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Dr. Barr,

I was only partially successful at sending my comments on the federal register web site; so here are all of them.

Questions Related to Continuously Collected Data Surveys Without a Surveyor Listening to the Audible Output

1. What types of system(s) or equipment (*i.e.,* instrumentation, including radiation detectors, and software) do you use or plan to use to record radiation detector location and raw instrument response?

    - A web search for “Radiation survey instrument rental equipment” produces several rental companies which provide calibrated instruments and exempt check sources that are ready for use upon delivery. We have rented from these companies various types of detectors: alpha, beta, and gamma, some with GPS units without major issues.

    - For our next land survey, the ERG RadScout is planned which is a Handheld GPS gamma survey system. The system comes with a touch enabled data logger, sub-meter GPS receiver, a Bluetooth Ludlum-2221, backpack, and all associated cables and charging electronics. The system comes with software to view real-time data in the field, export field data to removable drive (included), and export all data to shapefile format.

    - The survey teams that I have worked with have wrapped NaI detectors with a thin layer of lead shielding to reduce the background levels of radiation such that the MDCs and MDCRs were also significantly reduced. Although commercial lead collimators were available, the survey crew simply placed a 1/8-inch-thick piece of 6-inch-long lead around the detector, adding about 1 pound to the detector weight and reducing the background to about 7,000 cpm. The bottom of the detector is left uncovered. I have not identified peer reviewed papers evaluating this practice but would like the NRC to endorse it.

2. What methods do you use to calculate scan minimum detectable concentrations to ensure sufficient sensitivity to detect risk-significant levels of residual radioactivity or to better understand measurement uncertainty?

    Only MARSSIM recommended techniques as supported by NUREG-1507 Rev. 1 are used to calculate scan MDCs. However, knowing that the meters actually average data over two seconds or multiples of two seconds for output confounds the MARSSIM technique as MARSSIM seems to indicate that the meter outputs are counts in a second, so the input may be kind of disqualified.

3. What methods have you used to post-process data to identify areas for follow-up investigation (*e.g.,* use of radiation surveys maps, and statistical tests and measures to identify anomalous radioactivity to be targeted for follow-up investigation)?

- First and always, a quick visual check for elevated data and the related GPS locations; we send a technician out to verify and qualify the size immediately.

- Past work has included the use of Z-scores and mapping with SADA and Rockworks' Surfer (now up to version 20).

4. Have you experienced technical issues with data collection and analysis during previous surveys and what methods did you use to troubleshoot those issues? Do you have any lessons learned you could share related to the technical issues?

- One member of each group of GPS surveyors must be well trained in the technology and instrumentation to apply the correct State-base mapping plane coordinates; not having this person can have disastrous outputs. In other words, you cannot survey in California using a Montana state mapping plane coordinates. Seems simple enough until you realize that many states have more than one mapping plane.

- Some backpack GPS units have the receiver over one shoulder of the surveyor such that when his path is mapped, the lanes appear to be close or too far apart depending on which direction he was walking. Regulators like to see tight equidistant lanes so we moved the pole with the receiver to directly behind the surveyor head; even with this adjustment the actual survey point is about 10 inches in front of what is being recorded. For any required remediation, the 10 inches was of no importance in resurvey work as visual readings were used and the location physically flagged.

- Often the starts and ends of scan data are too low to be considered for averaging; this is thought to be a survey meter powering up and shutting down effect. These low value data points are simply deleted as part of the review process.

- Data must be down loaded at least twice per day (or at the end of every survey unit) to prevent any major losses from occurring. This data is reviewed by the site supervisor prior to site departure to assure that if data is missing, it is recollected prior to leaving the site. Once demob is done, we never want to return for missing data. We always make a backup for every day of field work.

- Regarding data log scans, an issue does exist in that some data loggers are limited to 2 sec averaging which does not fit with the 1 sec observation interval described in some examples in NUREG-1507 and MARSSIM. NUREG-1507 is quoted, "A surveyor moving a detector at one detector width per second across the center of a hypothetical 100-cm^2 hotspot will have an observation interval of about 1 second (assuming a nonvarying cross-section)…" It would seem that use of a data logger could not be applicable; however, draft MARSSIM Rev. 2 requires for scan-only surveys that a data logger be used for UCL determinations. Also, user directed observation intervals must be divisible by 2 for certain instruments.

– I personally like the inherent QC function provided when the technician is required to data log a scan; manually recorded maximum and average results are usually just guesses if not data logged.

– How an average count over a 2 sec or otherwise determined interval (multiple of 2) is applied mathematically could be established in the NUREG-1507 and MARSSIM examples. In particular, as values being considered are assumed as single measurements to calculate a mean are actually averages themselves, do the UCL equations establish what we need or should they be modified to account for the described averaging? Also, perhaps a listing of the data loggers with a simple one second interval count time could be developed if they exist.

– If the observation interval (i) = 2 seconds, and the data logger output is an average every 2 sec, can two successive average readings show that an area was falsely accepted as not elevated but would have been positive if the timing was 1 second different. Would that impact the MDC values presented in NUREG-1507 and should that be determined differently and discussed?

- Microshield™ software was applied when searching for discrete particles of radium. The net exposure-rate-to-concentration ratio (ERC) (microroentgen per hour (μR/h) per pCi/g) is established through modeling with an objective to determine the radionuclide concentration that is correlated to the minimum detectable net exposure rate. When using trailer mounted detectors and GPS data loggers, the field of view and MDC was established to requirements by adjusting the height to ground surface in Microshield™ inputs and the driving speed.

- When using trailer mounted detectors, a difficult problem is how to cushion the detectors from jostling and perhaps destroying themselves while driving over rough terrain. Selection of trailers with shock absorbers should be a requirement instead of just an axel. The design of the cup or older for the detector should be sufficiently large for a bubble wrap or other cushioning.

- When using trailer mounted detectors with GPS data loggers in the larger fields, the use of a foam concentrate marker system with discharge hose and drop tubes, assists with the completion of the survey with a visual marker on the ground:

  – Greatly enhances surveying by marking where the ground has been surveyed and allowing the operator to avoid overlap and skips

  – Reportedly works well on sprayer booms up to 30' and speeds up to 5 mph but my application only used 10'

  – Ran for approximately 1-1/2 hours before refilling

- Another major problem in walkover land surveys is how to keep surveyors walking in a straight line. A field expedient was placing short wooden stakes two meters apart on opposite sides of a survey unit with an offset of one m on the sides. A red drinking cup was placed on each stake and removed upon each approach; the surveyors walked in a relatively straight line with an eye on the next red cup. Of course, we always policed up the cups and used them over and over.

- Use of the computerized Monte Carlo methods briefly listed in MARSAME and by combining the detector characterization produced by the Monte Carlo N-Particle Transport Code (MCNP), mathematical geometry templates, and a few physical sample parameters, the system provided the ability to produce qualitative and quantitative gamma NaI walkover assays of demolished concrete in 12-16 inch high rows. Analytical sampling results were remarkably close to the walkover scan evaluations which ultimately saved dollars with a reduction in the number of samples required.

5. What areas do you see as challenges or gaps to radiological survey design and data analysis that could be addressed in future guidance (*e.g., a priori* scan minimum detectable concentrations calculation) or tool development (*e.g.,* data integration and post-processing)?

- A recent paper by Alecksen, T. and Whicker, R. *Retrospective Detection Sensitivity for GPS-Based Gamma Radiation Surveys*, (Health Physics, 124(6):451-461; 2023) indicated that a statistical analog to the a priori scan MDC has not been developed for a posteriori use. This would be a useful tool if developed.

- One of the methods for checking the assumptions of the statistical test is the Retrospective Power Chart and the procedure for generating power curves for specific tests is discussed in MARSSIM Appendix I.9. This is indeed a tedious (nightmarish) process and an NRC accepted/approved software package would be welcomed in the industry. Perhaps, the software “Compass” or Gogolak’s “MARSSIM Power” could be enhanced for this? These curves are required for both Scenario A and Scenario B. It is noted that users of VSP are able to produce retrospective (and prospective power curves) for Scenario B evaluations.

Questions Related to Subsurface Survey Design and Data Analysis

6. What types of instrumentation and approaches do you use to collect subsurface radiological survey data in the field? Specifically, what types of instrumentation and approaches has your organization used to perform surveys of hard to access locations in the subsurface (embedded piping, sumps, soils located at depth or underneath buildings, and bedrock)?

- Soil Core Scanning

  Soil cores are collected at most of my sites in each SU at identified systematic and bias locations using direct push technology. Soil cores are advanced to predetermined depths based on the HSA and DQO process unless refusal was encountered. Soil cores are scanned for beta-gamma activity with a Ludlum 44-2 1-inch by 1-inch NaI detector or a Field Instrument for Detection of Low Energy Radiation (FIDLER) to identify intervals of elevated activity in relation to depth. Each soil core is placed on a table (or pickup tail gate) adjacent to the borehole, where the acetate sleeve was cut open to expose the subsurface soils. The NaI detector is moved over the surface of the soils slowly, with the average count rate for each one-foot interval recorded on a log sheet; this was manually recorded to save time as data logging would only slow the process. To ensure subsurface soil with the highest level of activity is sampled for laboratory analysis, samples are collected from the interval containing the highest observed core scan count rate.

- Downhole Gamma Logging

Downhole gamma logging (DGL) is performed at each borehole to characterize in situ soils and provide data on gamma radiation levels by depth. A one-minute static measurement is performed using a Model 44-62 environmentally sealed 0.5-inch by 1-inch NaI detector suspended from a nylon cord with depth markings in order to ensure that accurate depth interval measurements were recorded. Measurements were collected at one-foot intervals, starting at the bottom of the borehole and working toward the ground surface. Each borehole was sleeved with polyvinyl chloride (PVC) casing prior to insertion of the Model 44-62 probe to prevent cave-in of sidewall soils and loss of the detector. DGL was performed for the entire predetermined boring depth per SU unless refusal (e.g., cave-in prevented installation of the PVC casing) or the presence of groundwater was encountered.

7. What types of methods and software (*e.g.,* geophysical methods and related software) have been used and subsurface data (*e.g.,* hard and soft data) have been collected, and what novel approaches have been used to combine or condition data to develop site conceptual models or mathematical models, or to show release criteria have been met?

None.

8. What statistical approaches have you used to show subsurface residual radioactivity meets release standards including consideration of uncertainty (*e.g.,* number and depth of samples, type of data and statistical approaches used to demonstrate compliance)?

None.

9. What approaches have you used to optimize subsurface survey designs including initial scoping to final status survey designs (*e.g.,* geometrical or geostatistical techniques)?

None.

10. What areas do you see as challenges or gaps with respect to subsurface surveys and data analysis that could be addressed in future guidance or tool development?

- The industry does not have a 3D software package except for the non-supported SADA.

- The industry remains lacking in NRC accepted geospatial modeling tools to analyze data and optimize sampling designs for subsurface modeling. I am aware that VSP is being upgraded for this purpose and I suggest that the final design be tested on a known contaminated field with correlation with actual at-depth sample results.