Tritium Detection Methods and Limitations

Tritium Focus Group Meeting, April 2014

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DOE-HDBK-1105-2002

RADIOLOGICAL TRAINING FOR TRITIUM FACILITIES

U.S. Department of Energy AREA TRNG
Washington, D.C. 20585

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Radiological Training for Tritium Facilities

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Voss (2000), J. T., LA-UR-00-2584, Los Alamos Radiation Monitoring Notebook, (2000).

Woehr (1994), W.J., Gatami, A. and Holodny, E. I., Radioactive Waste Volume Reduction in a University/Hospital Setting, 27th Mid-Year Topical Meeting of the Health Physics Society, February 12-16, Albany, NY (1994).

ION CHAMBER DETECTORS

- PORTABLE ION CHAMBERS
- AREA (ROOM) ION CHAMBERS
- EFFLUENT (STACK) ION CHAMBERS

PORTABLE ION CHAMBERS

200 to 400 cc active volume

5 to 10 uCi/m3 lower limit

10,000 to 200,000 uCi/m3 upper limit

AREA (ROOM) ION CHAMBERS

2000 cc active volume

1uCi/m3 lower limit

1 to 20 uCi/m3 upper limit

EFFLUENT (STACK) ION CHAMBERS

50 L active volume

5 uCi/m3 lower limit

1 to 50 Ci/m3 upper limit

10CFR835 tritium DAC factors

Tritium Oxide	2E-5 uCi/mL (20 uCi/m3)
Elemental	2E-1 uCi/mL
Insoluble STCs	2E-6 uCi/mL
Soluble STCs	1E-5 uCi/mL

LIQUID SCINTILLATION COUNTERS

- PORTABLE LSC
- LABORATORY LSC
- PROCESS LSC

Table 1 OF DOE 5400.5
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Appendix D OF 10CFR835

Tritium surface limit 10,000 dpm/100cm^2

RETROSPECTIVE TRITIUM SAMPLERS

- BUBBLERS
- HTO ABSORBERS

P-10 GAS COUNTERS

- PORTABLE SURFACE MONITORS
- LABORATORY SAMPLE COUNTERS
- P-10 STANDARD TRITIUM CALIBRATORS

TRITIUM CONCENTRATORS

- NAFION FIBER
- SELECTIVE EVAPORATION

LRAD –
LONG RANGE ALPHA DETECTION

- HISTORY OF LRAD AND ITS DERIVATIVES
- HOW THIS RELATES TO TRITIUM

MEASUREMENT LIMITATIONS

- MINIMUM AND MAXIMUM RANGE OF DETECTION
- UNCERTAINTIES
  - NIST-TRACEABLE TRITIUM STANDARD
  - TRITIUM DECAY CALCULATIONS
  - TRITIUM PERMEATION THRU CONTAINMENT (AND HYDROGEN INFILTRATION INTO CONTAINMENT)
  - CURRENT FLOW IN ION CHAMBERS
  - COUNTING EFFICIENCY

MEASUREMENT LIMITATIONS – CONTINUED

- UNCERTAINTIES - CONTINUED
  - SAMPLE SELF-SHIELDING
  - SAMPLE VOLUME
  - TEMPERATURE AND BAROMENTRIC PRESSURE
  - GAMMA CORRECTION
  - LEAKAGE CURRENT IN ION CHAMBERS
  - DARK CURRENT IN PMTS

INTERFERENCES

- EXTERNAL GAMMA FIELDS
- RADON AND THORON
- RADIOACTIVE GASES
- RF AND EMF
- AC AND BATTERY POWER FLUCTUATIONS
- TEMPERATURE SHOCK
- MECHANICAL SHOCK
- GEOTROPISM

CALCULATIONS

- CURRENT FLOW IN ION CHAMBERS
- ION COLLECTION EFFICIENCY IN ION CHAMBERS
- LSC EFFICIENCIES
- PROPAGATION OF UNCERTAINTY

CALCULATIONS

CURRENT FLOW IN ION CHAMBERS

For a 200 cc active volume at STP the ion chamber current flow is approximately 17 femto-amps for a concentration of 100 uCi/m^3

CALCULATIONS

PROPAGATION OF UNCERTAINTY

Tritium standard % uncertainty ~ 1.5%

Active sample volume % uncertainty ~2%

Gamma correction factor & uncertainty ~5%

Temperature & Pressure uncertainty ~2%

Combined % uncertainty ~

$\sqrt{(1.5^2 + 2^2 + 5^2 + 2^2)}$

$\sqrt{(2.25 + 4 + 25 + 4)} = 5.93$ % uncertainty

QUESTIONS ?
COMMENTS ?

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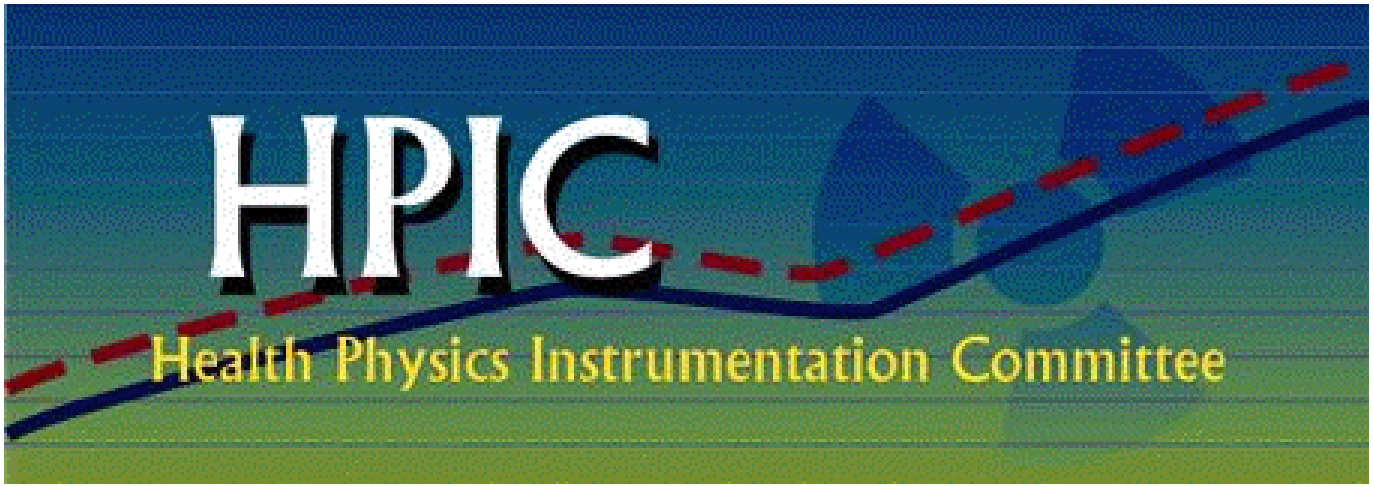

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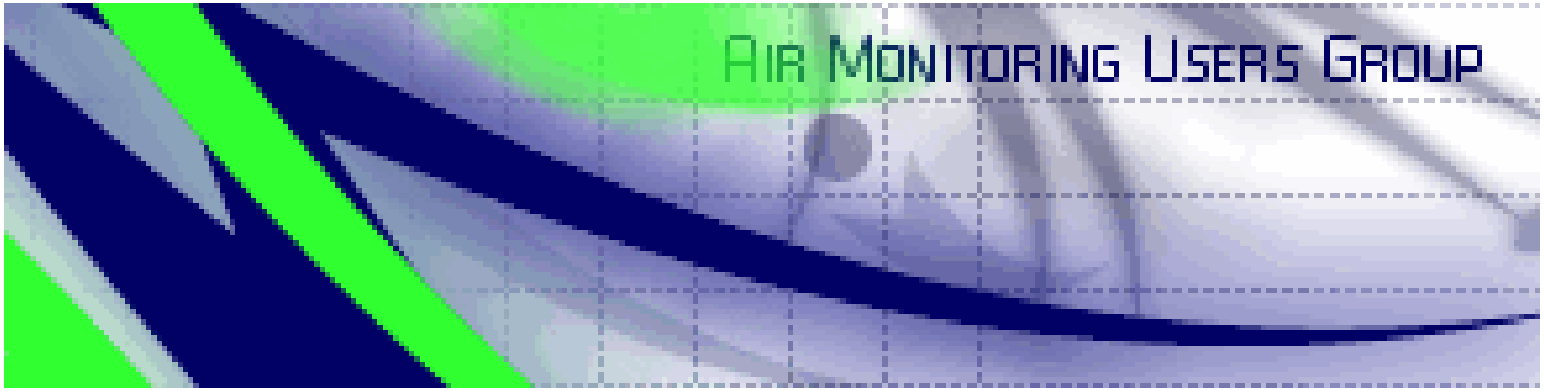

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