

Analysis of Data from Co-Located Landauer, Inc. Radtrak Detectors

Prepared by: Oscar Paulson

Presented by: National Mining Association



Introduction

- In two (2) cases discussed in this presentation uranium recovery licensees placed multiple Landauer, Inc. Radtrak detectors for identical time periods at the same location.
- This was done to verify the airborne radon activity data collected by these detectors.
- Data collected by two (2) companies, Cotter Corporation (Canon City Mill) and Kennecott Uranium Company will be discussed.

Data Collected by Cotter Corporation at Its Canon City Mill

- Radtrak data collected by Cotter Corporation that included co-located detectors from 2009 to 2013 was examined.
- This data was submitted by Cotter Corporation and was posted to the Colorado Department of Public Health and Environment (CDPHE) website on July 11, 2013.
- The data was examined and a review of the data prepared by Oscar Paulson was distributed to the Wyoming Mining Association's (WMA's) Uranium Industry Committee on July 15, 2013.
- In this data set were eight (8) pairs of data from co-located detectors that exhibited significant variability as well as a blank for which results were reported by Landauer, Inc.

Co-Located Radtrak Results

Cotter Corporation						
Canon City Mill						
Co-Located RadTrak Detectors						
Location	Placement Time		Reading			
	Start	Stop	Exposure		Average Radon Concentration	
			picoCurie/ Liter-days	Error Estimate	picoCuries per Liter	Error Estimate
AS-202	7/3/2012	10/4/2012	185.7	+/- 8.90	2.0	+/- 0.10
AS-202	7/3/2012	10/4/2012	50.4	+/- 3.68	0.5	+/- 0.04
AS-203	7/3/2012	10/4/2012	155.5	+/- 7.90	1.7	+/- 0.09
AS-203	7/3/2012	10/4/2012	76.6	+/- 4.98	0.8	+/- 0.05
AS-204	7/3/2012	10/4/2012	147.4	+/- 7.70	1.6	+/- 0.08
AS-204	7/3/2012	10/4/2012	78.8	+/- 5.07	0.8	+/- 0.05
AS-202	10/4/2012	1/8/2013	130.2	+/- 7.8	1.4	+/- 0.08
AS-202	10/4/2012	1/8/2013	60.9	+/- 3.27	0.6	+/- 0.04
AS-203	10/4/2012	1/8/2013	132.6	+/- 7.9	1.4	+/- 0.08
AS-203	10/4/2012	1/8/2013	50.7	+/- 3.36	0.5	+/- 0.03
AS-204	10/4/2012	1/8/2013	146.1	+/- 8.30	1.5	+/- 0.09
AS-204	10/4/2012	1/8/2013	62.0	+/- 3.93	0.6	+/- 0.04
AS-204	1/4/2010	4/6/2010	74.7	+/- 4.62	0.8	+/- 0.05
AS-204	1/4/2010	4/6/2010	9.9	+/- 0.8	0.1	+/- 0.01
AS-202	1/4/2010	4/6/2010	136.8	+/- 7.1	1.5	+/- 0.08
AS-202	1/4/2010	4/6/2010	66.4	+/- 4.23	0.7	+/- 0.05

Discussion of Results

- The variability of results for these co-located Radtrak units is large.
- In the case of Location AS-202 from July 3 to October 4, 2012 there is a four-fold difference.
- In addition, in the case of detector 486927, it was taken out of its Mylar bag and immediately sealed with the gold seal that is provided and shipped to Landauer, inc. for processing. A result of 1.5 pCi/L +/-0.09 (120.4 +/-7.1 pci/L-days) was reported by Landauer, Inc. for this detector.

Availability of This Data

- This data is available on the Colorado Department of Public Health and Environment's web site at:
 - <http://www.colorado.gov/cs/Satellite?blobcol=urldata&blobheadername1=Content-Disposition&blobheadername2=Content-Type&blobheadervalue1=inline%3B+filename%3D%22Letter+from+Cotter%3A+Radon+Monitoring+Data+2009-2013.pdf%22&blobheadervalue2=application%2Fpdf&blobkey=id&blobservice=MungoBlobs&blobwhere=1251862099101&ssbinary=true>

Discussion By Cotter Corporation

- Cotter Corporation discussed these results.
- Cotter Corporation's Semiannual Effluent Report (40.65 Report) for the first half of 2013 has been reviewed. The report states:
 - **Radon:** *Cotter has experienced greater variability among co-located detectors during the last 4 quarters. As noted in the previous semiannual report, we have been working extensively with the vendor to try to determine the cause of the variability. To be conservative, the highest value of either co-located or QC duplicate detectors at the boundary and nearby locations and the lowest value at the background locations have been selected to calculate the semiannual averages. See Tables RN-2A and 2B. These values are then utilized to show compliance with the annual effluent limit (Table RN-4). Also note that compliance with public dose limits was demonstrated in the 2012 annual report utilizing the MILDOS report.*
 - **Source:** *Semiannual Effluent Report – August 29, 2013*
- The entire report may be downloaded at:
<http://www.colorado.gov/cs/Satellite?blobcol=urldata&blobheadername1=Content-Disposition&blobheadername2=Content-Type&blobheadervalue1=inline%3B+filename%3D%221st+Half+2013+Semiannual+Effluent+Report.pdf%22&blobheadervalue2=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1251881123935&ssbinary=true>

Response from the Colorado Department of Public Health and Environment (CDPHE)

- Jennifer T. Opila of the Colorado Department of Public Health and Environment (CDPHE) responded in a letter dated November 20, 2013 stating:
 - *The analytical results for duplicate samples in the above-cited radon data sets are outside acceptable repeatability values. The Relative Percent Difference (RPD) for reported duplicates often exceeds 60% and in two instances exceeds 100%. The data presented in the above-cited documents are not quantitatively reliable and not acceptable for regulatory purposes. Analysis of the data sets presented indicates a problem with the laboratory methods or the sampling media, or both. Based on the available information, the data sets do not indicate a problem with the on-site sampling methods or protocols.*

Landuaer, Inc.'s Response

- Landauer, Inc. responded with a report dated December 12, 2013 and made the following recommendations:
 - Increase number of duplicate measurement locations to all locations for at least one (1) year.
 - Modify the assembly procedure of the DRNF outdoor air monitors to “*just in time assembly*” to reduce storage time and the number of background tracks on the detectors.
- Landauer, Inc. also suggested:
 - Increasing deployment time for each detector to six (6) months and using overlapping sets of detectors for three (3) month monitoring intervals.
 - Institute a quality assurance/quality control program with the Cotter Corporation detectors involving blank detectors and detectors spiked in Bowser-Morner’s radon chamber.

Response by the State of Colorado

- In a letter dated January 23, 2014 the State of Colorado requested a root cause analysis and asked numerous questions.
- In a letter dated March 13, 2014 Cotter Corporation replied committing to:
 - Conduct a 180 day overlapping exposure study
 - Send detectors to Bowser-Morner for spiking
 - Send trip blanks
- Accompanying this letter was a report/root cause analysis prepared by Landauer, Inc in which they attributed the problems to leakage of the Mylar bags in which the detectors were stored and shipped prior to use.
- Landauer, Inc. stated that they would:
 - Change the sealing procedure for the storage/shipment bags from a heat seal to a vacuum heat seal.
 - Change deployment instructions to include a check for storage bag integrity

Scope of the Problem

- Kennecott Uranium Company also has experienced similar problems with the detectors over time. These problems include:
 - A detector removed from the Mylar bag and immediately sealed with the gold seal and sent to Landauer, Inc. with a fictitious deployment interval from October 3, 2004 to November 1, 2004 returning a result of 1.2 pCi/L.
 - Subsequent blank detectors returned results at or near zero.
 - Two (2) co-located detectors located at the background/upwind air monitoring station deployed from April 2 to July 1, 2013 returning results of 3.8 +/- 0.14 pCi/L and 2.3 +/- 0.11 pCi/L. The results were averaged to obtain an upwind radon activity for the station.
 - Three (3) co-located Radtrak detectors placed from January 3 to April 2, 1992 at the upwind air station with results of 5.80, 5.30 and 8.60 pCi/L with an average of 6.57 pCi/L. In addition, during each month of that quarter three (3) co-located Radtraks were installed and retrieved for a total of nine (9) monthly Radtrak detectors for the quarter.
 - The January 1992 Radtrak results were 2.50, 5.20 and 4.00 pCi/L with an average of 3.90 pCi/L
 - The February 1992 Radtrak results were 3.70, 3.00 and 2.90 pCi/L with an average of 3.20 pCi/L
 - The March 1992 Radtrak results were 4.50, 6.20 and 7.10 pCi/L with an average of 5.93 pCi/L
 - In theory the sum of the exposures in pCi/L-days for the three (3) quarterly detectors should equal the sum of the exposures for the nine (9) monthly detectors. They do not.
 - The sum of exposures for the three (3) quarterly detectors was 1778.10 pCi/L-days while the sum of the exposures of the nine (9) monthly detectors was 1123.90 pCi/L-days

Scope of the Problem (con't)

- Three (3) co-located Radtrak detectors placed from January 3 to April 2, 1992 at the downwind air station with results of 4.20, 5.60 and 4.20 pCi/L with an average of 4.67 pCi/L. In addition, during each month of that quarter three (3) co-located Radtraks were installed and retrieved for a total of nine (9) monthly Radtrak detectors for the quarter.
 - The January 1992 Radtrak results were 2.40, 2.80 and 4.40 pCi/L with an average of 3.20 pCi/L
 - The February 1992 Radtrak results were 2.00, 3.20 and 3.20 pCi/L with an average of 2.80 pCi/L
 - The March 1992 Radtrak results were 3.37, 3.30 and 3.90 pCi/L with an average of 3.52 pCi/L
 - In theory the sum of the exposures in pCi/L-days for the three (3) quarterly detectors should equal the sum of the exposures for the nine (9) monthly detectors. They do not.
 - The sum of exposures for the three (3) quarterly detectors was 1259.20 pCi/L-days while the sum of the exposures of the nine (9) monthly detectors was 793.40 pCi/L-days.
- The above discussed 1992 data was submitted to the Nuclear Regulatory Commission (NRC) under cover of letter dated September 28, 1992 in response to questions raised during an inspection.

Discussion

- The issues with the Radtrak detectors were discussed with Landauer, Inc. in December 2004.
- In an e-mail dated December 7, 2004, Bill Rounds of Landauer, Inc. provided the following information:
 - The Lower Limit of Detection (LLD) for Radtraks read to high sensitivity (which these were) is 6 pCi/L-days which is 0.06 pci/L for a quarterly (approximately 100 day) placement.
 - In the case of a particular chip being discussed (Chip 4562541) six (6) net tracks were counted in twenty-four (24) measurement fields resulting in a calculated exposure of 11.6 pCi/L-days.
 - Thus one (1) net counted track must have an associated exposure of approximately 2 pci/L-days.
 - Thus the Lower Limit of Detection (LLD) of 6 pCi/L-days must be three (3) net tracks.
 - The effluent concentration limit for Radon-222 with daughters present is 1E-10 microCurie/milliliter which is 0.1 pCi/L which represents a dose of 50 mrems.
 - This value is only 0.04 pCi/L higher than the device's Lower Limit of Detection (LLD)
 - 0.1 pCi/L determined by a quarterly placement of a Radtrak detector represents a 10 pCi/L-day exposure which is five (5) net counted tracks. This is not very many tracks.

Conclusions

- Radtrak detectors have a Lower Limit of Detection (LLD) when read at high sensitivity of 6 pci/L days which for a quarterly (approximately 100 day placement) represents a Lower Limit of Detection (LLD) of 0.06 pci/L which is represented by approximately three (3) net tracks.
- This is only 0.04 pCi/L less than the effluent limit for Radon-222 with daughters present of 0.1 pci/L.
- A reading of 0.1 pci/L (10 pCi/L-days for a quarterly placement) represents five (5) net counted tracks.
- Radtrak detectors have at times provided false positives.
- Co-located Radtrak detectors have provided differing results.
- This problems has existed from 1992 to 2013, a period of over twenty (20) years.
- The State of Colorado has stated that the data collected by the Radtrak detectors “... *are not quantitatively reliable and not acceptable for regulatory purposes.*” (Jennifer Opila – November 20, 2013)
- Cotter Corporation and Landauer, Inc. are working to resolve the problems with the detectors.