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WIPP air monitoring measurements with the iSolo, Bladewerx ASC and the Alpha-7 CAMs

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Conduct of Operations

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- Primary drivers for choosing a method are driven by safety and quality
- Implementation procedure must readily facilitate verbatim compliance from a minimally trained individual
  - Someone who barely meets the training, experience and education requirements to work in that position
- Procedure has to produce a product which can be verified empirically to meet established precision and accuracy requirements
- Procedure must be sufficiently succinct and clear to allow identical actions to be taken by operators when adhering to verbatim compliance
  - Verbatim compliance is mandatory in ConOps

Chronology

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- 8/17/09 Began first Bladewerx ASC and iSolo instrument measurements
  - Measuring salt loaded and ambient dust loaded air filters only
- 9/8/09 Swapped out iSolo as calibration ran out
- 9/30/09 Began intermixing anthropogenic alpha, beta and mixed alpha beta source with Rn progeny measurements
- 10/8/09 Suspended ASC measurements
  - Process requires external laptop
  - Output indeterminate for extended count periods
- 10/19/09 Swapped out iSolo to conduct data transfer
  - 1 uCi (2e6 dpm) Am241 check sources saturate iSolo counter
  - Requested and obtained vendor support in data transfer

Chronology continued

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- 10/23/09 Data transfer difficulties, local Canberra rep helped but large amounts of data lost and deemed unretreivable
  - Unit returned to testing after incomplete data transfer
- 11/9/09 Began Alpha-7 measurements
- 12/8/09 Began another attempt at data transfer from iSolo for Canberra after alerting them to poor measurement results
  - Unit returned to testing after incomplete data transfer
- 1/4/10 Returned Eberline Alpha-7 loaner
- 1/18/10 Obtained and set up loaner Alpha-7 from LANL for additional measurements
- 2/4/10 Observed drastic noise spikes on Alpha-7
  - Replaced sample head and eliminated problem

Bladewerx ASC

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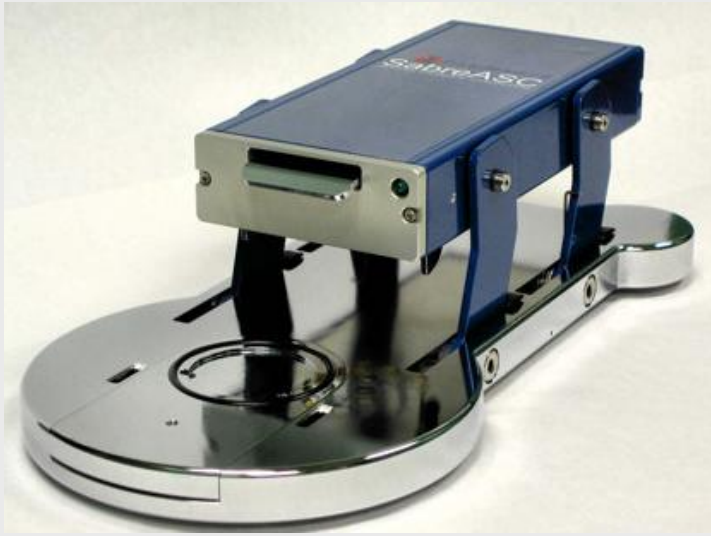
- Activity and spectrum logging
- Automatic min-count time determination
- Live “strip chart” display of activity, Detection Level, action level, and elapsed time
- Isotope peak-fitting algorithm
- Low maintenance



Initial indications were all good

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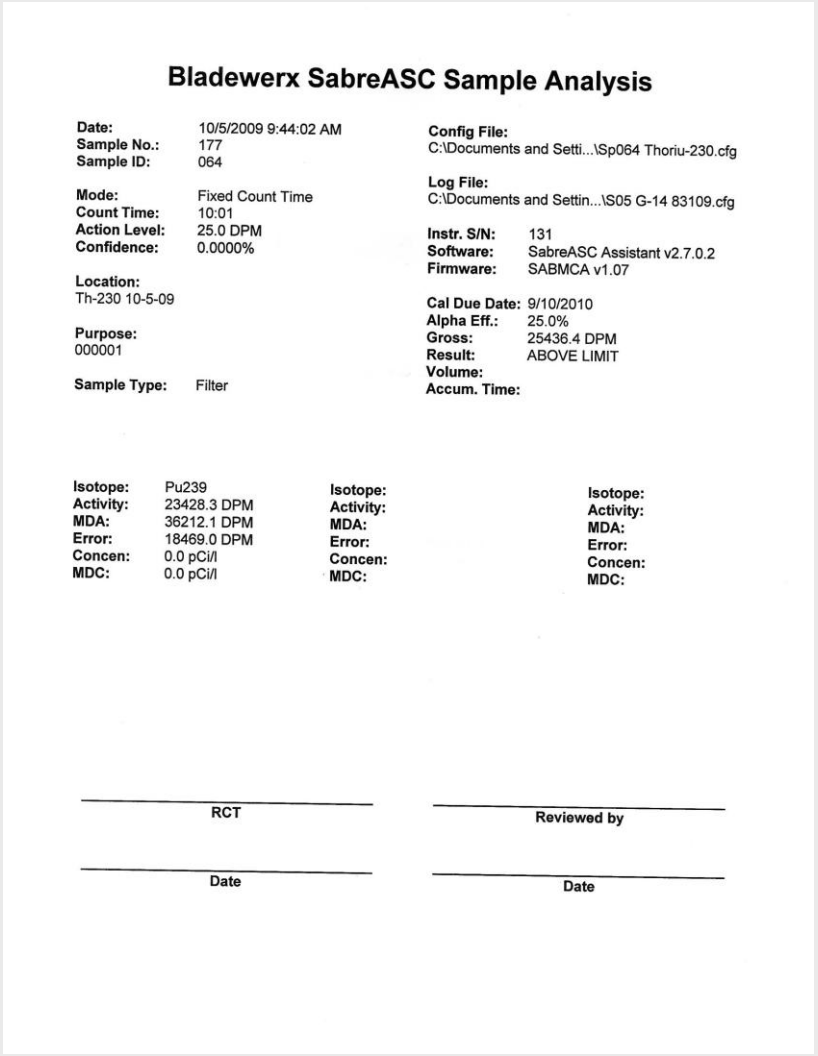
- Unit is small, sleek, portable and low maintenance
- Printout was straightforward and easy to read
- Instrument came from a reputable vendor
- Instrument was very cost effective compared to other potential systems.



Bladewerx SabreASC Sample Analysis

Date:	10/5/2009 9:44:02 AM	**Config File:**	C:\Documents and Setti...\Sp064 Thoriu-230.cfg
Sample No.:	177		
Sample ID:	064	**Log File:**	C:\Documents and Settin...\S05 G-14 83109.cfg
Mode:	Fixed Count Time	**Instr. S/N:**	131
Count Time:	10:01	**Software:**	SabreASC Assistant v2.7.0.2
Action Level:	25.0 DPM	**Firmware:**	SABMCA v1.07
Confidence:	0.0000%		
Location:	Th-230 10-5-09	**Cal Due Date:**	9/10/2010
		Alpha Eff.:	25.0%
Purpose:	000001	**Gross:**	25436.4 DPM
		Result:	ABOVE LIMIT
Sample Type:	Filter	**Volume:**	
		Accum. Time:	

Isotope:	Pu239	**Isotope:**		**Isotope:**	
Activity:	23428.3 DPM	**Activity:**		**Activity:**	
MDA:	36212.1 DPM	**MDA:**		**MDA:**	
Error:	18469.0 DPM	**Error:**		**Error:**	
Concen:	0.0 pCi/l	**Concen:**		**Concen:**	
MDC:	0.0 pCi/l	**MDC:**		**MDC:**	

RCT _____ Reviewed by _____

Date _____ Date _____

Reasons ASC system was not pursued

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- When activity could not be quickly assayed below limits, wait times of many minutes could ensue.
- When samples were counted for extended periods of time, the assay would “dogtail” going very high and very low in erratic oscillations.
- The unit required a peripheral laptop
  - Note the current WIPP path forward now requires a laptop
- The unit did not have a sufficiently simple written calibration/operation procedure
  - Note the current WIPP path forward required a new custom procedure to be written
  - A WIPP radiological engineer could not feel confident with the unit
- In retrospect, the unit probably should have been tested further prior to returning to the vendor.

Alpha-7, some vendor claims

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- Calculates isotopic activity by mapping the peak(s) rather than using regions of interest (ROI)
- Advanced peak shape algorithms
- Tracks alpha-emitting daughter products
- Automatic gain control based on naturally occurring peaks
- Spectrums updated once per second
- Pentium class PC based, Windows 2000 operating system
- Full-Featured Windows-based client software presents grahpical displays of spectrum and status to any networked or local PC
- Alpha spectral data updated every second, RadNet Compliant
- High visibility display for status and messages

Alpha-7

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- Initial unit sent back to Eberline
- Current unit on loan from LANL (we take their waste for good)
- Fit parameters look promising
- Display is large but requires external monitor

Current status of the alpha-7

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- Testing has not been overtly halted but the current WIPP path forward is to use a custom application of the iSolo
- The alpha-7 still has some very attractive features (such as large interactive display)
- No alpha-7's are currently owned by WIPP but the unit is on loan so long as future testing is continued
- The curve fitting algorithm has been validated by LANL (through Dave Wanigaman) to work appropriately for CAM applications
- The WIPP application is not for CAM use necessarily and so would require appropriate verification and validation

iSolo

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- Optional scintillation cosmic guard detector
- Vendor claims it automatically identifies and compensates for radon, thoron and progeny interference
- N NiMH battery power for 10 hours or more
- Compatible with essentially all filter types and multiple sizes

iSolo alpha Efficiency Calibration Results

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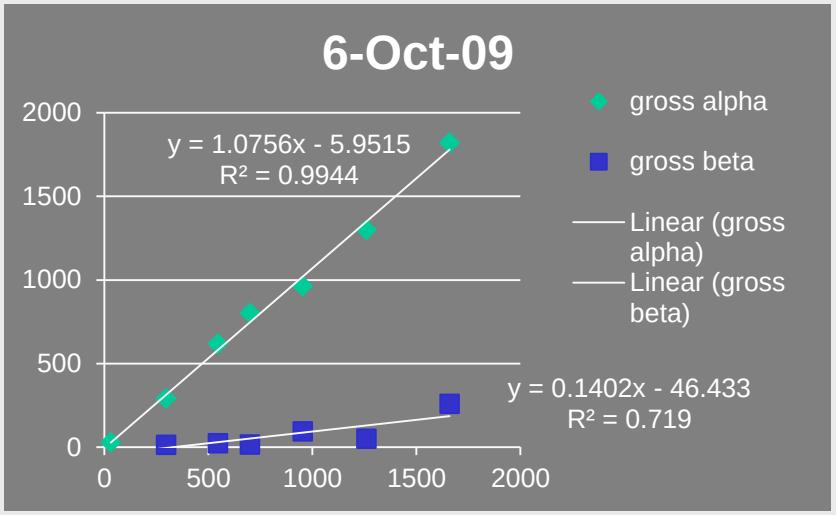
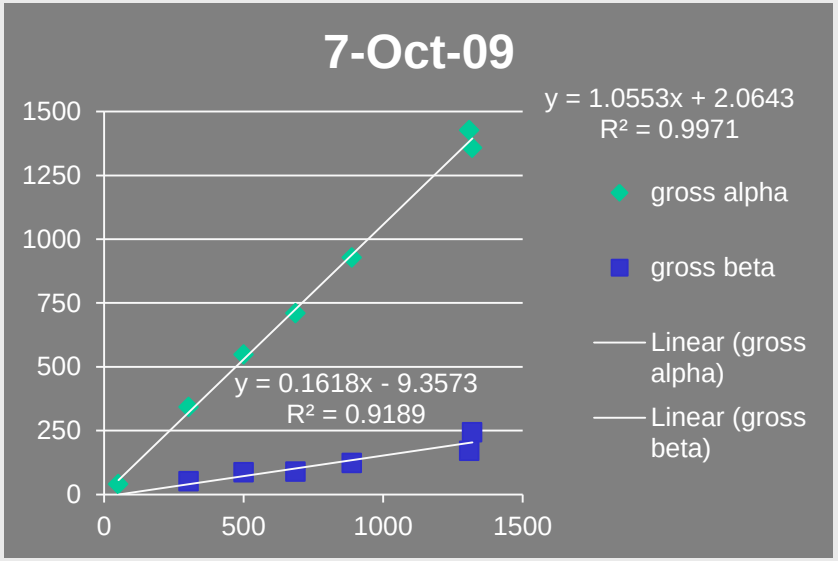
- All Pu239 sources showed a 15% proportional beta count result from the iSolo
  - In principle this could be corrected after the fact
- The calibration is well within tolerance.
  - The unit used in the measurements shown here had a slight positive bias (~6%)





iSolo beta Efficiency Calibration Results

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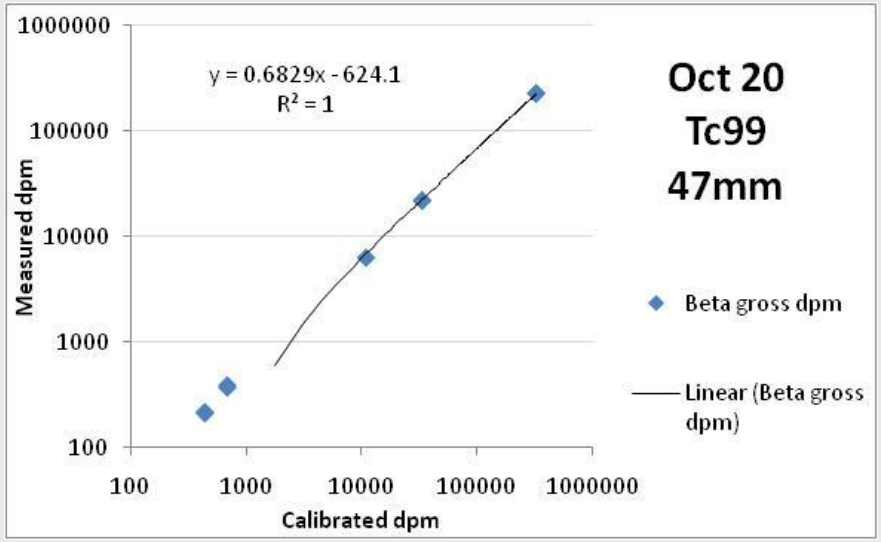
- For high energy beta (Sr/Y), calibration was very good
- For low energy beta (Tc99), calibration showed an activity dependent bias
  - Speculated to be due to low level discriminator to eliminate normal noise at low signal level
  - Beta is at the lowest energy levels



isotope	beta cal dpm	Beta gross dpm	Alpha gross dpm	beta efficiency
Tc99	446	215.52	13.5	4.83E-01
Tc99	446	209.46	14.1	4.70E-01
Tc99	697	386.18	4.01	5.54E-01
Tc99	697	367.99	3.5	5.28E-01
Tc99	11100	6255.28	0.45	5.64E-01
Tc99	34000	21787.8	4.01	6.41E-01
Tc99	34000	21801.66	2.23	6.41E-01
Tc99	331000	2.26E+05	27.15	6.83E-01
Tc99	331000	2.25E+05	29.53	6.80E-01

WIPP RAF measurements

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- Measurements made by an RCT supervisor
- Measurements made of actual radiation assessment filters taken during WIPP operations
- Measurements are only representative of a sampling of waste streams at WIPP
- Results considered include
  - Beta to alpha ratio as a function of gross alpha dpm
  - TRU activity estimate as a function of gross alpha dpm
    - Potential dependence found for blank filters having only radon progeny as verified by delayed counting

WIPP measurement of the RAF

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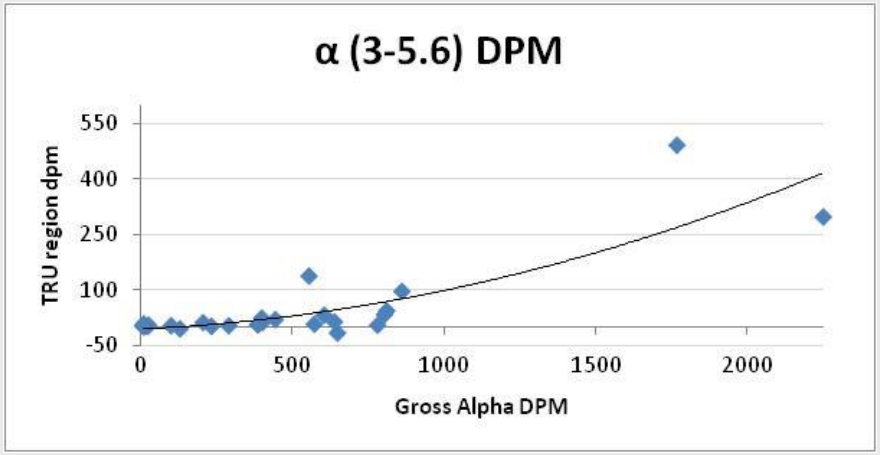
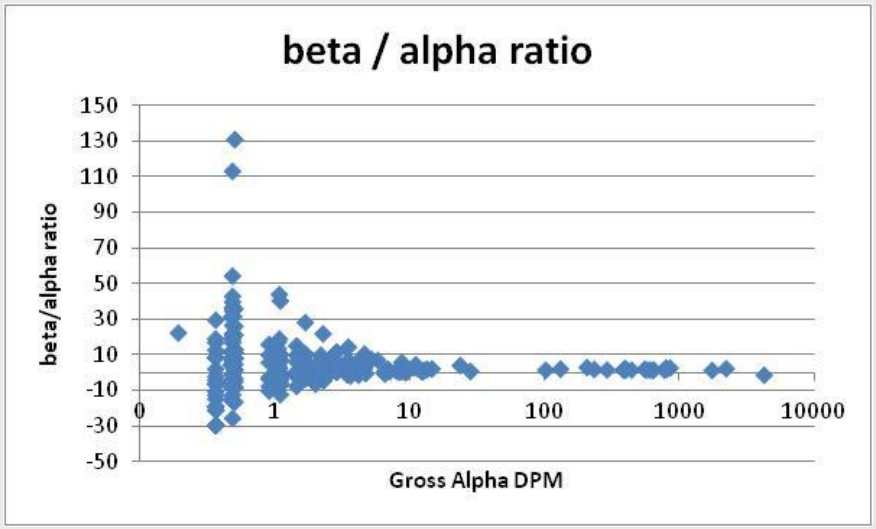
- Canberra algorithm shows TRU overestimate at elevated gross alpha indicating unacceptable performance for WIPP application
- Beta alpha ratio on blank filters asymptotically approached 2.3 ± 0.8
  - Would have to demonstrate the ability to discriminate mixed alpha beta anthropogenic





iSolo Measurement Results from WHC

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- Confirmation of the WIPP testing results that mixed alpha and beta anthropogenic has tendency to substantially underestimate TRU activity.
- Was done using both natural Uranium and Thorium containing materials.

Table 6 (WCH-172 Rev. 0)	308W Hood TH/U/Ra/Rn Test	
Time post sample (min)	Percent detected, Radon compensated	Count length
40	33.1%	10
50	20.3%	10
60	26.3%	10
100	51.9%	30

Table 7 (WCH-172 Rev. 0)		
Source/Nuclide	Percent detected, Radon compensated	Sample ID
Pu/Am	93.50%	1
Unat 47 mm	90.2%	2
Pu-239	95.50%	3
Unat	43.9%	4
Unat	8.1%	5 (30 min)
Unat	15.3%	6 (30 min)
Unat	72.7%	8
Pu-239	132%	9
Pu-239	117%	10
Pu-239	176%	12

WIPP measurements with mixed alpha and beta anthropogenic

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- Many values showed reasonable assay results, particularly with pure alpha anthropogenic
- Many mixed alpha and beta assays underestimated the TRU content to unacceptable values
  - Beta assay component acceptable
- Average blank filter assay 490 ± 73 dpm alpha (COV=15%)
- iSolo assay with used filters 328 ± 247 dpm alpha (COV=75%)
- Confirmed WHC results

iSolo blank filter (dpm)	Rn loaded filter with source (dpm)
384	409
439	505
521	747
510	98
558	83
528	327
481	129
409	
449	
624	

Recognition of iSolo results prompted WIPP to take a new direction

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- Keep it simple
- Make it operationally friendly
- Make sure a rigorous technical basis document includes verification and validation
- Base all safety related decisions on measurements from tested equipment and validated procedures

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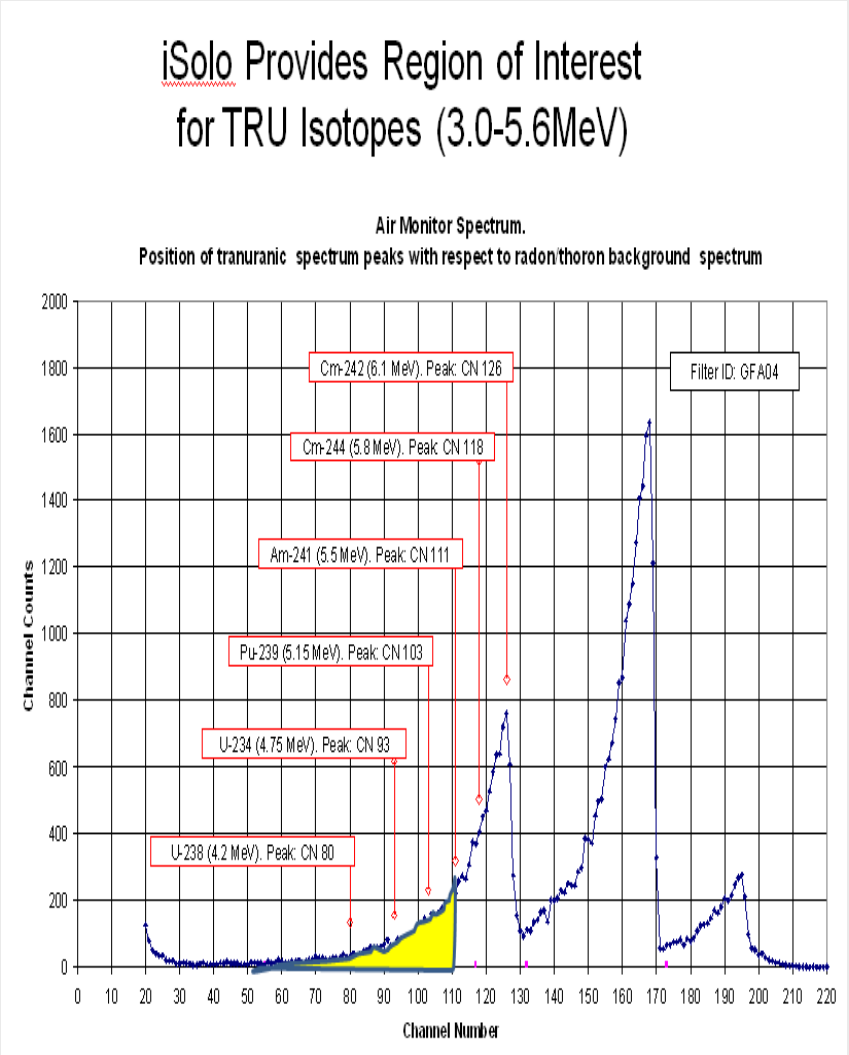
WIPP Simple Fix

- The TRU ROI contains only a small fraction of the total counts
- By ascribing the total number of counts in the TRU ROI to TRU activity, a conservative simple assay is possible.
- Requires laptop download and analysis of spectra.



WIPP Algorithm Approach

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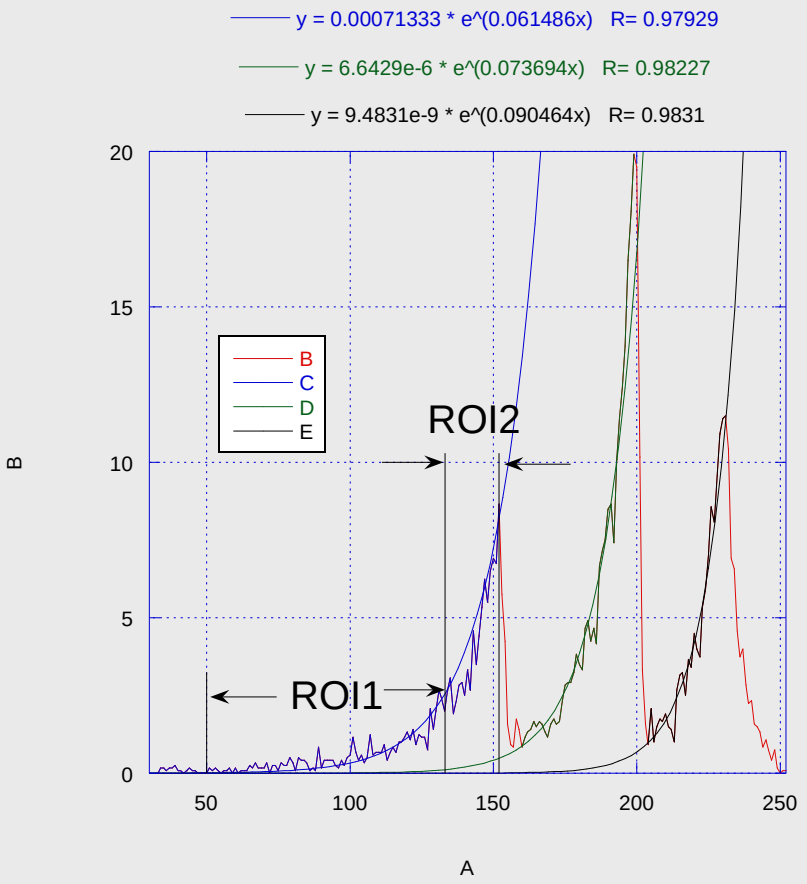
- Intended approach is modified ROI method
- The basic proportionality is given by
  - TRU counts for assay

    = ROI1 - 0.7*ROI2
- Correction for exponential tail on ROI2 only with new proportionality constant



Decay Curve Fitting Assay

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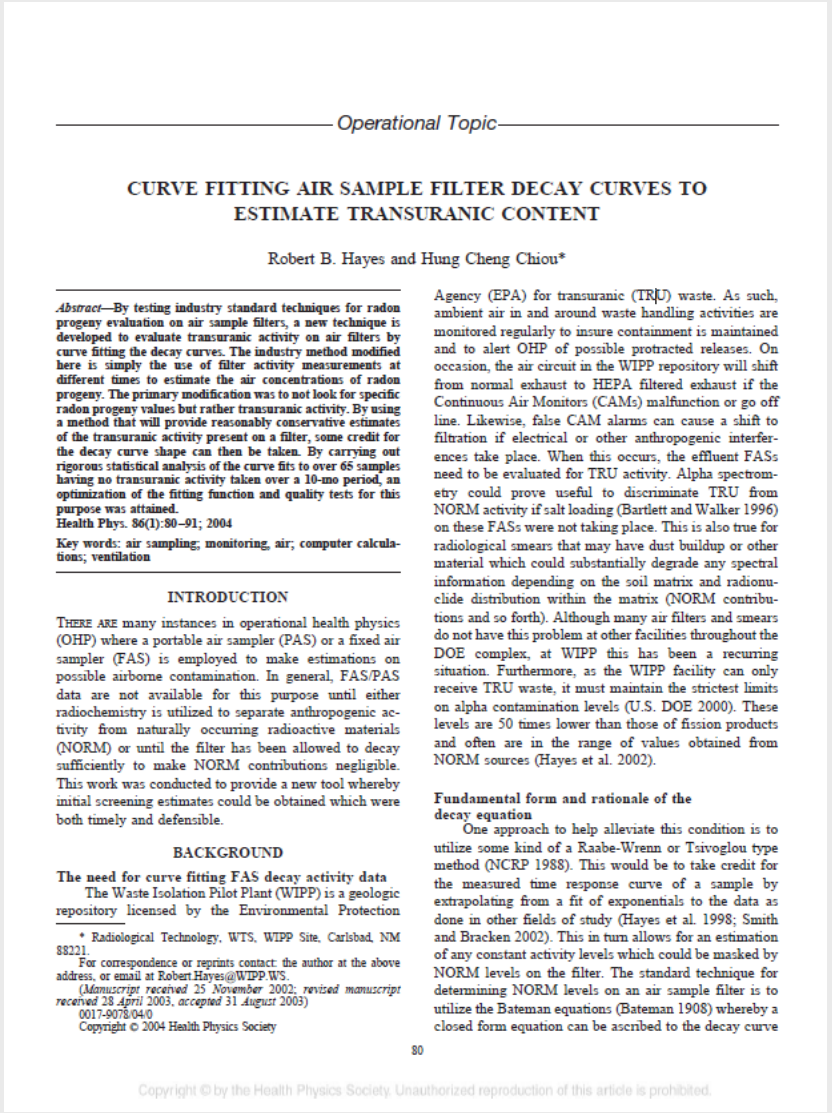
- Validated for gross alpha activity
  - Values tend to be in the range of only half the last measurement
- When used on only the TRU ROI, initial results are very promising
  - Preliminary results show 20 dpm limits may be routinely possible



Operational Topic

CURVE FITTING AIR SAMPLE FILTER DECAY CURVES TO ESTIMATE TRANSURANIC CONTENT

Robert B. Hayes and Hung Cheng Chiou*

Abstract—By testing industry standard techniques for radon progeny evaluation on air sample filters, a new technique is developed to evaluate transuranic activity on air filters by curve fitting the decay curves. The industry method modified here is simply the use of filter activity measurements at different times to estimate the air concentrations of radon progeny. The primary modification was to not look for specific radon progeny values but rather transuranic activity. By using a method that will provide reasonably conservative estimates of the transuranic activity present on a filter, some credit for the decay curve shape can then be taken. By carrying out rigorous statistical analysis of the curve fits to over 65 samples having no transuranic activity taken over a 10-mo period, an optimization of the fitting function and quality tests for this purpose was attained.
Health Phys. 86(1):80–91; 2004

Key words: air sampling; monitoring, air; computer calculations; ventilation

INTRODUCTION

THERE ARE many instances in operational health physics (OHP) where a portable air sampler (PAS) or a fixed air sampler (FAS) is employed to make estimations on possible airborne contamination. In general, FAS/PAS data are not available for this purpose until either radiochemistry is utilized to separate anthropogenic activity from naturally occurring radioactive materials (NORM) or until the filter has been allowed to decay sufficiently to make NORM contributions negligible. This work was conducted to provide a new tool whereby initial screening estimates could be obtained which were both timely and defensible.

BACKGROUND

The need for curve fitting FAS decay activity data

The Waste Isolation Pilot Plant (WIPP) is a geologic repository licensed by the Environmental Protection Agency (EPA) for transuranic (TRU) waste. As such, ambient air in and around waste handling activities are monitored regularly to insure containment is maintained and to alert OHP of possible protracted releases. On occasion, the air circuit in the WIPP repository will shift from normal exhaust to HEPA filtered exhaust if the Continuous Air Monitors (CAMs) malfunction or go off line. Likewise, false CAM alarms can cause a shift to filtration if electrical or other anthropogenic interferences take place. When this occurs, the effluent FASs need to be evaluated for TRU activity. Alpha spectrometry could prove useful to discriminate TRU from NORM activity if salt loading (Bartlett and Walker 1996) on these FASs were not taking place. This is also true for radiological smears that may have dust buildup or other material which could substantially degrade any spectral information depending on the soil matrix and radionuclide distribution within the matrix (NORM contributions and so forth). Although many air filters and smears do not have this problem at other facilities throughout the DOE complex, at WIPP this has been a recurring situation. Furthermore, as the WIPP facility can only receive TRU waste, it must maintain the strictest limits on alpha contamination levels (U.S. DOE 2000). These levels are 50 times lower than those of fission products and often are in the range of values obtained from NORM sources (Hayes et al. 2002).

Fundamental form and rationale of the decay equation

One approach to help alleviate this condition is to utilize some kind of a Raabe-Wrenn or Tsivoglou type method (NCRP 1988). This would be to take credit for the measured time response curve of a sample by extrapolating from a fit of exponentials to the data as done in other fields of study (Hayes et al. 1998; Smith and Bracken 2002). This in turn allows for an estimation of any constant activity levels which could be masked by NORM levels on the filter. The standard technique for determining NORM levels on an air sample filter is to utilize the Bateman equations (Bateman 1908) whereby a closed form equation can be ascribed to the decay curve

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0017-9078/04/0

Conclusion

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- WIPP has enjoyed 10 years of safe regulatory compliant operations disposing of radioactive waste in a fully licensed deep geological repository.
- WIPP has demonstrated a commitment to finding science based solutions to technically demanding problems and has enjoyed measureable success in doing so.
- WIPP is committed to the continuing science based operations focused on safety integrated into our regulatory compliant disposal of TRU waste in the worlds first licensed geological repository for TRU waste.
- WIPP culture succeeded in designing a safe and ALARA compliant LWFC for operations optimization.