Identification of Radiation Events for a Spectroscopic Radiation Weather Station

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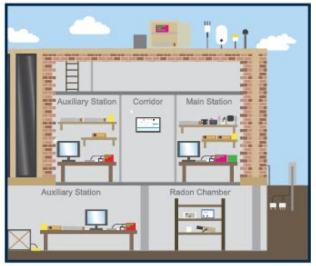
Abstract

Initial streams of meteorological and radiological data were collected from a Radiation Weather Station (RWS). The heart of the system is a 25.4 cm diameter spherical high pressure ion chamber (HPIC), located on the roof of a building, with a response time of less than 10 s and a zero stability of approximately +5 nSv h^{-1}, which is set to sample every 10 min. The RWS collects a background gamma ray spectrum every hour from a 11 cm x 42.5 cm x 5.5 cm NaI(Tl) detector near the HPIC. That detector has a very high sensitivity but limited energy resolution. One goal for the RWS is that transients in radiation level could be quickly and automatically identified. Very small but statistically significant changes in radiation background would initially be flagged from fluctuations in the HPIC measurements. Next, examination of the corresponding gamma ray spectrum for the time period corresponding to the HPIC increase could be initiated. Net counts in pre-identified regions of interest corresponding to the characteristic energies for radionuclides of concern could be compared to an expected background. The unperturbed average background spectrum would grow increasingly more statistically reliable as the RWS accumulates an ever-greater history of local background fluctuations. Once a radionuclide has been identified, weather parameters such as rainfall, wind speed and direction, solar energy, and possible solar flare information could be examined intelligently to identify the source of the transient increased background. Preliminary data collected from the initial RWS operation of reveal increased radon progeny on the rooftop during periods of rain. In addition, very occasional peaks corresponding to possible radionuclide releases are observed Data from the RWS are also available which were captured during a partial solar eclipse.

Objectives

- Establish background radiation levels
- Identify unusual radionuclides releases
- Public information (independent source)
- Provide undergraduate research projects
- Recruiting to nuclear fields

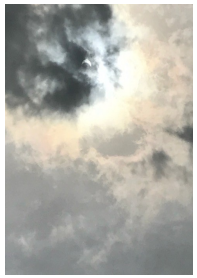
Methods

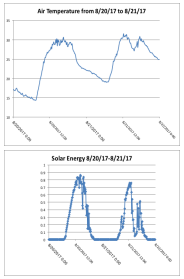


Results

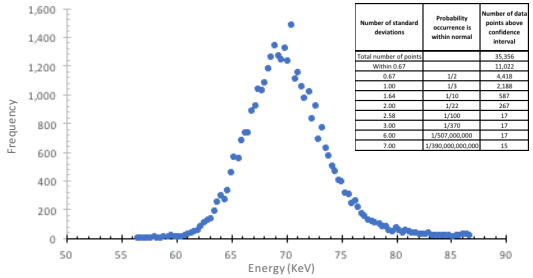
1. Partial eclipse event
2. HPIC data distribution (nSv h^{-1}) for 35,648 points over 330-d period (average = 70.4 ± 5.5 nSv h^{-1}) with number of events observed outside expected normal distribution shown in inset
3. Correlation of elevated HPIC levels with rain indicating radionuclide washout
4. Overall average NaI spectrum (black), based upon 1,936 file collected over 107-d period, shown with spectra collected during rain (green and orange)
5. Rain event-to-average NaI spectral ratios for two different rain events (green and orange). No changes are observed for K-40 as source intentionally placed near detector to monitor for drifts
6. Increase in NaI count rates over average background spectra (black) for two rain events (orange and green).

Result 1



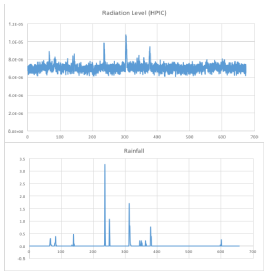


Result 2

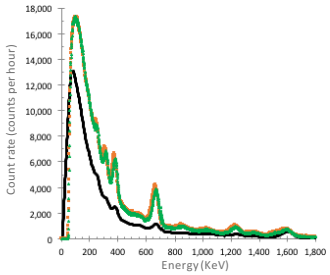


Number of standard deviations	Probability occurrence is within normal	Number of data points above confidence interval
Total number of points		35,356
Within 0.67		11,022
0.67	1/2	4,418
1.00	1/3	2,188
1.64	1/10	587
2.00	1/22	267
2.58	1/100	17
3.00	1/370	17
6.00	1/507,000,000	17
7.00	1/390,000,000,000	15

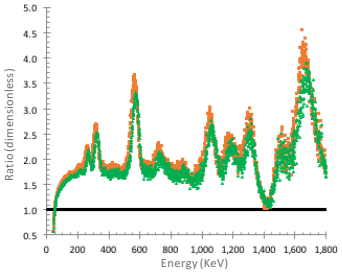
Result 3



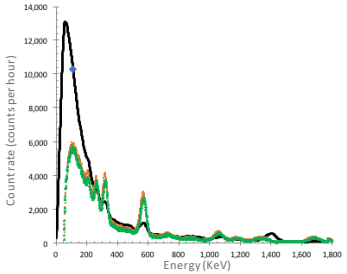
Result 4



Result 5



Result 6



Conclusions

- HPIC very sensitive to small, rapid changes
- Large NaI(Tl) detectors very sensitive, but limited energy resolution
- Significant background increases associated with rain, likely Rn progeny
- Average normal background spectrum useful for analyzing transient spectra
- K-40 source helps monitor gain shifts
- Spectral analysis methods being developed to identify radionuclides

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Consortium for Verification Technology

National Nuclear Security Administration