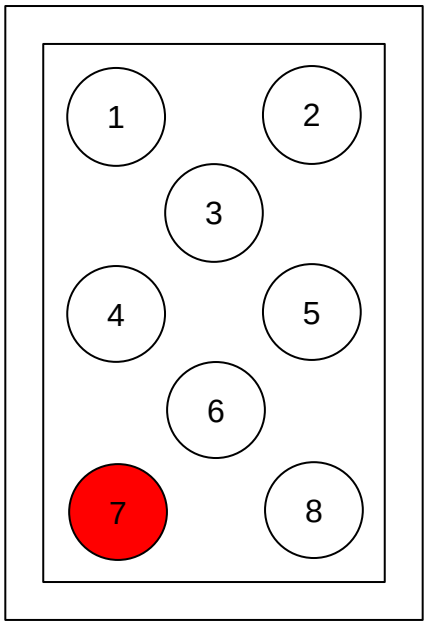
MF167

Nuclide: $^{90}Sr/^{90}Y$ Activity: 3.4 Bq/cm^2



Detector Position	Time (s)	Number of Counts	% Deviation from ξ
Position 1	2000	10458	-1.58
Position 2	2000	10229	-3.74
Position 3	2000	10361	-2.49
Position 4	2000	10402	-2.11
Position 5	2000	10658	0.30
Position 6	2000	10324	-2.84
Position 7	2000	11810	11.14
Position 8	2000	10763	1.29
	ξ of Counts	10626	
	σ_{n-1}		

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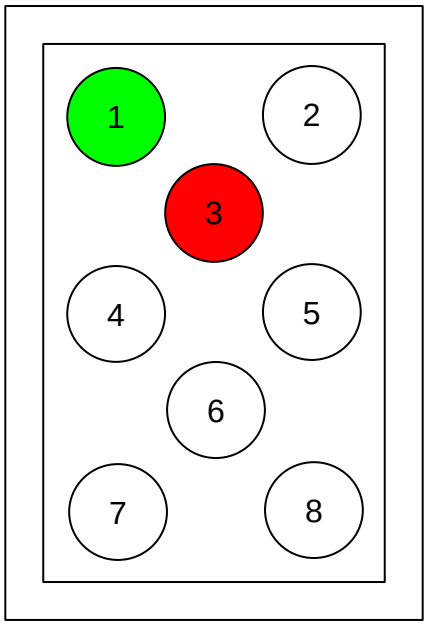
MF168

Nuclide: $^{90}Sr/^{90}Y$ Activity: 18 Bq/cm^2



Detector Position	Time (s)	Number of Counts	% Deviation from ξ
Position 1	500	12422	-11.9
Position 2	500	14360	1.84
Position 3	500	15613	10.7
Position 4	500	13492	-4.31
Position 5	500	14509	2.90
Position 6	500	14825	5.14
Position 7	500	12836	-8.96
Position 8	500	14745	4.57
	ξ of Counts	14100	
	σ_{n-1}		

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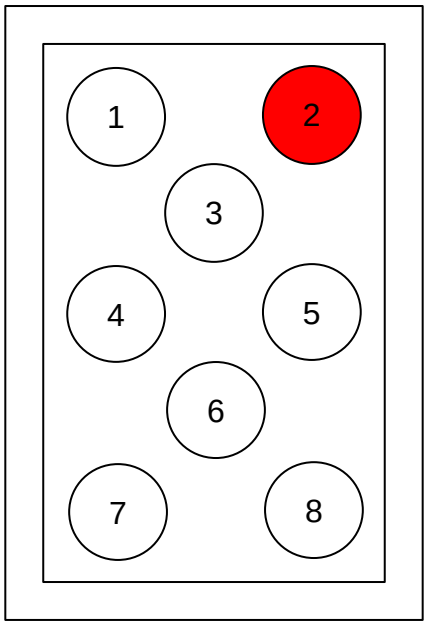
MF170

Nuclide: $^{90}Sr/^{90}Y$ Activity: 18 Bq/cm^2



Detector Position	Time (s)	Number of Counts	% Deviation from ξ
Position 1	400	11956	6.9
Position 2	400	12494	11.7
Position 3	400	11405	-2.0
Position 4	400	11434	-2.3
Position 5	400	11115	0.6
Position 6	400	10376	-7.2
Position 7	400	10173	-9.0
Position 8	400	10503	-6.1
	ξ of Counts	11182	
	σ_{n-1}	808	

Characterisation of Contamination Reference Sources Measurements

Results:-

- Further measurements made on the worst ^{241}Am sources
  - using AP2
  - measured over entire area of source
  - approximately - 10 to +14 % non-uniformity

Characterisation of Contamination Reference Sources Measurements

- Retrospective measurements on existing sources (same construction)
- 14 out of 19 exhibit similar non - uniformity
- Nuclides include:-
  ^{36}Cl, ^{238}Pu, ^{147}Pm, ^{129}I and $^{90}Sr/^{90}Y$

Characterisation of Contamination Reference Sources Measurements

Conclusion

- We will be cautious with future purchases and acceptance testing
- We will scrutinise carefully all ‘definitive’ data !
- Caused us to revised our methods, procedures and uncertainties for contamination calibration work