

CERTIFICATE OF CALIBRATION

VOSS ASSOCIATES

DATE OF CALIBRATION: December 18, 2009

This report Certifies that Voss Associates has Calibrated said instrument and hereby attests to it's sensitivity to the Isotopes listed below:

Manufacturer: Technical Associates Model: NexBeta Serial #: 11006

Description: the NexBeta measures Beta activity in water utilizing a one liter, flow-through measurement chamber. The manufacturer recommends this monitor for measuring Beta emitters in drinking water.

Environmental Conditions During Calibration

Temperature: 70⁰ F % R/H: 30%
Barometric Pressure: 30.12" Hg Background Radiation: 0.01 mR/hr

Instrument Operating Parameters

NexBeta HV Setting: PMT "A" 520 V, PMT "B" 552 V
NexBeta Window Setting: 100 to 1000 mV

Readings taken in "Co-incidence Mode"

Calibration Sources

Cs-137	0.1940 uCi/L	SN #: CS137-VA200902
K-40	0.0207 uCi/L	SN #: K40-VA200902
Sr-90	0.0165 uCi/L	SN #: SR90-VA200902

Background Count Rate With Clean Water:	21.4 CPS
Cs-137 Net Count Rate:	125.5 CPS
K- 40 Net Count Rate:	26.6 CPS
Sr- 9 Net Count Rate:	96.0 CPS

Counts Were Collected for 60 Seconds

	CPS per uCi/L
Cs-137:	647 CPS/ uCi/L
K- 40:	1,285 CPS/ uCi/L
Sr- 90:	5,818 CPS/ uCi/L

Minimum Detectable Count Rate (MDCR)

$$\text{MDCR} = \frac{2k \sqrt{R_B \times T_S \times (1 + T_S / T_B)}}{T_S}$$

"k" for the 95% Confidence Level is 1.65

$$\text{MDCR (CPS)} = \frac{2 \times 1.645 \sqrt{21.4 \times 60 (1 + 60/60)}}{60} = 2.8 \text{ CPS}$$

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Minimum Detectable Concentration (MDC)

Calculated From the Isotope Measurement Data for a 60 Second Count:

Cs-137: 647 CPS/ uCi/L = $1.55E-3$ uCi/L per CPS = $4.33 E-3$ uCi/L MDC
K-40: 1,285 CPS/uCi/L = $7.78E-4$ uCi/L per CPS = $2.18E-3$ uCi/L MDC
Sr-90: 5,818 CPS/uCi/L = $1.72E-4$ uCi/L per CPS = $4.81E-4$ uCi/L MDC

MDC versus Sample Count Time

	Cs-137	K-40	Sr-90
2 min	$3.04E-3$ uCi/L ($3.04E+3$ pCi/L)	$1.52E-3$ uCi/L ($1.52E+3$ pCi/L)	$3.37E-4$ uCi/L ($3.37E+2$ pCi/L)
20 min	$9.61E-4$ uCi/L ($9.61E+2$ pCi/L)	$4.82E-4$ uCi/L ($4.82E+2$ pCi/L)	$1.07E-4$ uCi/L ($1.07E+2$ pCi/L)
1 hr.	$5.58E-4$ uCi/L ($5.58E+2$ pCi/L)	$2.80E-4$ uCi/L ($2.80E+2$ pCi/L)	$6.19E-5$ uCi/L (61.9 pCi/L)
24 hr	113 pCi/L	57 pCi/L	13 pCi/L

MDC CALCULATIONS:

MDC calculations are based on the assumption that the sample stream is uniformly mixed, activity levels are reasonably constant during the measurement period listed, background radiation levels are reasonably constant, and the background count times and measurement count times are the same.

Limitations of this Calibration:

There were no observed limitations during the calibration of this instrument. The collected data indicates a fairly linear relationship between count rate and Beta energy; that is, as the Beta energy increases so does the count rate for a given concentration of Beta emitter. For those Beta emitters not used during this calibration, then a relationship between the anticipated count rate versus the Beta energy of the subject radio-nuclide could be established.

Measurement Uncertainty: 2.29%
Overall Uncertainty: 5.50%

Calibrated By: James Tom Voss, NRRPT, CHP

Signature James S. Voss Date: December 18, 2009
James Tom Voss
Lab Director and Chief Metrologist

FOOTNOTE:

CREDENTIALS:

Tom Voss is a registered radiation protection technologist with the NRRPT, a Certified Health Physicist with the ABHP, and a Fellow of the Health Physics Society with 45 years of experience in Health Physics, beginning with sampling and analyzing nerve gas in 1965 at Dugway Proving Grounds then joining the Southern California Edison Company at the San Onofre Nuclear Generating Station. He has published over 300 technical papers. His background includes field surveying, instrument calibration and repair, chemical analysis, water purification, procedure writing, technical training, and technical consulting. He is a member of the ANSI (American National Standards Institute) and IEC (International Electro-Technical Commission) standards development teams. Tom can be contacted at JTVOSS@NEWMEXICO.COM, or cell phone at 505-920-1470, or through the Voss Associates website at WWW.VOSS-ASSOCIATES.COM.