ARCHIVE: **Archived due to citation changes resulting from the 2014 rule revisions. Refer to VA30007.14.002 for the updated document.**

TITLE: **Difference Between Incremental or Multi-Increment [1](MI) Sampling and Composite Sampling**

DATE EFFECTIVE: March 2009

HISTORY: New addition to the Technical Guidance Compendium

KEYWORDS: composite sampling, decision unit, exposure unit, identified area, incremental sampling, multi-increment sampling, MI sampling, 95 percent upper confidence limit of the mean

RULE/ AUTHORITY: OAC 3745-300-07 (F)(5)(c)(iii)

QUESTION: What is incremental or multi-increment (MI) sampling and when is it appropriate? What are the differences between traditional composite sampling and the MI sampling techniques?

BACKGROUND: Incremental or multi-increment (MI) sampling is a sampling methodology that has been recently added to the 2009 VAP rules. Prior to this addition, the VAP rules allowed only for the collection of discrete, or point, sampling when investigating VAP properties. Previously, to get a representative concentration within the study boundaries the investigator had the choice to either select the maximum concentration or derive a representative concentration by calculating the 95% upper confidence limit (UCL) of the mean. Each methodology relied upon the use of discrete samples.

With the inclusion of the MI sampling technique, an investigator can use a rigorous form of composite sampling to obtain a representative concentration for a chemical of concern (COC) without selecting the maximum concentration. If the site decision unit[2] is represented by a single MI sample, the MI sample provides an estimate of central tendency concentrations and thus may eliminate the need for further statistical analysis of the data such as calculating the 95% UCL of the mean.

In addition, MI sampling provides a better mechanism to investigate a

[1] The VAP rules use the term "incremental sampling". Since the term multi-increment (MI) sampling is also used in literature, the TGC includes a reference to the MI term.
[2] Most sites need to be broken down into areas about which a decision needs to be made regarding the

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extent and magnitude of contaminants and how to achieve applicable standards. Examples are fill area(s); drum(s); different process areas; areas supporting a particular land use; etc.

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broader aerial extent since multiple sub-samples or aliquots can be collected across the area to be investigated. This method thus provides the investigator with a more accurate and reproducible estimate of average contaminant concentration across the decision unit. MI theory also states that the method increases the probability of assessing potential "hot spots" that may have otherwise been missed during conventional discrete sampling.

ANSWER: MI is a more rigorous form of composite sampling that is designed to generate a result that is reproducible and defensible. Traditional composite sampling generates a result that may be close to average concentration(s) but is not necessarily reproducible.

MI SAMPLING STRATEGY

A critical *pre-requisite* for MI sampling is defining the decision unit. In the VAP, the decision unit can be the identified area(s) (IA) or the exposure unit(s) (EU), or both; an IA or EU can also include multiple decision units. Generally, a decision is not considered to be larger than ¼ acre. The decision unit delineation, while helpful, is *not* a critical pre-requisite for discrete sampling. The decision as to which discrete samples are to be included within a specific IA and/ or EU can be made at a later stage (for example, when demonstrating that applicable standards are met in the IA and/ or EU).

The decision unit delineation is dependent on the data quality objectives (DQOs) for the Property. Once the decision unit boundaries are defined, MI sub-samples or aliquots can be collected within the decision unit(s) depending on how the volunteer wants to investigate the property. As all VAP phase II investigations involve the investigation of IAs, the volunteer may utilize MI sampling for each IA; however, if the CP designates the entire property as an exposure unit (as in the case of some commercial sites) then it may be more appropriate to use the MI sampling technique across the entire property. It is up to the CP and the Volunteer to investigate the property based on the reasonably anticipated land use and subsequently develop the data quality objectives to tailor the investigation that achieves the best results through a correct sampling strategy.

Multiple MI samples may be collected within a single decision unit, but an MI sample should *not* be collected across more than one decision unit (i.e., a single MI sample is not generally used to represent multiple decision units).

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Statistically, MI samples cannot be included with discrete samples (as a single dataset) to calculate a representative concentration across the decision unit (IA or EU). This approach would weight discrete samples more heavily in the dataset, and the resulting concentration might be more biased towards the average of the discrete samples.

The differences between MI and traditional composite sampling collection and processing are highlighted below.

SAMPLE COLLECTION

Traditional Composite Sample

A composite is a combination of discrete samples. Typically, during composite sampling an investigator will grid off an area and collect a number of samples within the grid.

MI Sample

A MI sample is one that is comprised of multiple aliquots randomly collected from the decision unit. The decision unit is typically less than ¼ acre. The aliquots are collected randomly to avoid sampler bias. (Note: In areas within the decision unit that visibly or potentially may be a “hot spot”, a discrete sample may be warranted.)

An effective, inexpensive, and easy method of locating aliquot locations is the “random walk” method. With this approach, the sample collector wanders over the decision unit and randomly grabs a small aliquot of soil. Typically, a stainless steel 7/8” step probe is used to collect the surface soil. The depth of the increment is decided on a decision unit by decision unit basis, and should be part of the DQO process.

Generally, a minimum of 30 increments should be collected in the decision unit. If replicates yield a variability that is too great, then the number of aliquots would have to be increased and more sample mass would be required.

SAMPLE PROCESSING

Traditional Composite Processing

The discrete samples are placed in a container (often a bowl) and mixed. A subset of this mixture is collected and sent to the laboratory for analysis.

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MI Processing

Once a minimum of 30 aliquots are collected, they are combined, and placed into a pan and dried. Subsequent MI sample processing can take place either in the field or in the lab. The sample is sieved (#10) and then ground to obtain a consistent particle size. The ground sample is laid out and another MI sample is collected to fill the sample container. Other methods to collect the final sample have been accepted, like the "line and scoop method" (EPA 600/R-92/128).

Some key aspects to MI sampling include:

- the results are independent of the sampler;
- the results are reproducible and thus can be expressed with a degree of confidence;
- the results can be extrapolated to locations not sampled; and
- the sample error can be estimated.

CAVEATS:

MI APPLICABILITY

MI sampling has been extensively used for the analysis of most explosives and metals. However, the MI sample process includes sieving and grinding which may cause volatilization and thermal decomposition. Thus, MI sampling is not an appropriate sampling technique for COCs such as the volatile organic compounds (VOCs) and some semi-volatile organic compounds (SVOCs) and inorganics such as mercury. The CP and Volunteer should use the DQO process to determine if MI sampling is appropriate for the COCs at the Property.

DEEPER OR SUBSURFACE SAMPLES

MI sampling may not be a cost-effective strategy to collect deeper or subsurface sampling below a foot (e.g., using a Geoprobe®), given potential field sampling costs. Also, from a statistical standpoint, MI samples cannot be mixed with deeper discrete samples (i.e., treated as one dataset) when trying to determine a representative concentration for a deeper point of compliance (one that includes both shallow and deep soils, for example).

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MI SAMPLING COSTS

It may be necessary to balance mobilization and analytical costs when making sampling strategy decisions. While MI sampling may require more field and/ or lab processing time, other analytical and statistical evaluation costs may be reduced. The CP and Volunteer should determine whether MI sampling is the most resource effective sampling strategy to achieve the data quality objectives.

SUMMARY: A composite sample is a collection of multiple discrete samples combined to form the sample whereas an MI sample is one that is comprised of multiple aliquots that are combined and processed, either in the field or in the laboratory, to form the sample. Contrary to composite sampling, MI sampling produces results that are both reproducible and defensible.

OHIO EPA CONTACT: For any questions concerning this issue, please contact the VAP central office at (614) 644-2924.

SOURCES OF INFORMATION: Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies, July 1992, EPA 600/R-92/128.

Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples, November 2003, EPA/R-03/027.

Multi-Incremental Sampling for Soils and Sediments, Ohio EPA-Division of Emergency and Remedial Response, January, 2007, Standard Operating Procedure 2.6.1.

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