L15d Validation of workplace monitoring

Surface contamination measurements with portable devices

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Validation planning

- Define detection limits
- State acceptable uncertainties
- Setup working conditions for validation
- Perform measurements
- Estimate uncertainty budget

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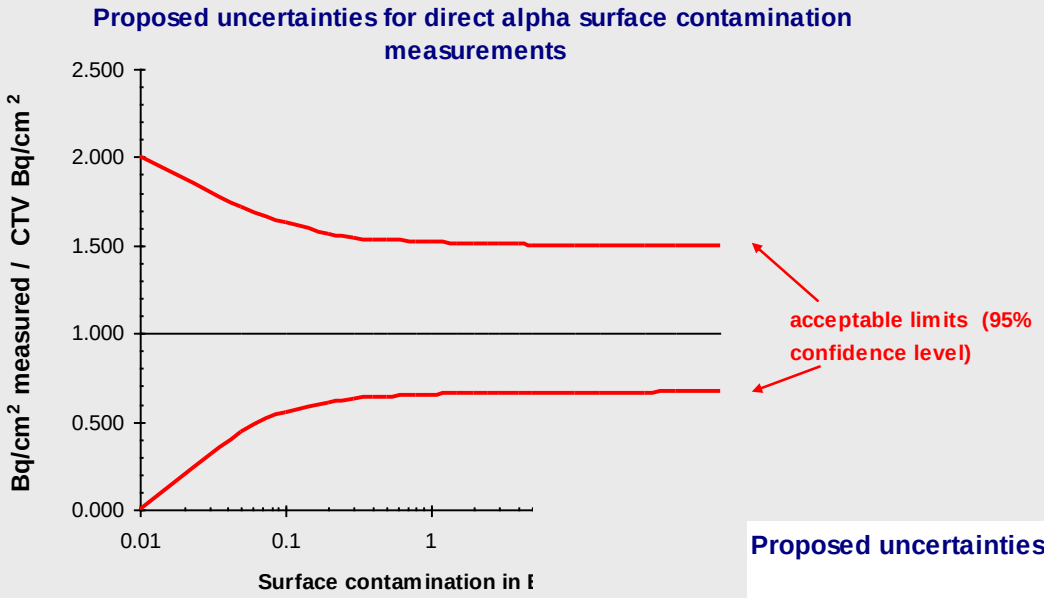
Detection limits

For release of items from controlled to uncontrolled areas, the limits for surface contamination are:

- 0.1 Bq/cm^2 for α-emitters
- 1.0 Bq/cm^2 for β-emitters

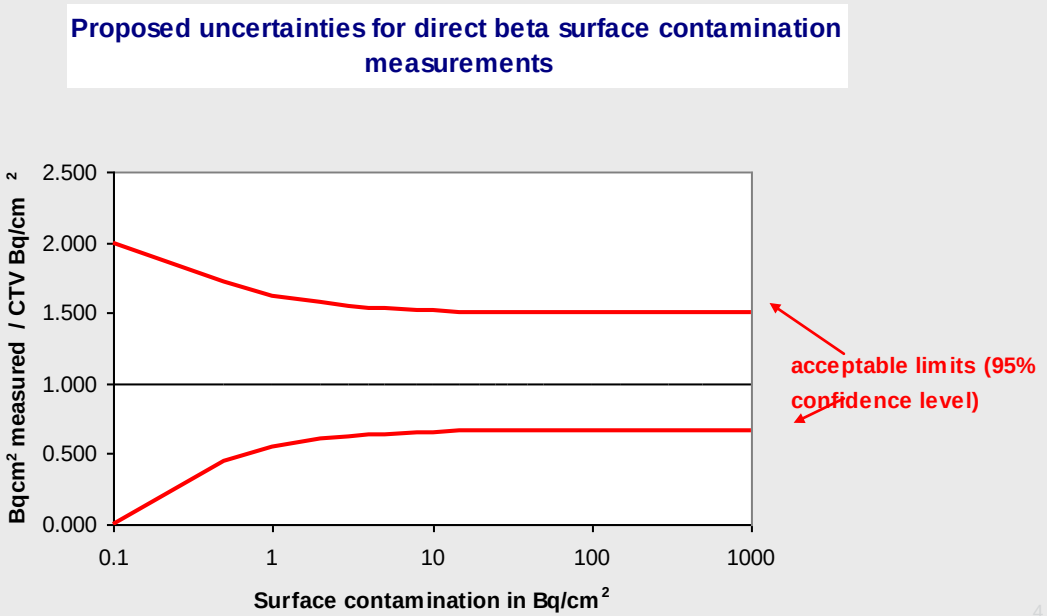
Acceptable uncertainty



Proposal

+ 50% and – 30% at ten times the detection limit

±100% near the detection limit



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Preparation for validation

a) Prepare a 20 cm x 20 cm area sample of workbench, flooring material or other material such as a tray;

b) Prepare a solution containing approximately 1600 Bq of Sr-90;

c) Prepare a solution of approximately 160 Bq of Am-241;

d) Cover the 400 cm^2 of material more or less evenly with the two above mentioned solutions;

Validation measurements

e) Measure and record the surface contamination with different monitors used by different technicians;

f) Make a wipe of the above-mentioned surface;

g) Count the wipe-test sample for alpha and beta emitters and record the result.

h) Dispose of the contaminated surface to the active waste.

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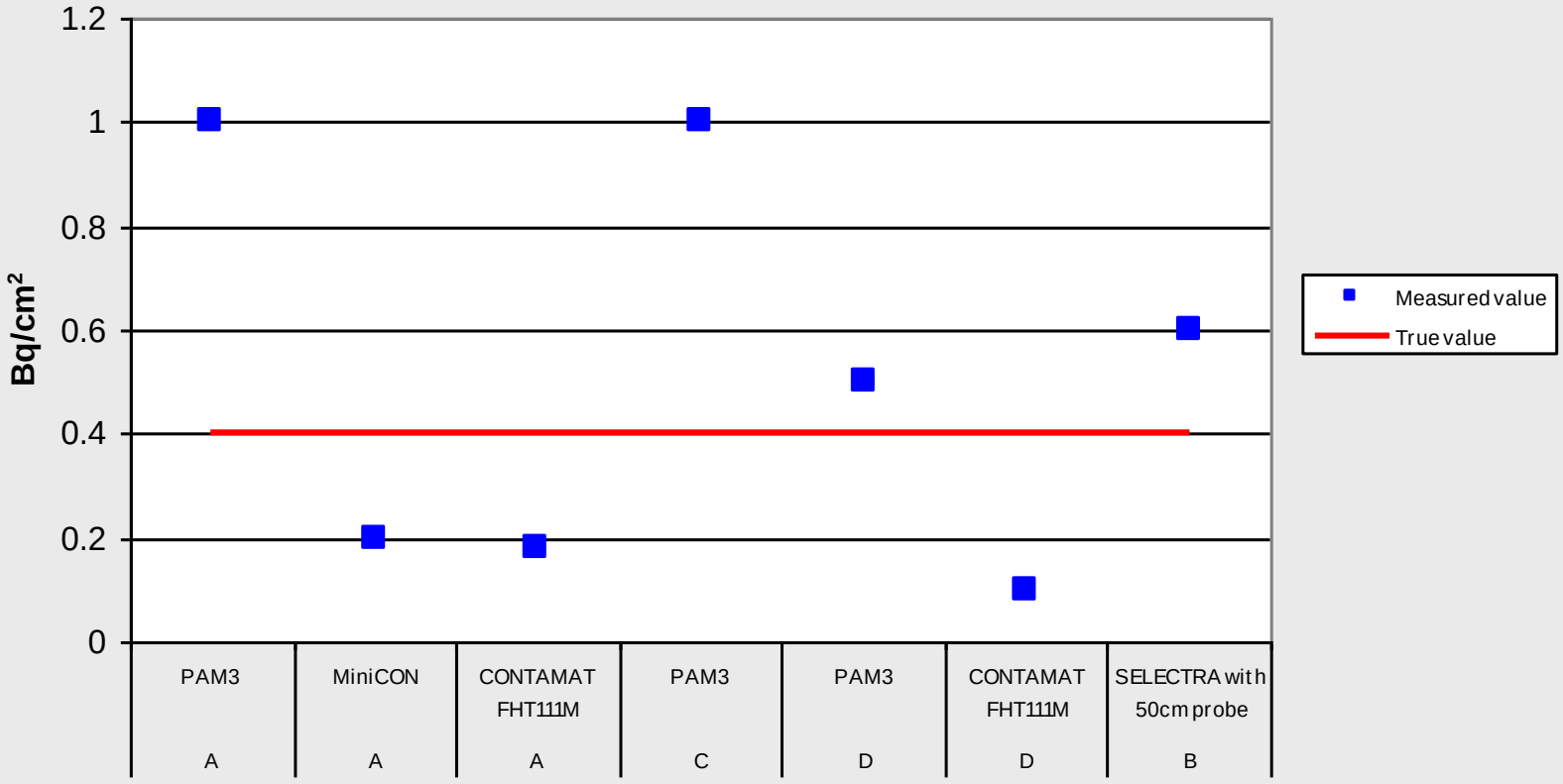
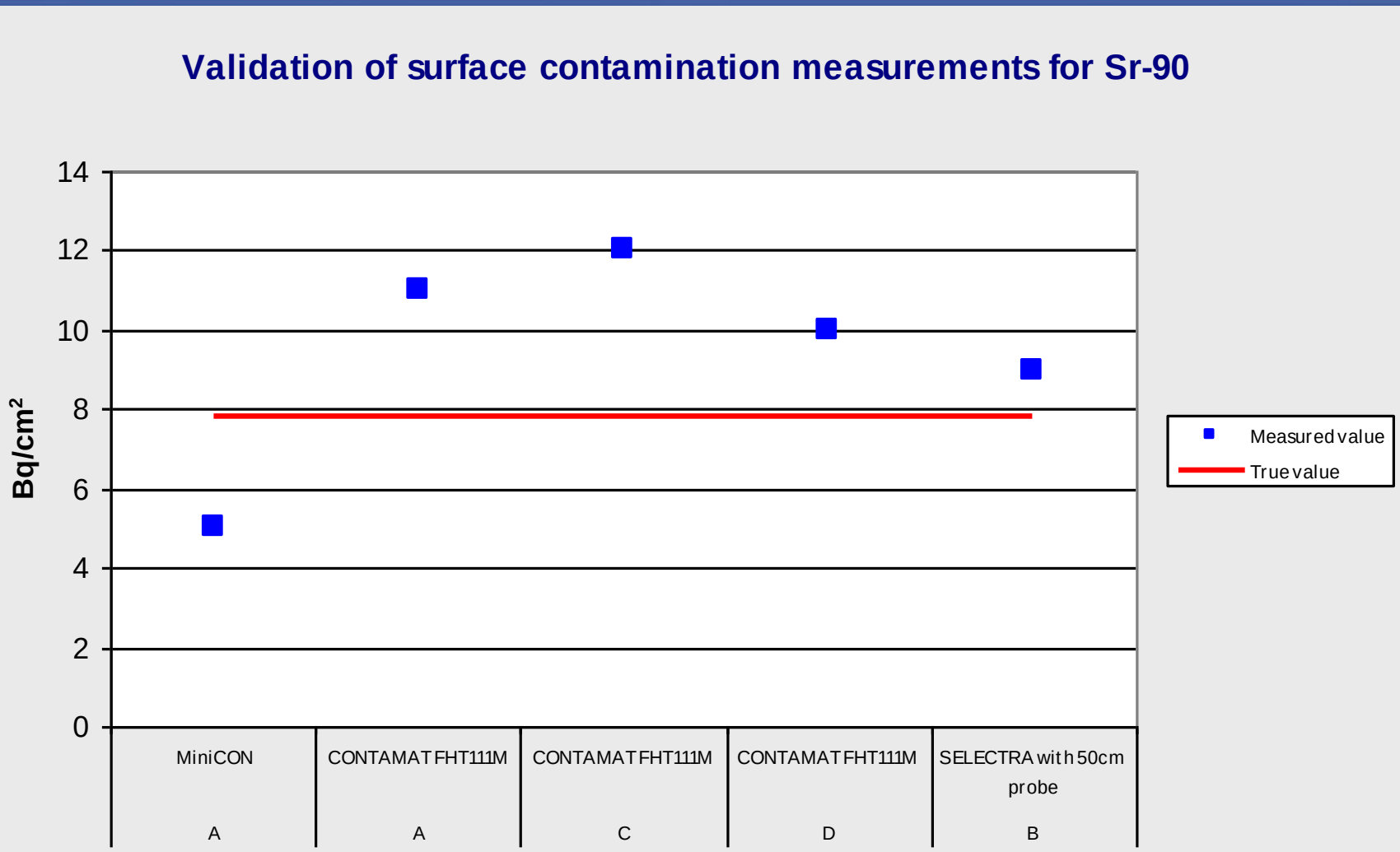
Measurement α-emitter



Measurement β-emitter



Measurement uncertainty

Influencing factors can be:

- Background reading
- Instrument reading instability
- Analogue instruments – parallax and scale resolution
- Uniformity of surface contamination
- Detector-source positioning factor
- Calibration factor uncertainties
- Energy dependence
- External electromagnetic fields
- Environmental factors

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Uncertainty estimation α-emitters

Alpha emitters							
Quantity	(i)	Uncertainty dx(i) %	Probability distribution	Divisor	c(i)/y	u(i) %	u(I)^2
Background measurement	1	30	normal	1	0.02	0.60	0.36
Scale reading	2	5	rectangular	1.73	1	2.89	8.35
Parallax	3	5	rectangular	1.73	1	2.89	8.35
Contamination uniformity	4	20	normal	1	1	20.00	400.00
Detector-source distance	5	20	rectangular	1.73	1	11.56	133.65
Electromagnetic fields	6	NA	-	-	-	-	-
Environmental factors	7	10	rectangular	1.73	1	5.78	33.41
Calibration factor	8	3	normal	1	1	3.00	9.00
				Combined standard uncertainty %			24.35
				Expanded uncertainty (k=2) %			48.69

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Uncertainty estimation β-emitters

Beta emitters							
Quantity	(i)	Uncertainty dx(i) %	Probability distribution	Divisor	c(i)/y	u(i) %	u(I)^2
Background measurement	1	30	normal	1	0.02	0.60	0.36
Scale reading	2	5	rectangular	1.73	1	2.89	8.35
Parallax	3	5	rectangular	1.73	1	2.89	8.35
Contamination uniformity	4	20	normal	1	1	20.00	400.00
Detector-source distance	5	6	rectangular	1.73	1	3.47	12.03
Energy dependence (beta)	6	20	rectangular	1.73	1	11.56	133.65
Electromagnetic fields	7	NA	-	-	-	-	-
Environmental factors	8	10	rectangular	1.73	1	5.78	33.41
Calibration factor	9	3	normal	1	1	3.00	9.00
				Combined standard uncertainty %			24.59
				Expanded uncertainty (k=2) %			49.19

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Validation statement

- After evaluation of the α and β validation measurements and the uncertainty budget estimation, it can be said that surface contamination rate measurements may be made with an uncertainty of

  49 % (k = 2 for a 95% confidence limit).