Acceptance Criteria for the Analysis of Performance Testing Samples for Effluent and Environmental Programs-Revisited

RETS/REMP Meeting

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Presentation Topics

- Review Current acceptance criteria for Effluent Performance Testing (PT) samples

- Propose new criteria for Eckert & Ziegler Analytics Effluent and Environmental Programs

- Solicit Input and Questions from Participants

EZA's PT Programs for Nuclear Power Industry

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- Radiological Effluents Measurements
  - Samples provided for most effluents;
    liquids, filters, charcoal, gases
  - Acceptance criteria from discontinued NRC Confirmatory Measurements Program

- Environmental Monitoring
  - Replacement for former EPA programs
  - Program provides more media/radionuclides -charcoal cartridges soil, water, vegetation air filters soil, water,
  - No acceptance criteria or pass/fail

Criteria for Accepting the Licensee's Measurements

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- The licensee's measurement is in agreement if the value of the ratio falls within the limits shown in the following table for the corresponding resolution.

Resolution*	Ratio
< 4	0.4 - 2.5
4 - 7	0.5 - 2.0
8 - 15	0.6 - 1.66
16 - 50	0.75 - 1.33
51 - 200	0.80 - 1.25
> 200	0.85 - 1.1

*Resolution is reciprocal of the NRC Uncertainty

i.e. 5%=1/.05 =20 Ratio = NRC Value/Licensee Value

Problems with Current Acceptance Criteria

- Designed for Split Samples
- Not appropriate for spiked samples which are chemically well behaved (no plate-out in liquid samples)
- Only uncertainties of EZA are taken into account
- Acceptance criteria too generous
- Not statistically based
- Doesn’t meet current recommendations in NRC Regulatory Guide 4.15 Rev. 2 and “MARLAP, Multi-Agency Radiological Analytical Protocols Manual”

Proposed Acceptance Criteria

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- Same Criteria used in ANSI-N42.22 for comparison between NIST and NIST-traceable Source Manufacturers

- Difference between the EZA value and Participant’s value must be less than the combined standard uncertainty of the difference multiplied by the coverage factor k=3

$$|V_A - V_C| \leq 3\sqrt{\mu_A^2 + \mu_C^2}$$

where $V_A =$ Analytics' Value ,

μ_A is the combined standard uncertainty of V_A,

$V_C = Customer's Value$

μ_C is the combined standard uncertainty of V_C

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Calculation of Uncertainties

- Requires Participants to include the combined uncertainty for each measurement which must include all <u>significant</u> uncertainties, not just counting uncertainty.

- Uncertainty budget must be determined for all variables in the equation for calculating results. Generally 2-4 factors will contribute most to the uncertainty depending on type of counting and analysis.

Gamma-ray Spectroscopy Uncertainty Budget includes:

- Counting Efficiency
- Counting Uncertainty
- Branching Ratio
- Half-life
- Sample Volume

Example of Combined Standard Uncertainty for Gamma Analysis of Liquid

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$$A(Bq/mL) = \frac{G - B}{\varepsilon * t * P_\gamma * V * e^{-\lambda * \Delta t}}$$

Where G = gross counts in photo peak, B = counts in background under photopeak ε = efficiency for gamma –ray energy of interest

t= counting time in sec, Pγ= probability of gamma ray emission

V= Volume of Sample, mL λ = decay constant , sec^{-1}

Δt = decay time,

Combined standard uncertainty in % is:

$$\mu_A(\%) = 100 * \sqrt{\left(\frac{\mu_{G-B}}{G-B}\right)^2 + \left(\frac{\mu_\varepsilon}{\varepsilon}\right)^2 + \left(\frac{\mu_{P\gamma}}{P\gamma}\right)^2 + \left(\frac{\mu_V}{V}\right)^2 + (\Delta t)^2 * \left(\frac{\mu_\lambda}{\lambda}\right)^2}$$

Uncertainties for other Methods

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- Expanded Uncertainty = $k * u_c$
- where k= coverage factor usually 2 (~2 sigma ~ 95 %) confidence) k=3 (~ 3 sigma ~ 99%)

- Radiochemical Measurements may additionally include uncertainties for:
  - Chemical yield
  - Self absorption factors
  - Quench corrections

QUESTIONS??