Gamma Products-Planchet Sample Changer for Ra228 & Ra226 Analysis

Each G3000 for Ra228 includes:

- G3000-S Front door shield (8" x 8" x 10"ID)
- 6" Steel Walls 5" detector slot with bushing
- Set up for standard in-line vertical dipstick germanium detectors (4" OD end cap unless otherwise specified)
  Customer must supply Gamma with detector dimensions
- 2 removable sample cartridge, each containing 25 carriers (for planchets 2" x 5/16" deep)
- Low background elevator and slide assemblies, minimal materials in the counting cavity
- PC-based system controller, running DOS operating system, works as a RS232 slave to the spectroscopy PC
- G3000 Software
- Installation on-site system assembly and test, function demonstrated via the RS232 link
- Customer is responsible to get off the truck and in the counting room
- Operators manual
- 1 Yr. Warranty parts and labor 90 days on site

The G3000 Automatic Planchet Sample Changer is set up for Ra228 Analysis. It's used for standard in-line vertical dipstick germanium detectors (4" OD end cap unless otherwise specified). Low background elevator and slide assemblies, minimal material in the counting cavity. 2 removable sample cartridges, each containing 25 carriers for planchets.

The motor control subsystem including power supplies, drive logic, end or travel sensors and cabling for 2-axis automatic control. 2-zone continuous Gas Purging system with enclosed sample ready stack and flow meters. Pentium class PC Controller, running DOS operating systems works as a RS232 slave to the spectroscopy. The external mode using a PC serial port via an RS232 to communicate changer commands from an outside source. It does not include detector, MCA, Spectroscopy PC or Integration with it.

Ra-226 & Ra-228 Drinking Water Analysis by gamma-spec (Sales points)

(8Jan06 complied with care from assumed reliable sources – everyone is responsible for their own interpretations)

The Safe Drinking Water Act (SDWA) requires all Public Water Supplies (PWSs), to measure the **Ra226** and **Ra-228** activity of their water systems at **each individual collection point** for a minimum of 4 successive quarters. There are some provisions to composite samples. Gross alpha is required <15pCi/L total including unknowns. If the gross alpha radioactivity measured as > 5 pCi/L, then the measurement of **Ra-226 is also required** to show compliance with the 5pCi/L total limit for Ra226 and Ra-228. As **Ra-228 is a beta emitter and will NOT** be seen in a gross alpha screen, **ALL samples must be tested specifically for Ra-228.** These requirements will generate a very significant increase in the amount of Rad testing on drinking waters in 2006 – 2007 and to some extent beyond.

Doing the Ra-228 by gamma spec has two advantages relative to the traditional methods: 1) dramatically **reduced chemistry work** for sample preparation and 2) you automatically get **Ra-226 & Ra-228 at the same time.**

The SDWA anticipates treatment for waters out of compliance; it would seem logical that the testing requirements for the treated waters would be the same. But?

General Requirements for Acceptable Water:

Gross alpha<15pCi/L
Combined Ra226/8 <5pCi/L
Ra-224 is part of gross alpha but holding time to long (t-1/2=88h)
Beta emitters 4mrem/yr (outside the scope of the a/B and Ra226-R228 problem)
U <30ug/L all isotopes, this is a mass specification not isotopic
Requirements cover community water systems, all size and categories
Rules may require treatment to be installed – there are discussions of methods in EPA documents required 1pC/liter MDA
Initial monitoring in 4 successive quarterly measurements shows compliance
Measurement to be done between 2003 and 31Dec2007
Some systems may be grand fathered in based on data prior to 2003
There are provisions for either reduced or increased monitoring based on measured activities

DATES:

Data collected prior to Dec 2003 may be eligible for use as grand fathered data
ON 8Dec03 Water systems begin initial monitoring unless the State permits use of grand fathered data.
31 Dec07 all systems must complete initial monitoring,

Ra-228 Analysis plan – by chemistry and traditional Beta counting

Do a chemical separation for radium, then an in growth for Ac-228, another chemical separation for the Actinium and then **multiple and immediate gross Beta counts before the Ac-228 decays (t=1/2 6.1 hr)** (chemical separations via methods Ra-05 or 904.0). There are mathematical corrections for: 1) in growth between the Ra precipitation and the Ac separation, (36hrs is equilibrium) 2) decay time between the Ac separation and starting the count and, 3) the decay during counting interval. (The typical count time for the RA-228 measurement is ~50min. You need to do 2 counts with some time separation to show it is decaying properly and confirm that nothing else broke through the chemistry procedure)

Ra-228 Analysis plan – by gamma spec:

EPA approval of g-spec method expected to be signed 15Dec05 and should be published in the Federal Register the next week (That didn't happen – it is now predicted to be mid Feb 06)

Ra-228 is measured from its Ac-228 daughter and Ra-226 is measured from its Bi-214 and Pb-214 daughters

A 2 liter aliquot is spiked with BaC1 (~45ug) and then hit with H2SO4 to precipitate the BaSO4 (~80mg recovery weight) – the weights are compared (after adjustment for the compounds) for a recovery factor. The precipitate sample is collected as a ~20mm spot on a planchet or small button and presented to a HPGe detector for counting. The method needs a short-fat HPGe detector with diameter >50mm and depth sufficient, also ~50mm, for stopping the 911 and 968key photons of Ac-228. **Extra size can just add extra background.** (This **typically results in a 10-20K sec (3-6hr)** counting time. It is cost efficient to **automate this process with a sample changer** in order to get back shift and weekend production out of your detector. There is no Ra-228 requirement that the samples be counted quickly after preparation. A 2 week in growth is recommended for the Ra-226 if needed)

There is an assumption that the Ac-228 comes down quantitatively with the same precipitation as the Ra (if not a 2 day in growth re-establishes equilibrium)

Ra-226 daughters Pb-214 and especially Bi-214 have significant true summing problems in gamma spectroscopy, and those problems are compounded by these close counting geometry's. However if you do your initial calibrations with a NIST Ra standard the problem all goes away into the calibration. You are still left with the reduced apparent efficiency due to the counts lost to the summing. The equilibrium chain is broken by the initial sample prep-you need 15 – 20 days of ingrowth after the H2SO4 precipitation to re-establish equilibrium

Typically the Ra-228 drives the count time as the MDA for Ra226 will be ~1/2 that for Ra228 at a given count time

Airborne Rn-222 bkg in the lab is of interest as its decay leaves Pb-214 and Bi-214 that can accumulate in the detector/shield or in/on in the samples during preparation. The short half lives mean that the process is self-cleaning if current re-accumulation can be controlled.

Decay Schemes

Th-228 (5.7y) --> Ac-228 (6.1h) 338keV(12% + 911keV(29%) + 968keV**(17%)
**968 is a multiple peak with branch summed – watch peak width
There are not many complicating gamma down chain from Ac228

Ra-226(16000y)-->Rn-222(92h)-->Po-128(183s)-->
Pb-214(26m) 295keV(19%)+352keV(37%) -- >
Bi-214(20m) 609keV(46%)+1120keV(15%)+1764keV(16%)
There are not many complicating gamma down chain from Pb and Bi214

Ra-224(88h)-->Rn-220(56s)-->Po-216(0.2sec)-->
Pb-212(10h) 238keV(43%)-->Bi-212(60h)727keV(12%)
Ra-224 is part of gross alpha but pre-analysis holding time may be too long(t-1/2=88h)

System MDA requirements:

TABLE 1, REQUIRED REGULATORY
DETECTION LIMITS FOR THE VARIOUS
RADIOCHEMICAL CONTAMINANTS

Contaminant	Detection Limit (pCi/L)
Gross Alpha	3
Gross Beta	4
Radium-226	1
Radium-228	1
Cesium-134	10
Strontium-89	10
Iodine-131	1
Tritium	1,000
Other radio nuclides and Photo/Gamma Emitters	0.1 of the rule