MINI-INSTRUMENTS LIMITED

MINI-MONITOR

SERIES 900

SCINTILLATION MINI-MONITOR

WITH TYPES 41, 41S, 42A/B & 44A/B PROBES

Our instruments are subject to continuous development and minor changes in detail may occur which are not incorporated in this manual

Issue 4
May 1997

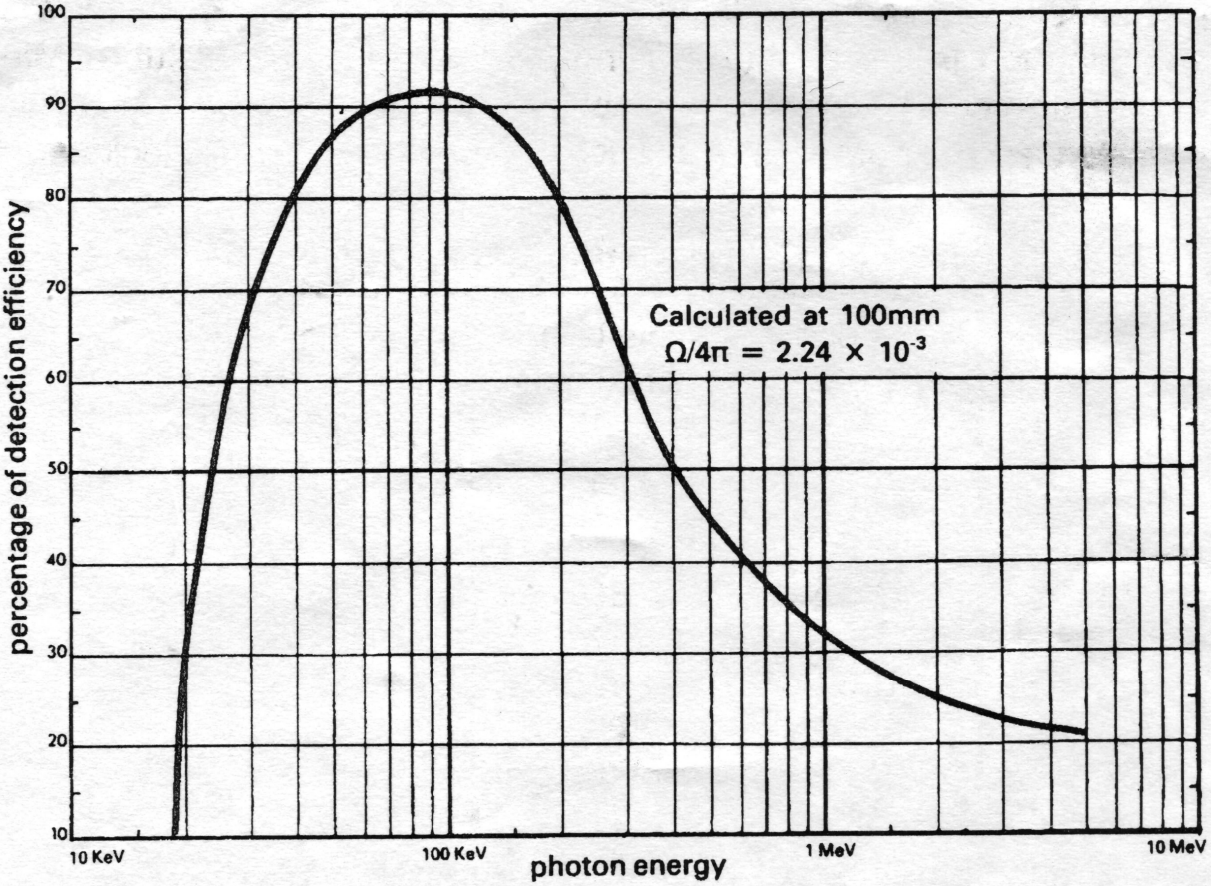


Fig. 1 Photon detection efficiency of type 41 probe

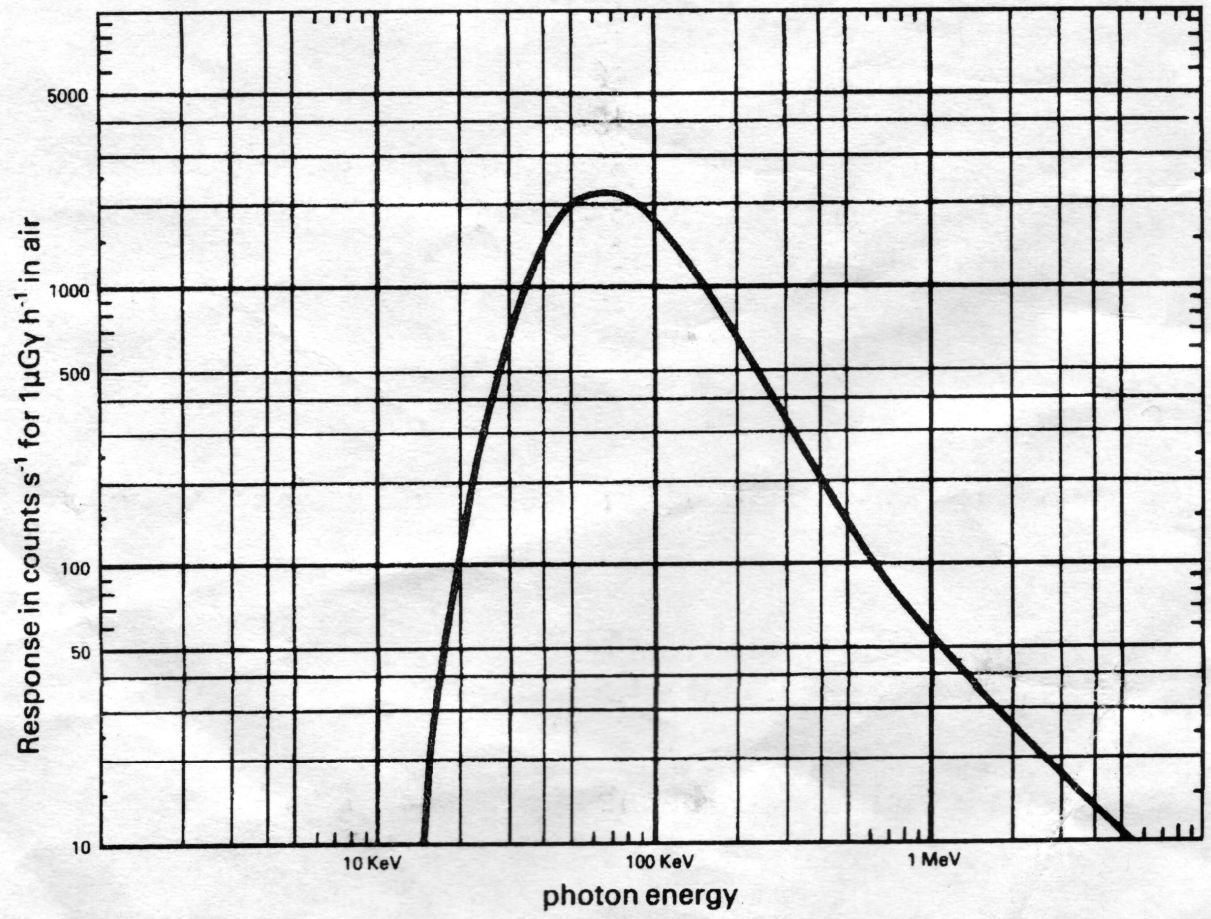


Fig. 2 Gamma dose response of type 41 probe

Table 1 shows the calculated response to 1μCi (37k Bq) of each of a selection of radio-nuclides. The nuclides are β – γ emitters so contamination is better found using a thin window G-M tube (Mini-instruments model E). The figures at one metre, however, serve as a guide for waste disposal purposes. A correction for air absorption is included.

Table 1

Nuclide (1 μCi)	counts s^{-1} at 20mm	counts s^{-1} at 1m
(^{22}Na)	1270	1.07
^{51}Cr	73	0.058
^{55}Fe	0	0
^{57}Co	1360	0,74
^{58}Co	571	0.48
(^{60}Co)	666	0.58
^{67}Ga	1080	0.63
^{75}Se	1790	1.15
^{99m}Tc	1200	0.69
^{109}Cd	855	0.39
^{111}In	2610	1.63
^{113}In	588	0.41
^{123}Te	1590	0.89
^{123}I	1990	0.92
^{125}I	1610	0.75
^{133}Ba	2800	1.53
(^{131}I)	723	0.55
(^{137}Cs)	487	0.37
(^{170}Tm)	124	0.059
(^{192}Ir)	1520	1.19
^{195}Au	1610	0.77
(^{226}Ra)	849	0.68
^{241}Am	654	0.30

Note 20mm is approximately the distance from the end of the probe to the crystal.

Owing to scattering from the collimator the sensitivities are generally higher than the values quoted.

Refer to B. L. Diffey, Radiation Protection Dosimetry Vol 4 No 2 1983 p115-117 for details on the method of calculation.

Sensitivity to other radiations

The probe is not sensitive to alpha radiation.
The probe is opaque to β radiation with energies below 1 MeV.
There are no figures for neutron response.

Probe adjustment

To set up a probe without a source locate the HV and overload controls. Set the HV control to minimum (fully clockwise). Set the overload control to minimum sensitivity (fully anti-clockwise). Slowly raise the HV potential. Initially, the count rate is low, between 1–10 counts s^{-1}, but it rises sharply due to the onset of photomultiplier noise. Set the control just below where noise starts.

The probe may now be used but it is advisable to check against a suitable source. An ^{129}I source emitting 28 keV X rays is brought near to the crystal until the counting rate is about 500 counts s^{-1}. The control is turned back until the counting rate has fallen sharply away. The two positions of the control should be quite distinct and by setting the control half way the probe is now sensitive over its useful range with a minimum of background noise. Now turn to the maintenance section to set the overload control.

3.2 Scintillation probe type 41S

The type 41S scintillation probe is based on the type 41 probe. The main differences are a larger scintillation crystal and no lead shielding. The probe is therefore more sensitive and has a non-directional polar response over a wider energy range. The crystal diameter is 19mm and its length is 38mm. The probe housing has an end window of aluminium with a thickness of about 0.8mm while the side walls are 3mm thick. This makes the probe suitable for detecting gamma radiation with energies greater than 30keV. As there is no additional lead shielding the background count is higher than the type 41 – in a typical background where the doserate is less than 0.15μGy/h, the count rate is about 30–50 cps.

The response to gamma radiation is summarised below:

Nuclide	Response in counts s^{-1} per μGy h^{-1}
^{241}Am	3800
^{137}Cs	320
^{60}Co	172

Figure xx shows the gamma doserate of the probe over the range 16.3KeV to 1.25MeV (^{60}Co). Figure 7 shows the polar response for 60KeV (^{241}Am) and 0.662MeV (^{137}Cs).

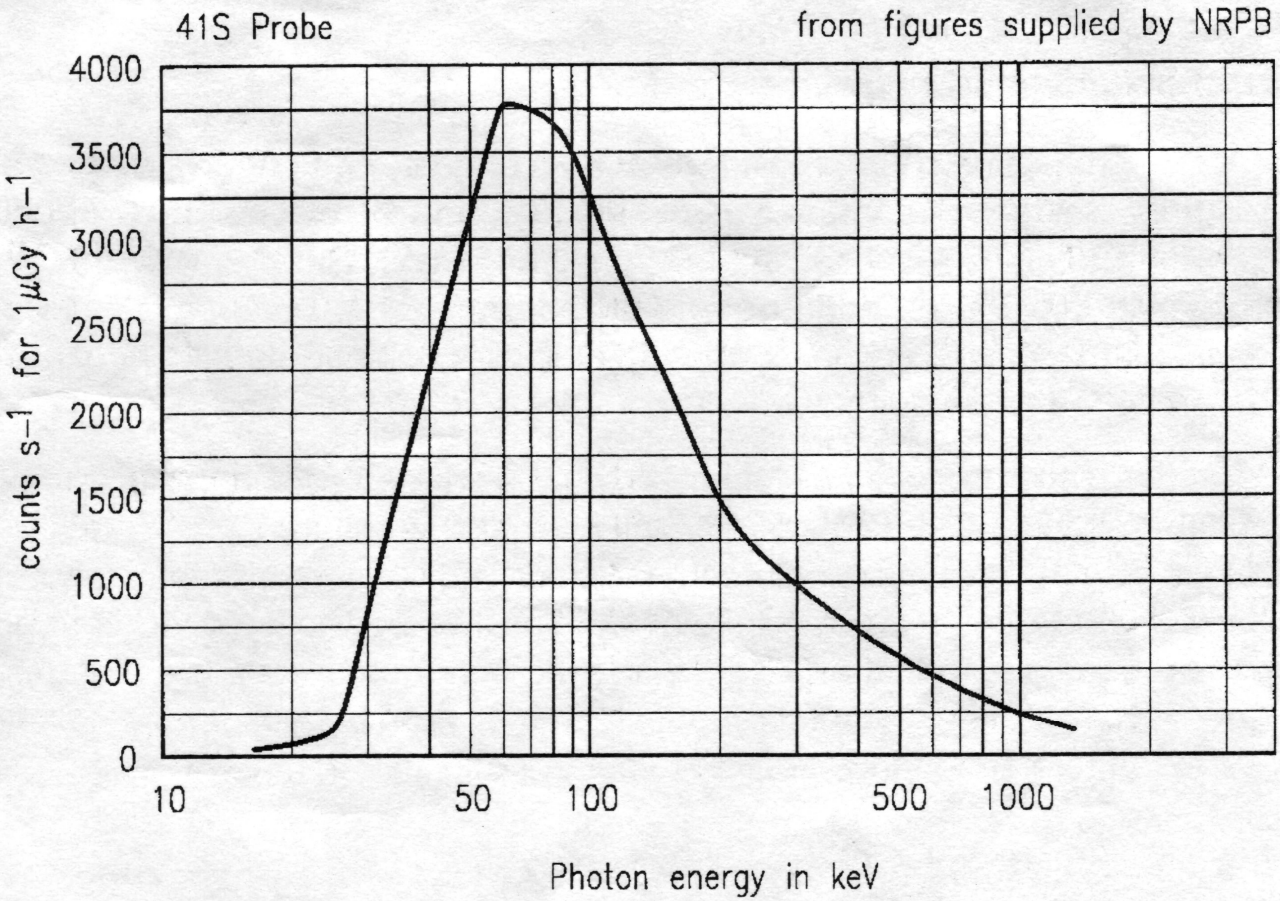


Table 1 shows the calculated response to 100kBq of each of a selection of small area radionuclides. The figures for 1m serve as a guide for waste disposal purposes. A correction for air attenuation is included but not for self absorption in the waste itself. **Note:** These figures are only a guide and do not necessarily represent the response of your particular probe. Specific applications may require calibration with a particular nuclide or nuclides.

Table 5

Nuclide (100kBq)	counts s^{-1} at 20mm	counts s^{-1} at 1m
^{241}Am	2000	0.9
^{57}Co	378"5	2.1
^{99}mTc	3340	1.9
^{125}I	5070	2.3
^{131}I	2110	1.8
^{137}Cs	1465	1.3
^{60}Co	2049	2.1
^{226}Ra	2498	2.3

Sensitivity to other radiation

The probe is not sensitive to alpha radiation.
The probe is not sensitive to β radiation below 1.5MeV.
There are no figures for neutron response.

Probe adjustment

To set up a probe without a source locate the HV and overload controls. Set the HV control to minimum (fully clockwise). Set the overload control to minimum sensitivity (fully anti-clockwise). Slowly raise the HV potential. Initially, the count rate is low, between 1–10 counts s^{-1}, but it rises sharply due to the onset of photomultiplier noise. Set the control just below where noise starts.

The probe may now be used but it is advisable to check against a suitable source. An ^{129}I source brought near the detector until the counting rate is over 100 counts s^{-1} is recommended. The HV control is then turned back until the counting rate falls away. The two positions of the control should be quite distinct and, by setting the control half-way, the probe is now sensitive over its useful range with a minimum of background noise. Refer to the maintenance section to set the overload control.

3.3 Scintillation probe type 42A and 42B

This probe is designed for detection of low intensity X rays where a short lead collimator becomes an advantage. The low background count of 1.5 to 3 counts s^{-1} is derived from using a crystal of 1 mm thickness. The crystal diameter is 23 mm. A full specification can be seen in section 7.

There are two crystal window materials. The type A probe has an aluminium window 0.05mm thick and the type B probe a beryllium window 0.25mm thick. A 70% transmission is obtained for X ray energies of 10 keV and 4 keV respectively. At the high energy end both probes fall to 50% efficiency at 100 keV.

Figure 3 shows the calculated photon detection efficiency and figure 4 shows the response in counts s^{-1} to an absorbed dose rate in air of 1 μGy h^{-1} over the sensitive photon energy range. The response to 1 μGy h^{-1} of ^{137}Cs radiation is approximately 10 counts s^{-1}.

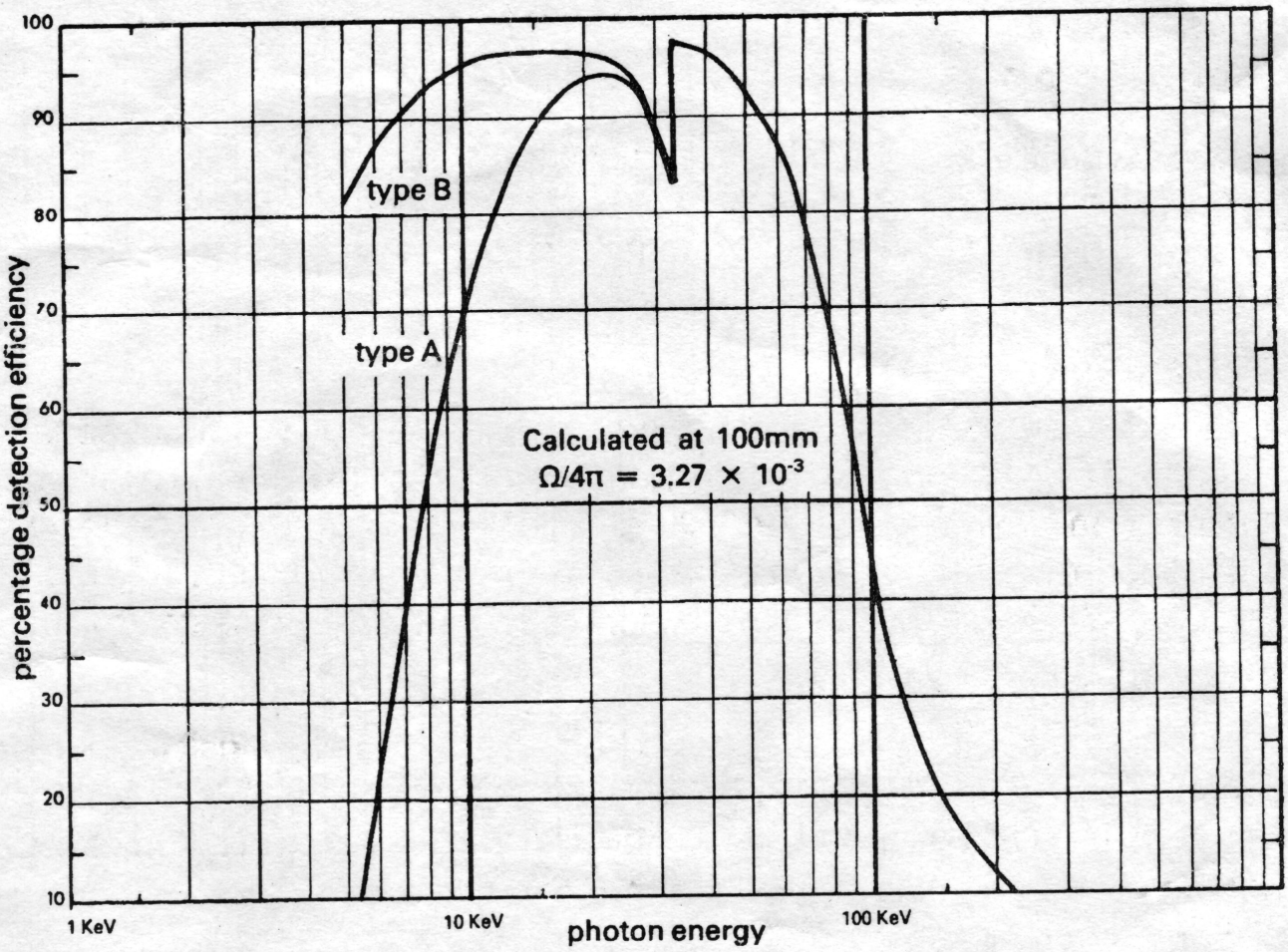


Fig. 3 Photon detection efficiency for type 42 probe

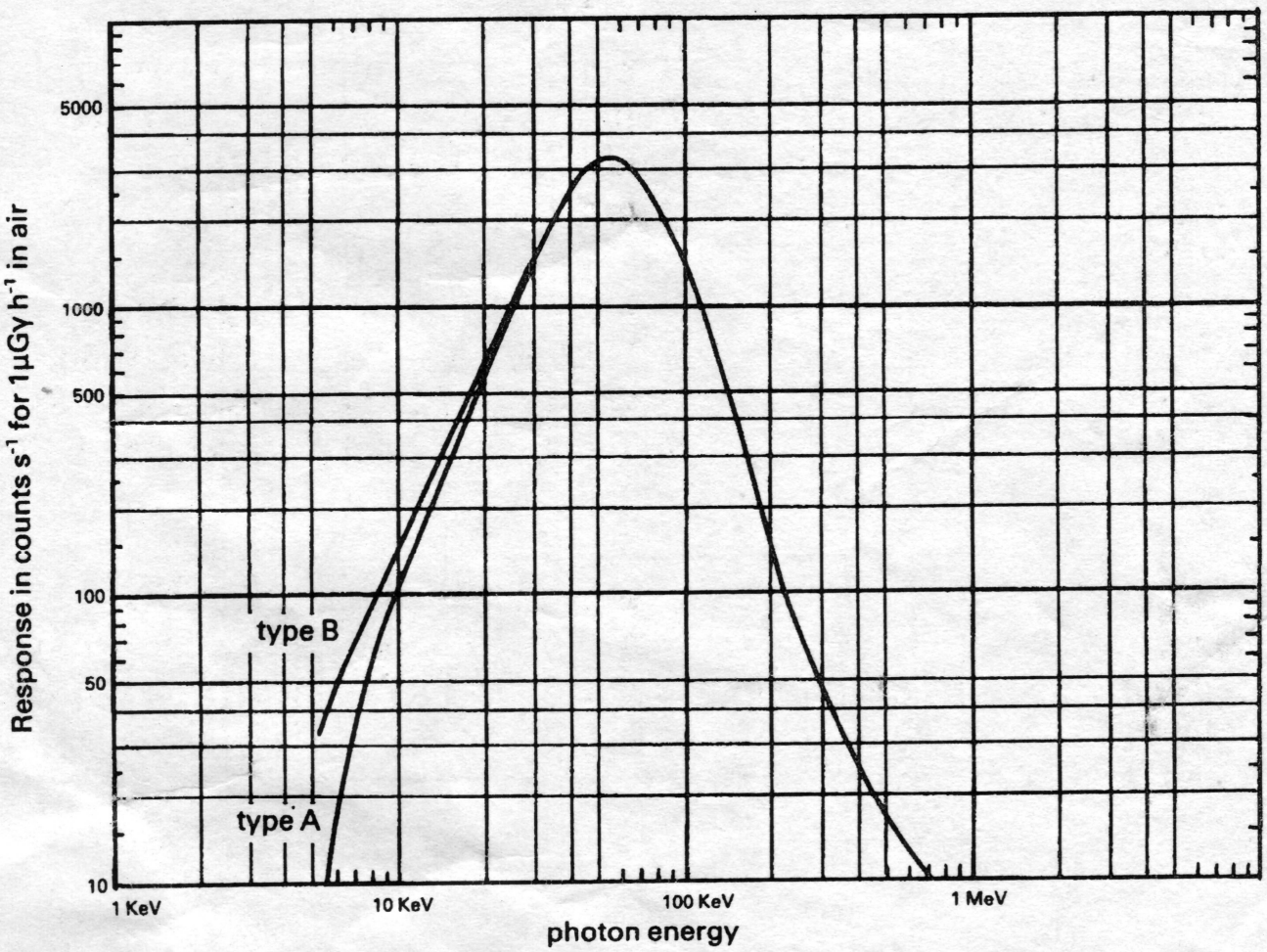


Fig. 4 Gamma dose response of type 42 probe

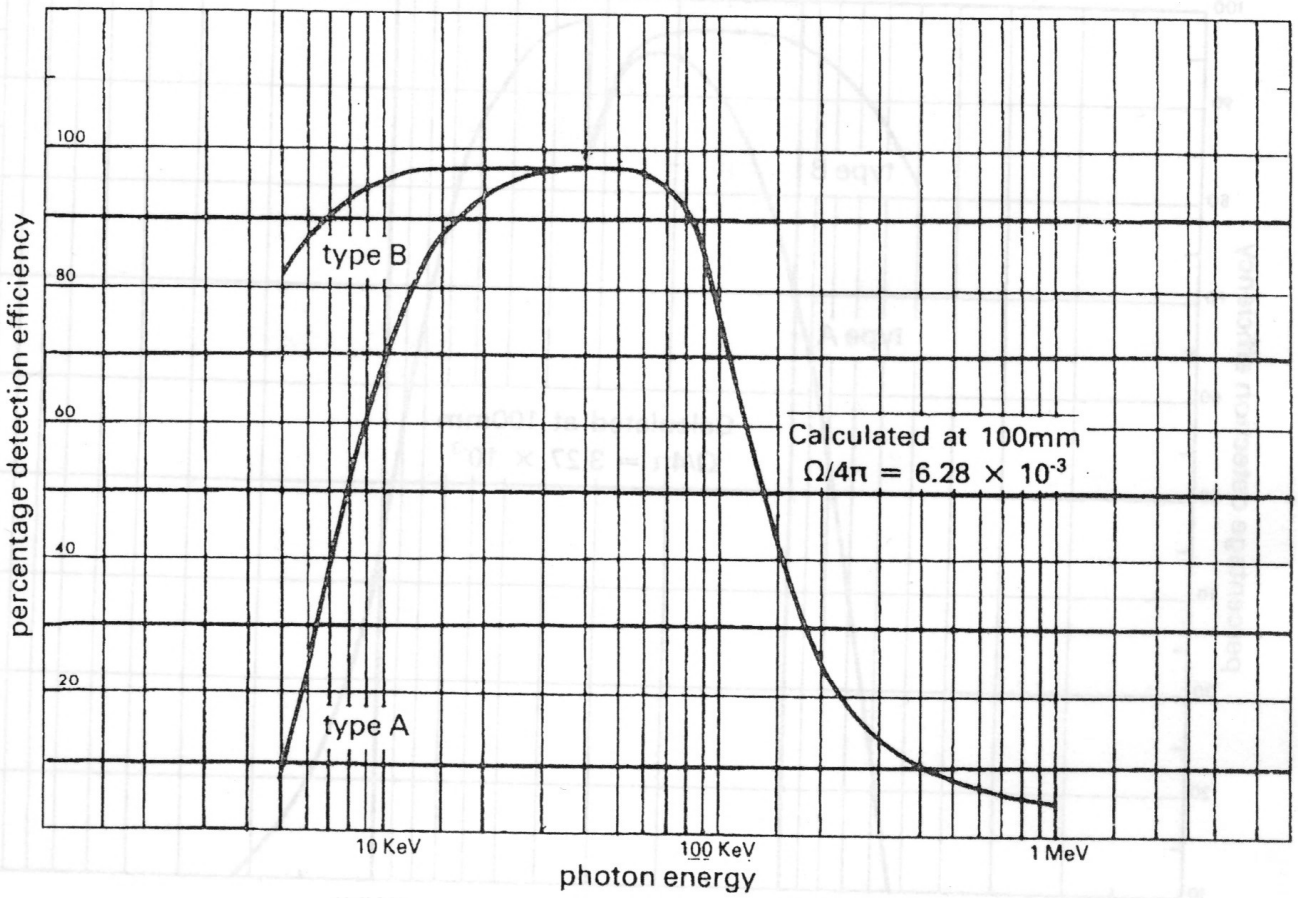


Fig. 5 Photon detection efficiency of type 44 probe

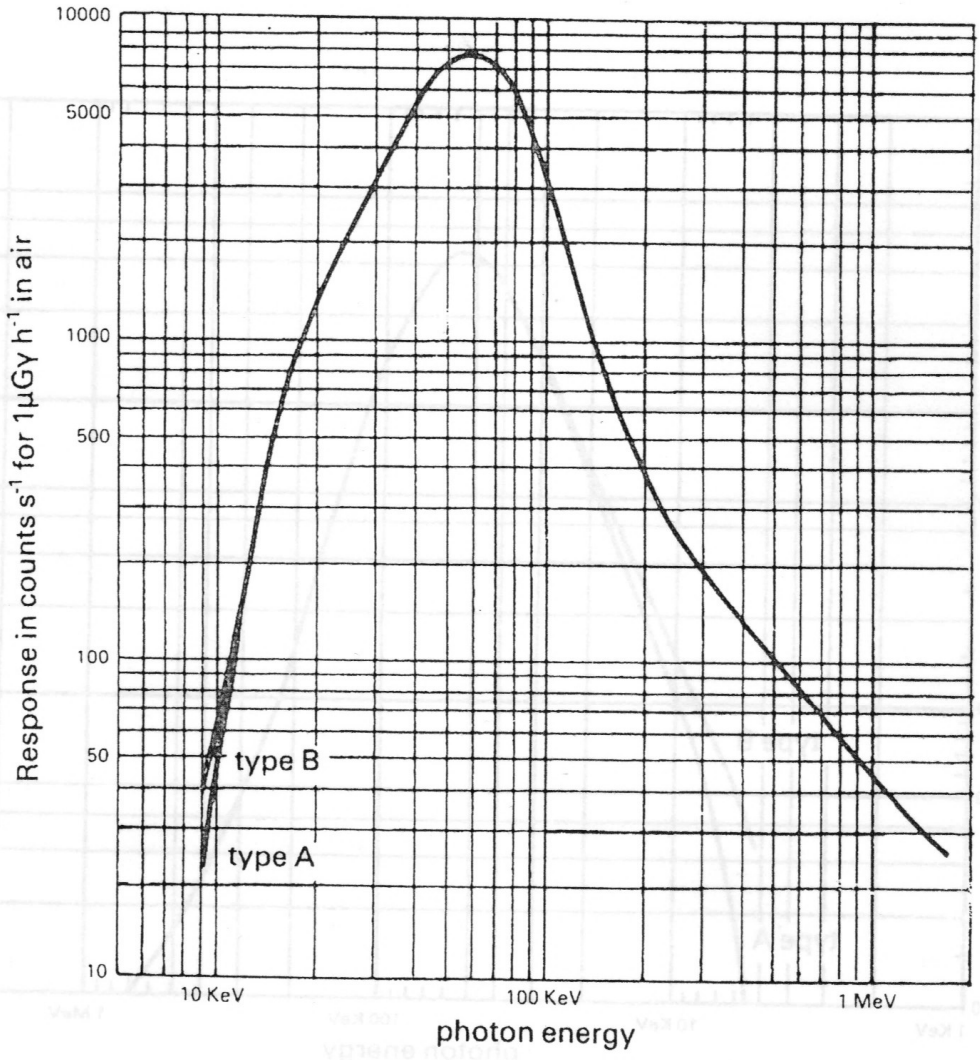


Fig. 6 Gamma dose response of type 44 probe

Spot contamination measurements

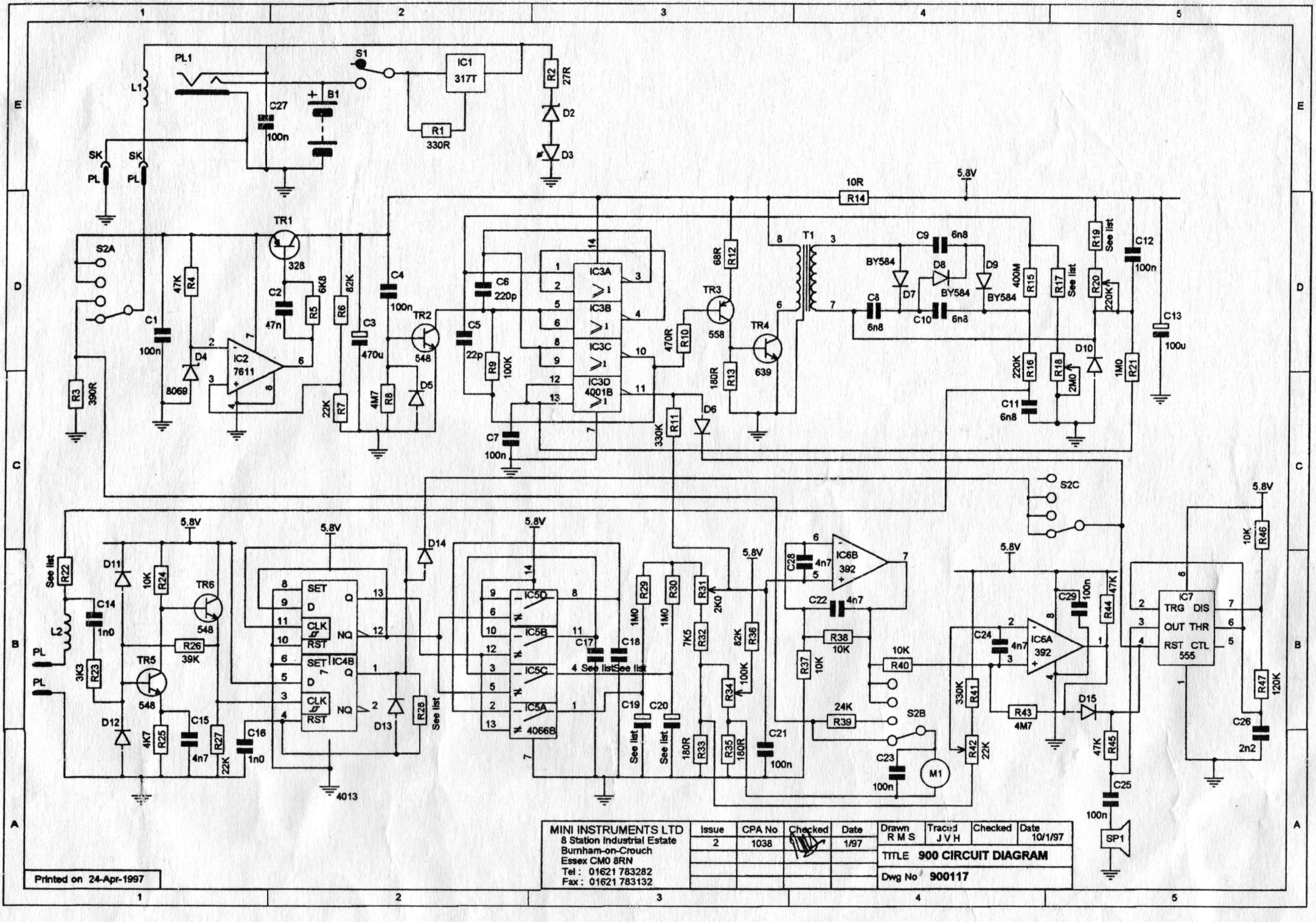
Table 3 lists the sensitivity of each probe to a number of common electron capture nuclides. Contamination is rarely evenly distributed and the figures given at 10 mm enables an estimation for spots of activity. The figures at one metre can be used to estimate waste disposal activity. Attenuation of the intervening air is included in the calculation but not, of course, the waste material.

Table 3

Nuclide (1 μCi) (37k Bq)	counts s^{-1} at 10 mm type A	type B	counts s^{-1} at 1 m type A	type B
(^{22}Na)	1920	1910	0.43	0.43
^{51}Cr	197	1510	0.030	0.043
^{55}Fe	256	1860	0.013	0.061
^{57}Co	6760	9840	1.61	1.66
(^{58}Co)	1240	2630	0.22	0.28
(^{60}Co)	935	929	0.21	0.21
^{67}Ga	6250	8170	1.37	1.58
^{75}Se	8310	9590	1.87	2.05
^{99m}Tc	4560	4560	1.10	1.10
^{109}Cd	8540	8790	2.22	2.27
^{111}In	11500	11700	2.87	2.90
^{113m}In	2490	2530	0.63	0.64
^{123m}Te	7190	7230	1.81	1.81
^{123}I	10300	10400	2.62	2.64
^{125}I	12200	12300	3.21	3.25
(^{131}I)	1650	1640	0.39	0.39
^{133}Ba	12700	14600	3.8	3.8
(^{137}Cs)	1240	1240	0.31	0.31
(^{170}Tm)	658	655	0.17	0.17
(^{192}Ir)	2820	2810	0.65	0.65
^{195}Au	8360	8310	2.22	2.21
(^{226}Ra)	1430	1420	0.32	0.32
^{241}Am	5880	6210	1.51	1.57

Note The calculated figures include soft X ray emissions from sources. The higher values of sensitivity quoted for the beryllium window probe can only be achieved with negligible absorption above the source and a well-adjusted probe.

The bracketed nuclides emit charged particles. The figures include contributions from X, γ and annihilation radiations only.



MINI INSTRUMENTS LTD	Issue	CPA No	Checked	Date	Drawn	Traced	Checked	Date
8 Station Industrial Estate Burnham-on-Crouch Essex CM0 8RN Tel : 01621 783282 Fax : 01621 783132	2	1038		1/97	R M S	J V H		10/1/97
					TITLE	900 CIRCUIT DIAGRAM		
					Dwg No	900117		

Printed on 24-Apr-1997

Diodes

D_2	BZX83 C9V1
D_3	IMO5120
D_4	ICL8069
$D_{5,6,10-15}$	IN4148
D_{7-9}	BY584

Integrated Circuits

IC_1	LM317
IC_2	7611DCPA
IC_3	HEF4001
IC_4	HEF4013
IC_5	HEF4066
IC_6	LM392M
IC_7	TLC555CP

Transistors

TR_1	BC328
$TR_{2,5,6}$	BC548B
TR_3	BC558
TR_4	BC639

Meter

M_1	500μA taut band moving coil

The ratemeter may be configured with a probe not manufactured by Mini-Instruments Ltd. If the probe has no pre-amplifier it may be necessary to modify the input circuit. If this is done R_{26} is increased in value to provide more sensitivity e.g. a value of 180K is fitted if the monitor is used with an AP2 probe. The maximum recommended value for R_{26} is 330K.