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TEST REPORT: CANBERRA iCAM ON THE 291-H STACK

Summary

A Canberra model iCAM, "Alpha Beta Continuous Air Monitor" was tested for service on the 291-H stack effluent. This testing occurred during dissolver operations between April 19 and May 24, 2005. This monitor was tested per the Test Plan (Reference 1). With a newly-designed acid-resistant detector, the iCAM performed very well and shows no sign of degradation. The iCAM is housed in 292-3H.

Test Criteria

The test scope was to evaluate the durability and algorithm functionality of the iCAM with the corrosive-resistant detector.

The durability is demonstrated by the stable response of the iCAM to the Am-241 and Cl-36 sources. It is also demonstrated by the absence of either fault indications on the instrument or any visual indication of deterioration.

The algorithm functionality is demonstrated by low derived readings for long-lived particulate radioactivity in the presence of large and variable thoron levels. The readings were consistent with the environmental samples of record for stack effluent particulate radioactivity during this period.

History

In early 2004, the iCAM was installed for evaluation. It functioned well whenever a new detector was installed, but the original detector design was not resistant to the corrosive atmosphere of the stack. The stack effluent contains nitric acid and oxides of nitrogen due to dissolution operations.

Three model 450 detectors were tried and none lasted more than three weeks. The first was installed in February or March 2004 and had no history of successful operation. It may have worked for some period of time before May. (There was limited technical oversight of the iCAM at this time.) The second was installed August 11 and failed August 24-28. The third was installed September 21 and failed October 8.

The last detector to fail was analyzed by Scanning Electron Microscope (reference 4). The detector originally had an aluminum coating 1500 angstroms thick. Inspection showed that there were two distinguishable areas of the detector, the middle portion, which was spotted lightly with residual portions of the coating and an edge, where the coating was much denser with a texture appearing scaly under the microscope.

New Detector

The iCAM was provided with a new, acid-resistant detector, the Canberra AR/450 ASV. Canberra offered the detector free of charge for testing and it has not yet been marketed commercially. This detector model is also being tested at the Sellafield site.

The new detector was expected to have some sensitivity to light, but sensitivity was checked and found to be negligible. The nylobraid hoses leading to and from the iCAM were sealed against light to ensure that light sensitivity not be an issue.

The AR/450 ASV is a single diode detector; it lacks a second diode which was used by the model 450 for gamma sensitivity. David Ryden of Canberra noted, “An iCAM fitted with single-diode detector will not be able to dynamically compensate for varying gamma backgrounds. I think that this should only be a problem if the iCAM is exposed to high and variable ambient gamma fields. (Without gamma compensation, the beta background due to ambient gamma radiation is approximately 1.5 c.p.s per microGray/hour.)” Since we have low and steady gamma rates at the sample room in 292-3H, the lack of gamma compensation has not been a problem.

Original installation with the new detector provided low source check readings on iCAM # 0348. We took the first iCAM out of service and installed the detector in iCAM, #0155 on March 29, before the test period. The cause of iCAM #0348 failing will be investigated when a tube is available for calibration.

Source Check Evaluation

Source checks have been very consistent over the test period. Source check data is provided in the chart below. Beta background varies most notably, but has not been a problem. This variation is due to a buildup of contamination of Pb-212 on and around the detector.

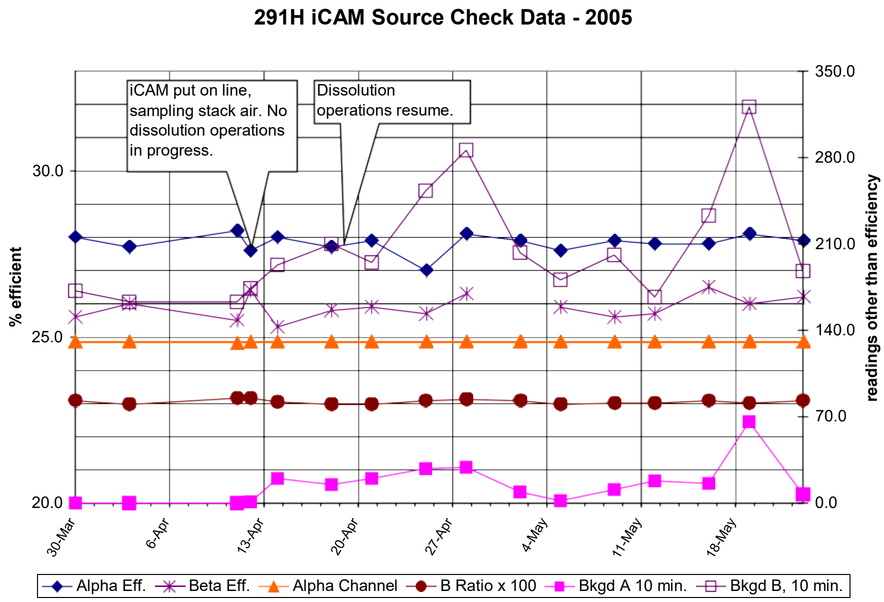

Figure 1: 291H iCAM Source Check Data, 2005

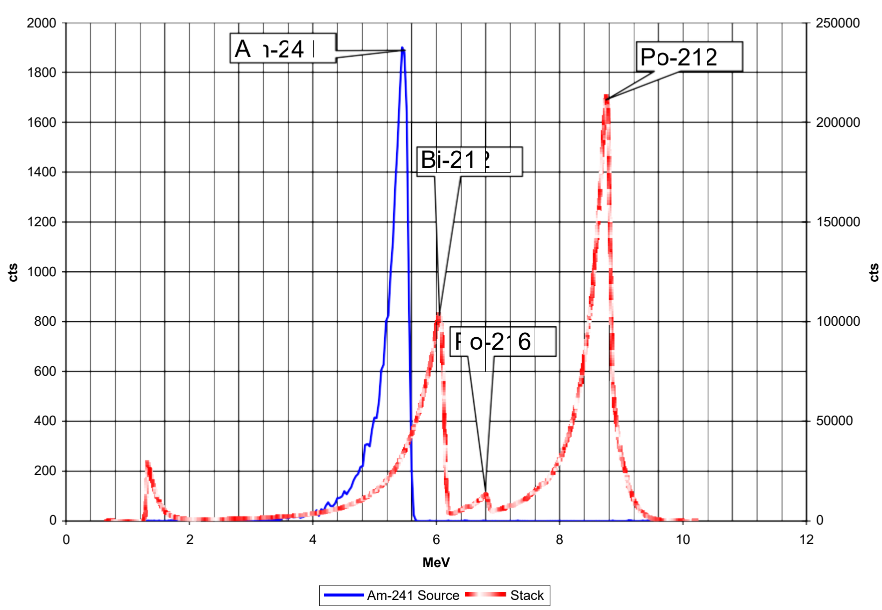

Figure 2: Thoron spectrum from stack and Am-241 Source Check

Algorithm Functionality

The iCAM algorithm calculates long-lived radioactivity by subtracting the radon and thoron daughter contributions in the alpha energy spectrum from the region of interest.

The sample spectrum above shows the normal thoron-dominated radioactivity and the source check spectrum in our region of interest for long-lived radioactivity.

The iCAM archives data per the following protocol until reset:

- 5 minutes (Gross CT - Counting Time),
- 20 minutes (Gross LT - Long Term) and
- 1 week (Gross).

Air sampling for particulate radioactivity is always impacted by radon and thoron decay products. The 291-H stack effluent differs significantly from normal, radon-dominated air. This is demonstrated in the next figure which sampled the local air in 292-3H and the stack air:

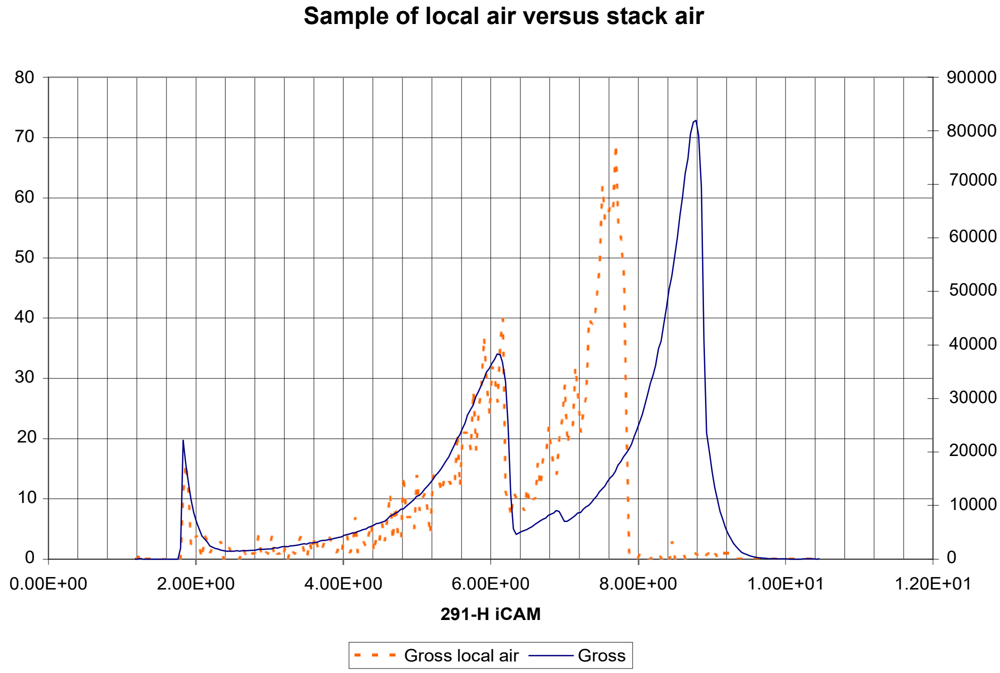

Figure 3: Stack (thoron) vs. Local (radon) Air

A minor change was made per the vendor's instructions to fine-tune the algorithm to the thoron spectrum. The parameters, provided in Table 1 establish the expected location of the thoron daughter peaks and structure of their tails. The parameters are proprietary, but it is known that the K values refer to channel numbers and beta readings provide tuning of the algorithm based on the factor, Wbeta.

Table 1: Tailored Parameters for Thoron-dominated effluent air with AR450 detector

Parameter	Default Value	Modified Value (Requires Am-241 Calibration Check)
Section: Compensation		
K2 Default	122	131
K3 Default	143	152
K4 Default	185	170
KRN1	134	143
KTn1	135	144
KRn2	178	165
KTn2	207	219
Section: Compensation		
RK4	1.52	1.31
RKTn1	1.105	1.10
RKRn2	1.46	1.27
RKTn2	1.695	1.67
Section: Internal Development		
Ern2Min	1.02	1.04
ER2Max	1.1	1.09
W3	15	5
W4	8	7
Wbeta	5	3

The parameter changes caused the compensation to change in the range of about channel 110 to 155 as shown in the snapshot spectra (COMP LT line) before and after the change:

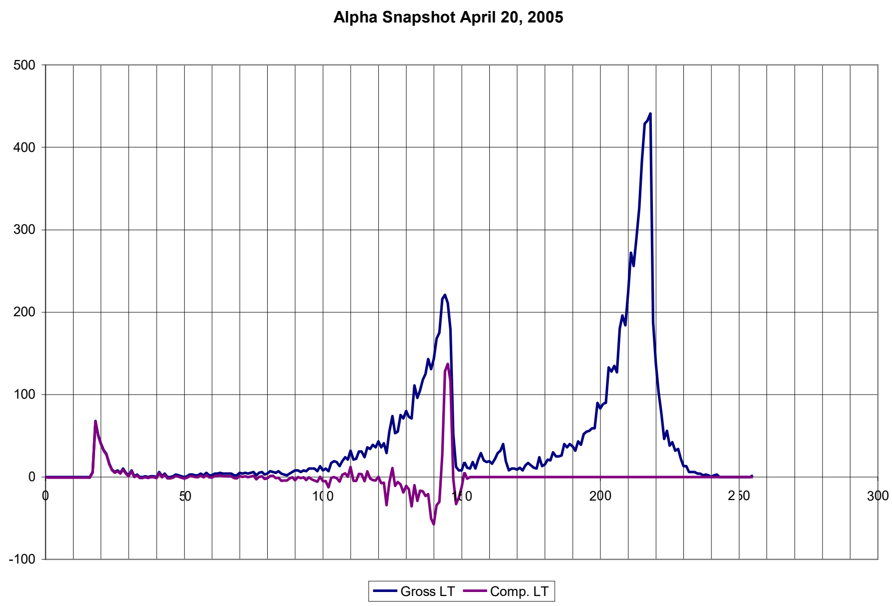

Figure 4: Alpha Spectrum before parameter change

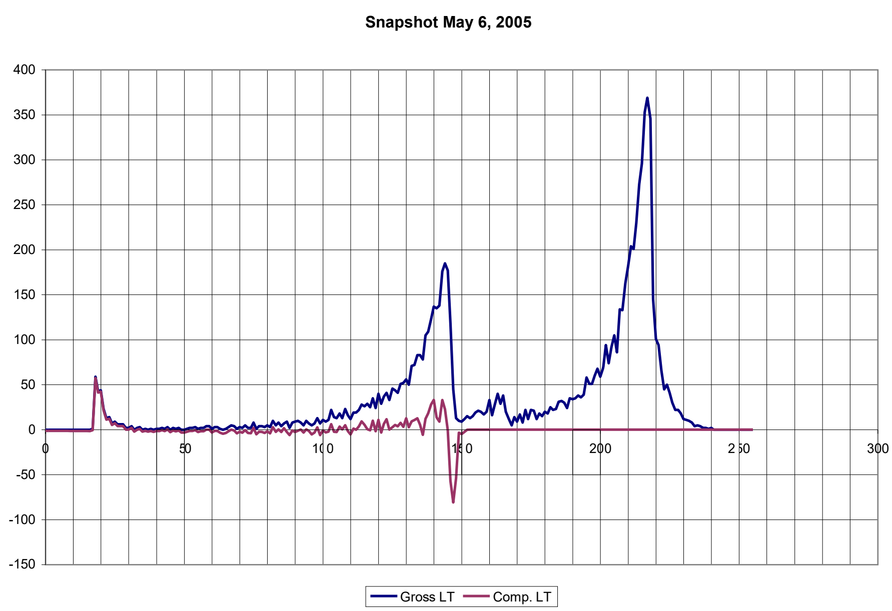

Figure 5: Alpha spectrum after parameter change

The compensation change succeeded in correcting the prior negative bias. Figure 6 shows the compensation values for all 448 snapshot spectra collected during the test period. After the change on April 28, the values show that the negative bias has been removed in almost all cases. Figure 7 shows that small negative values are associated with short acquisition times.

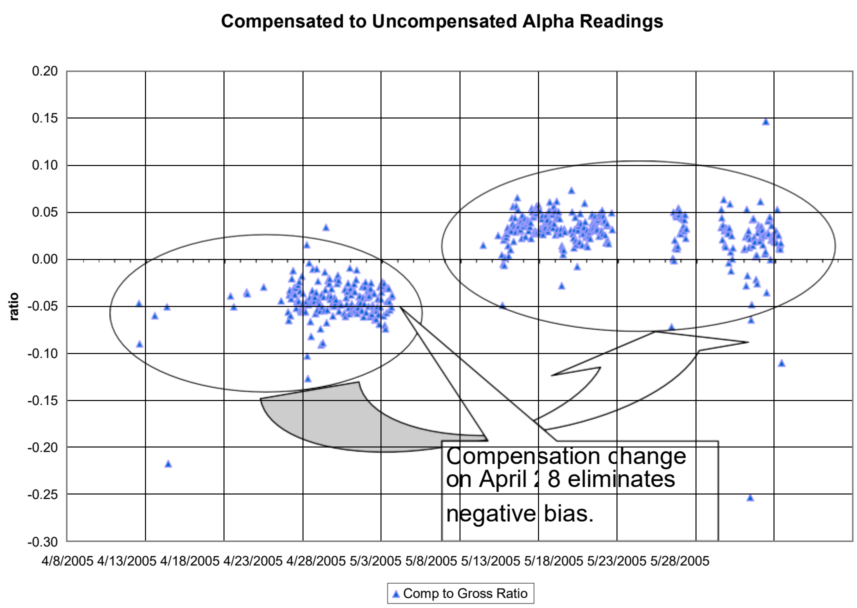

Figure 6: Comp to Gross Ratio

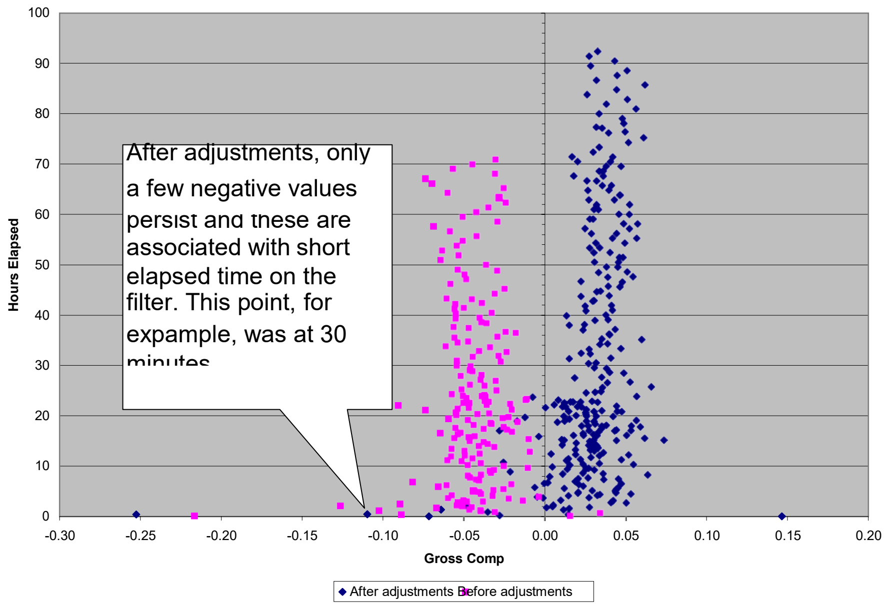

Figure 7: Compensation corrected by adjustments to parameters

A normal range had been established for evaluation of the iCAM as +/- 10 alpha DAC-hrs. The iCAM sometimes exceeded the high end of this range. After the parameter change on April 28, the highs were associated with high thoron levels. There was no significant stack discharge during the test period. Below are archived data for the test period.

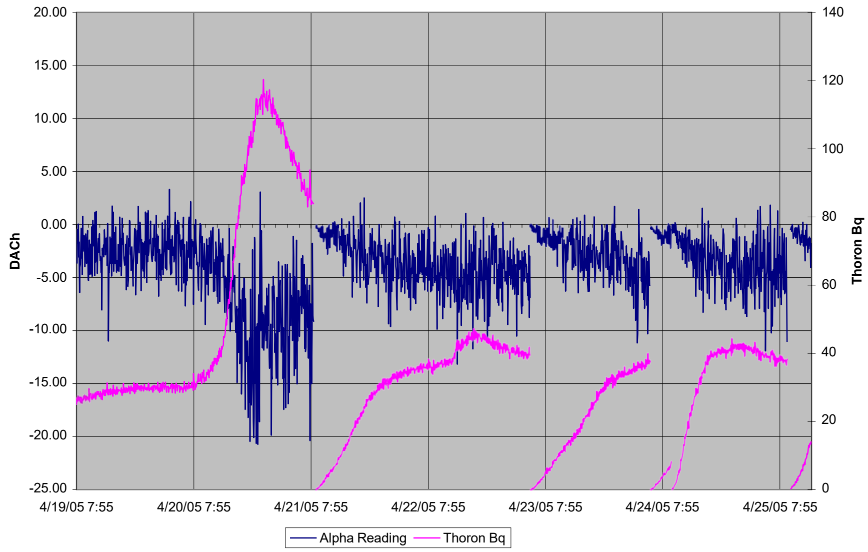

Figure 8: Archive April 19-April 2005

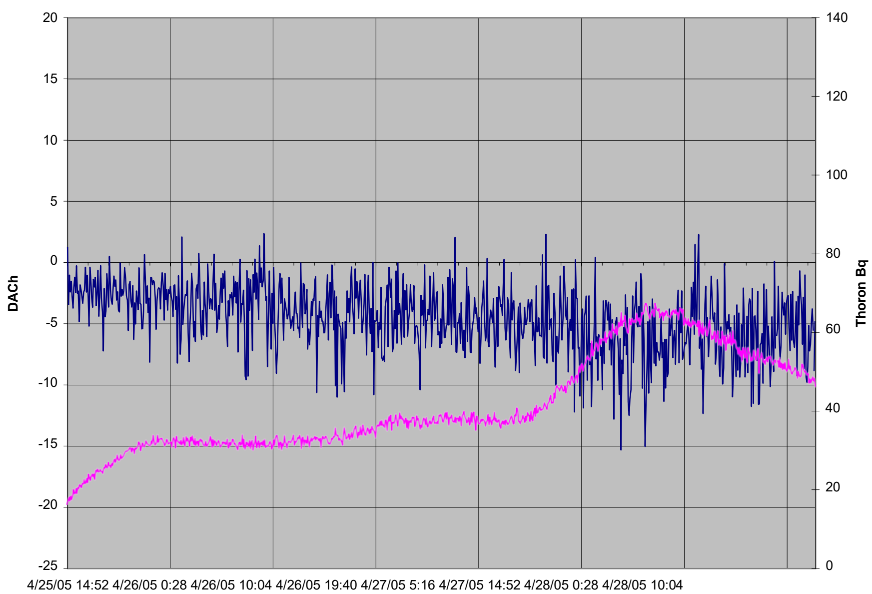

Figure 9: Archive April 25 –April 28, 2005

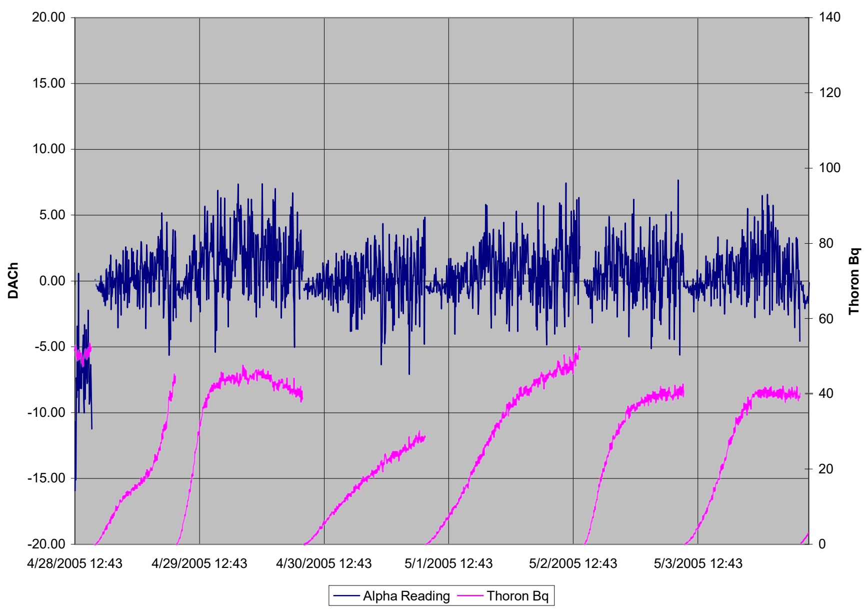

Figure 10: Archive, April 28 - May 4, 2005

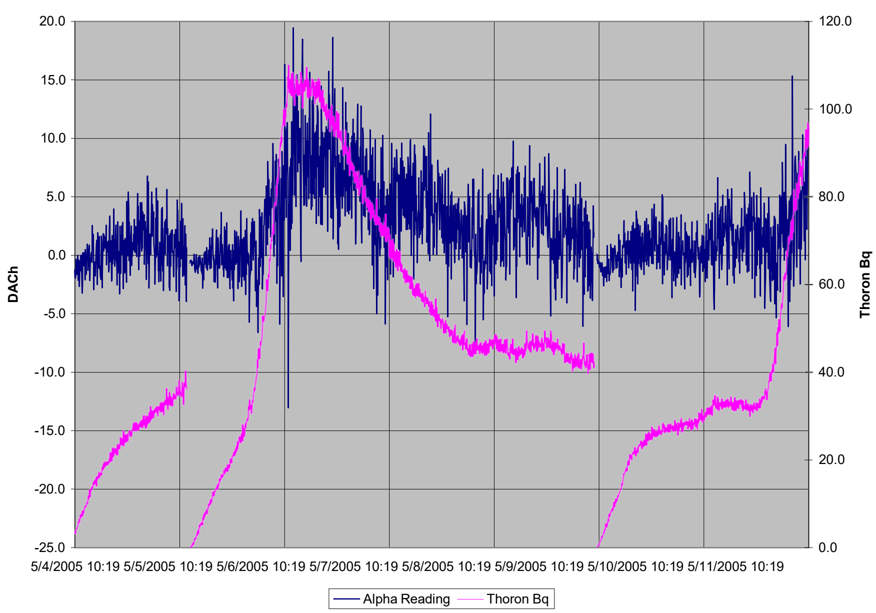

Figure 11: Archive, May 4 - May 11, 2005

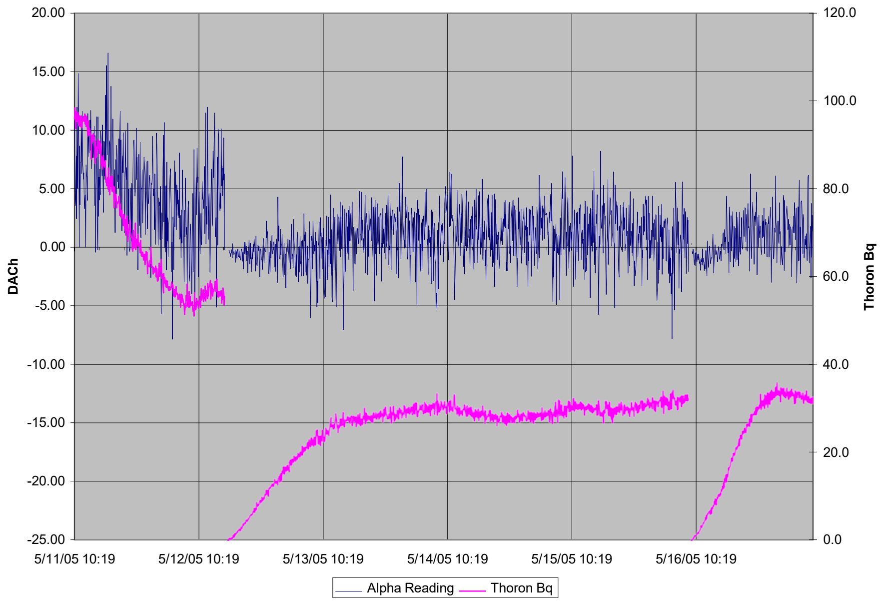

Figure 12: May 11 to May 17, 2005

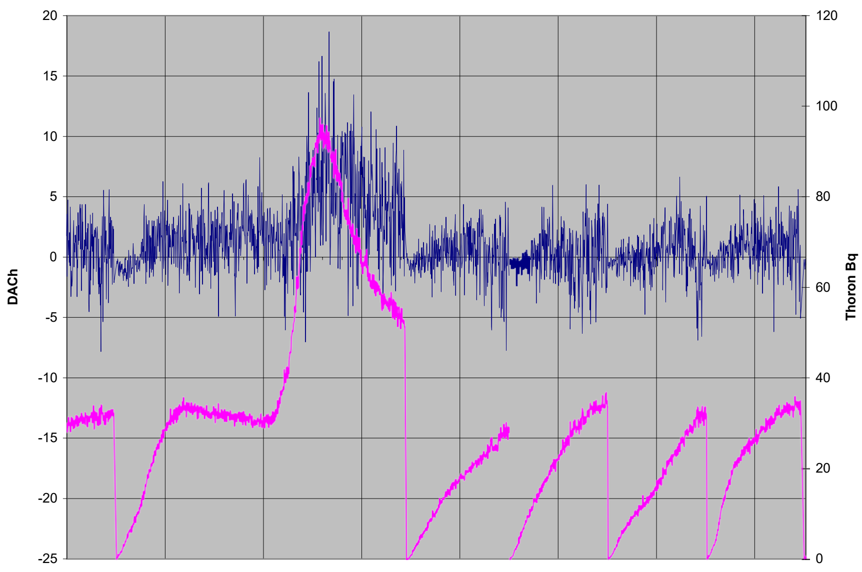

Figure 13: Archive, May 15 - May 23, 2005

Additional Details and Observations

Data was evaluated from the 448 snapshots via a custom data extraction program. The data extraction yielded interesting results, the evaluation of which could yield useful information about our source term and effluent characteristics. Here is an example, the very short-lived Po-216 peak relative to the much longer Bi-212 peak. Po-216 has driven changes to the parameters for the system, so understanding it could lead to further improvements in the algorithm. (Twelve ratios associated with short sample durations were negative and are not shown.)

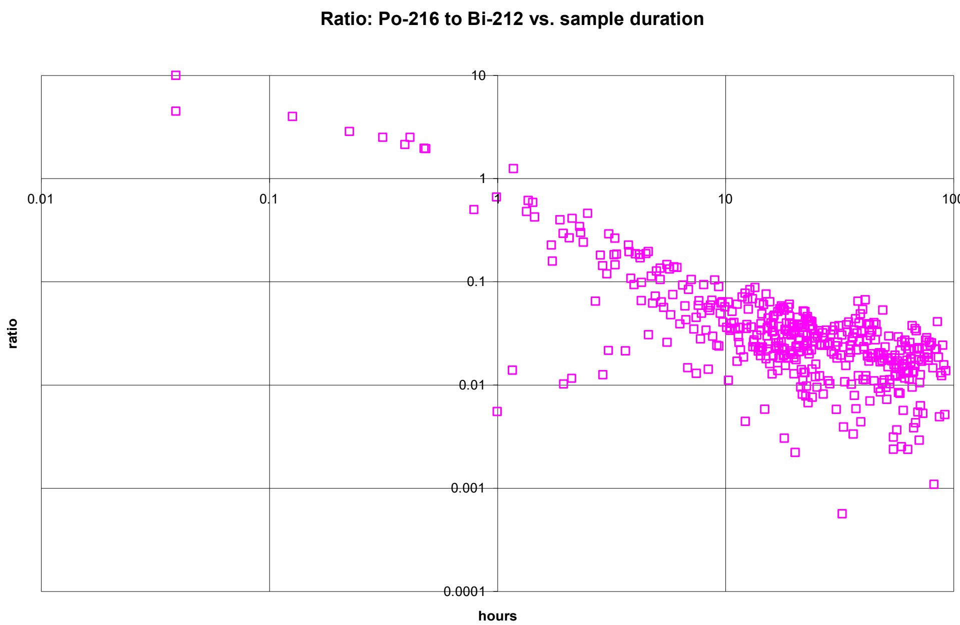

Figure 14: Po-216 to Bi-212 ratios vs. collection time

Conclusion

The iCAM has met or exceeded the test criteria. The corrected algorithm removed negative bias, particularly for episodes of high thoron levels. A revised, normal upper limit for alpha DACh is recommended based on trends shown above.

Actions

The only action resulting from the test report is to revise the acceptable range to allow alpha DACh readings up to 20 DACh without replacing the filter. This change has been made in the operating procedure. Readings at this level may occur due to high thoron levels, producing a positive bias for long-lived DACh readings. This is a small bias with respect to the alarm set point and has no negative impact on operations.

References:

1. J-TPL-H-00015 Revision 0, STARTUP TEST PLAN, 291-H Stack iCAM Startup.
2. CBU-HCP-2004-00172, 291-H ALPHA/BETA PARTICULATE STACK MONITOR IMPLEMENTATION, M.G. Hogue to A. R. GOODWYN, August 31, 2004.
3. DRAFT iCAM: Acid-Resistant PIPS Detector Type AR/A450 ASV User Guide, David Ryden, Canberra Harwell Ltd, 11th March 2005
4. SEM Report of failed Canberra iCAM 450 PIPS detector, Tony Curtis, SRNL, March 29, 2005.

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R.J. Smith, 735-2B
M.J. Negron, 704-2H, 132
R.S. Bailey, 704-2H, 165
B.R Patel, 704-2H, 176
Z.D Madtes, 705H, 65
D.D. Solomon, 221-H
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