Management Aspects of Implementing the New Effluent Air Monitoring Standard

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Abstract

The revision to ANSI/HPS N13.1, "Sampling and Monitoring Releases of Airborne Radioactive substances From the Stacks and Ducts of Nuclear Facilities," went into effect in January 1999 -- replacing the 1969 version of the standard. There are several significant changes from the old version of the standard. The revised standard provides a new paradigm where representative air samples can be collected by extracting the sample from a single point in air streams where the contaminants are well mixed. The revised standard provides specific performance criteria and requirements for the various air sampling processes – program structure, sample extraction, transport, collection, effluent and sample flow measurement, and quality assurance. A graded approach to sampling is recommended with more stringent requirements for stacks with a greater potential to emit. These significant changes in the standard will impact the air monitoring programs at some sites and facilities. The impacts on the air monitor design, operation, maintenance, and quality control processes are discussed.

1. Introduction

1.1 Purpose

The purpose of this paper is to assist managing radionuclide stack air sampling systems in implementation of the new ANSI standard. The new American National Standard for Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities (ANSI/HPS N13.1-1999) was instituted on January 12, 1999 and replaces the ANSI N13.1-1969 version. The importance of this standard has been recognized by the U.S Environmental Protection Agency (EPA). EPA has proposed an amendment to 40 Code of Federal Regulations Part 61 Subpart H and I which will reference the new standard. There are several significant changes from the old version of the standard. The standard now provides a new paradigm where representative air samples can be collected by extracting the sample from a single point in air streams where the contaminants are well mixed. The revised standard provides specific performance criteria and requirements for the various air sampling processes – program structure, sample extraction, transport, collection, effluent and sample flow measurement, and quality assurance. A graded approach to sampling is instituted with more stringent requirements for stacks with a greater potential to emit. The revised standard is now focused solely on effluent sampling from stacks and ducts. Workplace sampling is no longer addressed.

1.2 Overview Of The ANSI/HPS N13.1 1999 Standard

The standard addresses issues directly related to the process of collecting samples of air from directed airflows such as in stacks or ducts. It sets forth guidelines and performance criteria for air sampling nozzles, transport lines, sampling points, sample collection devices, flow measurements, and quality assurance. However, the analysis of samples (both on-line and off-line), interpreting or reporting results, regulatory issues, and design safety requirements are not addressed.

Table 1-1 Content of Standard

Clause 0	Introduction covering the motivation behind the new standard, the concept of sampling from well mixed airstreams, and the contents of the different clauses
Clause 1	States the scope of the standard and its relationship to other standards and regulations
Clause 2	Describes other standards and methods incorporated (made normative) by reference
Clause 3	Defines special terms and symbols used in the standard
Clause 4	Covers setting sampling objectives based on a graded approach, the potential for releases, and action levels
Clause 5	Discusses the requirements for selecting sampling locations
Clause 6	Covers the requirements for designing the sampling system components
Clause 7	Describes the requirements of an acceptable quality assurance program specific to air sampling

There are two main parts to the standard. The main body contains seven clauses (see Table 1-1) that provide the requirements and guidance on the subjects of the design of the sampling program, hardware design, and quality assurance. The annexes (see Table 1-2) provide additional information that would assist in system design. No requirements are presented in the annexes.

The body of the standard includes performance criteria, requirements, and recommendations that, if followed, will provide samples of the highest quality that will meet the strictest current regulations. However, the standard can also be applied to sampling systems used for purposes other than regulatory compliance, such as monitoring a process at a location other than a final discharge point. Some guidance is provided for documenting exceptions taken for satisfying less rigorous requirements.

Table 1-2 Content of Annexes

Annex A	Techniques for measurement of flowrate through a stack or duct
Annex B	Modeling of particle losses in transport systems with an example of using a computer code to estimate aerosol penetration through a transport system
Annex C	Special considerations for the extraction, transport and sampling of radioiodine
Annex D	Selecting filters for collecting airborne radioactive particles
Annex E	The statistical basis for evaluating effluent sampling errors and uncertainty
Annex F	Conducting sampling system performance verification
Annex G	Transuranic aerosol particulate characteristics and the implications for extractive sampling in nuclear facility effluents.
Annex H	Tritium sampling and detection.

Requirements and recommendations are usually identified with “shall” and “should” statements. There are about 200 unique requirements and recommendations; however, not all would apply in every given circumstance. Many of these are linked together and a number of them are repetitious. The standard usually uses the word “shall” to denote when compliance is required with the standard. The manager should keep in mind that the standard was not designed to be a regulator document. However, the standard has responded to how the 1969 standard was applied in regulations by including the term “should’. The term “should” denotes a recommendation, good management practice, or a desirable action in order to meet the intent of the standard. There are about 170 “shoulds” in the new standard. “Shoulds” however are not required by the user to meet the intent of the standard. A user meeting the “shalls” will meet the standard. The user is encouraged to address the “shoulds” since they are intended as a good management practice. However, in a number of places in the document expected “shalls” have been noted with only the good management practice “shoulds.”

2.0 Changes in the Standard

The original version of ANSI N13.1-1969 "*Guide to Sampling Airborne Radioactive Materials* " was the first standard written to address stack air sampling. It also contained general guidance on workplace air sampling. The body of the standard contained the guidance on sampling in the workplace and from stacks and ducts while the three Appendices contained guidance specific to sampling from stacks and ducts.

The revision focuses only on sampling from stacks and ducts. (It also incorporates lessons learned on the application of the original standard.) Air sampling environments of the stack and ducts were considered sufficiently different from workplace sampling that separate standards were judged by the ANSI N13.1 committee as necessary.

Although the American National Standards Institute (ANSI) issued the *Guide to Sampling Airborne Radioactive Materials* (ANSI N13.1-1969) in 1969, the term "guide" was in the title and was used often in the standard. That version was the first written standard that addressed air sampling and at that time it represented the state of the art. Some of the guidance is still relevant today, while some parts are vague, misleading, variously interpreted, and outmoded. In the ensuing decades, there have been significant improvements in air sampling technology that needed to be reflected in a revision. Also, once the standard was included in 40 CFR 61 Subpart H experience was gathered from how regulations were applied to the old standard. Considerable clarification was also needed to adequately address programmatic and management issues and commonly misunderstood guidance. Initial work on the revision was begun in 1985, serious progress was begun in 1994 by a working group under the auspices of the Health Physics Society Standards Committee.

In 1989, the U.S. EPA issued a National Emission Standard for Hazardous Air Pollutants (NESHAP) for airborne radioactive emissions from DOE facilities (40CFR61, Subpart H). It required compliance with ANSI N13.1-1969, specifically those parts addressing stack sampling. It also required the application of EPA methods for the measurement of stack airflow and the analysis of samples. Finally, it required assigning emission points to one of two categories based upon estimates of potential annual dose to the nearest maximally exposed individual in the absence of emission control devices. In the higher potential dose category ($\geq$ 0.1 mrem/yr), continuous emission sampling was required. Only periodic confirmatory sampling was required for the lower category.

The issuance of the NESHAP rule was usually interpreted as transforming the stack sampling guidance of ANSI N13.1-1969 into requirements. One difficulty immediately arose. Some points of guidance became requirements, whether or not it was still technically appropriate. The rule also made it difficult to develop or employ improved technology unless one was willing to use the cumbersome alternative method process. An example of this was in developing new probes. The 1969 standard allowed room for the use of new probes while regulations required obtaining approval for the new probes as an alternative. Since this approval was sometimes a lengthy process, the tendency was to use only probes which matched the 1969 Standard. Consequently, the revision of the standard was needed not only to implement technical advances, but also in response to how the regulations were applied to the 1969 Standard.

The new standard clarifies what should be requirements to meet the standard , what should be recommendations, and what should remain as guidance or helpful information. The revised standard makes heavy use of performance criteria and the terms "shall", "should", "may", or "required" to distinguish what is really required for good sampling to meet the standard, what is recommended, and what is guidance or information. Finally, the revised standard allows for the use of new technical advances when they become proven. It is hoped that the "shoulds" noted in the new standard will not be turned into "shall".

The newly revised standard for effluent air sampling differs from the 1969 version greatly in every step of the process of collecting air samples that are representative of the characteristics being measured. The major changes in the standard will be outlined in the following sections. It will be followed by speculation on the changes in the regulatory requirements. Finally, the impacts of these changes on the management of the emission sampling program will be discussed.

2.1 Philosophy

The major difference between the versions is that lessons learned on the application of the original standard were incorporated into the new standard. The 1969 version was written as a guide or a collection of recommended best practices. The strongest action phrases were typically: must be, should be preferably, are to be preferred, should ideally, may be, or can be. Although the recommendations represented the state of the art for their time, they were often compromised in their implementation because of the weak wording in the standard. Recommendations for performance validation were usually ignored because of the overall weakness of the action verbs and the lack of validation technology. As a result, only a few of the recommendations were given prominence and they became the de facto standard for purposes of auditing compliance with the standard :isokinetic, multi-nozzle probes, distances between flow disturbances and sampling probes. To further weaken the original standard, the recommendations for the number of nozzles on a probe were extrapolated to accommodate large stacks, resulting in unacceptable nozzle openings that were too tiny to serve their purpose. The new standard includes stronger action verbs and distinquishes between requirements, recommendations, and information.

2.2 Sampling Program

The first significant change is the required written technical basis addressing the sampling objectives, the graded approach for meeting the objectives, the relevant facility conditions and airborne contaminants, and the action levels signaling changing conditions of significance.

Considerable space is given to how a graded approach is to focus resources on emission points with the greater potential to emit. Fewer resources can be used on emission points with lesser potential to emit. While estimating potential emissions is required, the user is free to develop estimating methods and to define categories for implementing sampling instrumentation. Possible estimating methods and a sample graded approach are provided to aid implementation of the standard. The graded approach for sampling assigns Potential Impact Categories (PIC) based on the dose to the maximum exposed individual from unabated emissions. The sample graded approach has more categories than the current NESHAP rule. While it is nearly always prudent to conduct some type of air sampling at facilities containing radioactive materials, the sample approach allows in the lowest category for no sampling, only an administrative review is required.

The revised standard provides more elaborate discussion on planning for sampling normal and off-normal conditions. Sampling systems are required to reliably function under all normal operating conditions as defined in the standard. They should also accommodate or account for off-normal conditions, recognizing that there are limits to this ability.

The document also provides discussion of recommendations for sampling difficult radioactive contaminants such as very large sized particles and reactive or condensing gases and vapors. Some of the performance criteria for particle sampling are based on a minimum design particle size of 10 microns aerodynamic diameter (AD). Rationale for choosing this minimum is presented. Adjusting the design criteria for still larger particles is allowed, if warranted.

The final programmatic change is the requirement for establishing defensible action levels and designing to ensure that the action levels are measurable.

2.3 Sampling System Design

The sampling system design can be broken into the following sections.

2.31 Sampling locations

The original standard had the following criteria for sampling locations:

- Distance from flow disturbance to sampling point should be a minimum of 5 stack diameters downstream, preferably 10 or more
- Velocity distribution is measured, flow is fully developed, and mixing is complete
- Where there are difficult cases with several streams coming together in the stack, particle distribution should be evaluated
- Vertical run is favored over a horizontal run to avoid particle stratification due to gravity settling
- The particle and gaseous composition at the sampling point should be representative
- Just to be safe, use several sampling nozzles located per the recommended method
- Single point sampling justified if contaminant distribution is shown to be uniform

The significant change with the revised standard is that the sampling probe is required to be located where it has been demonstrated that the contaminants are well mixed and the flow is fully developed. This allows for the use of the preferred single nozzle probe. (Multiple nozzle probes are also allowed if they meet performance criteria.) Performance criteria defining adequate mixing of contaminants and flow are provided. Methodology for the demonstration is also provided. The demonstration tests can be conducted on either the actual stack, a scale model, or another geometrically similar stack. There are four parts to the demonstration tests. If scale model or similar stack results are applied, only the fully developed flow needs to be demonstrated on the actual stack in question. Complex multi-nozzle probes are no longer recommended.

2.3.2 Sample extraction

Sample extraction refers to separating the sampled air from the main airstream. This is usually done with one or more nozzles on a probe. The original 1969 standard contained the following guidance regarding sample extraction:

- A multi-nozzle probe is to be used on stacks larger than a certain size to compensate for a lack of proof of contaminant mixing
- A single nozzle probe is justified if contaminant distribution is shown to be uniform in the stack
- Each nozzle is to sample isokinetically, i.e., the velocity just inside the nozzle matches the velocity of the free airstream approaching the nozzle. This is to avoid favoring one size of particles over another while maintaining the representative nature of the sample for all particle sizes
- Where multiple nozzles are used, they should be located at points of the average and equal velocity
- Preferred to use a probe that exposes the collector directly to the airstream
- The probe should be readily removable for inspection or cleaning

- Abrupt changes in flow direction should be avoided to minimize impaction of particles
- Four example designs were provided, three of which show a constant internal diameter of the nozzle

The significant changes with the new standard include:

- Preference for a single nozzle probe once contaminant uniformity is demonstrated
- Certain performance criteria apply addressing sample aspiration and transmission through all nozzle designs
- Limits on the fraction of stack cross section that can be taken up with nozzles
- Requirements for inspections of nozzles
- Isokinetic sampling is no longer a requirement, it alone is no longer a sufficient description of the nozzle performance
- Flow through nozzles required to be controlled and to be proportional to the stack flow for stacks with greatest potential impact

2.3.3 Sample transmission

Sample transmission refers to the fraction of extracted sample that gets delivered to the sample collector or detector through the sampling lines. The original standard's guidance included:

- Avoid condensation on the inside of sampling lines
- Preferred to use a probe that exposes the collector directly to the airstream
- The degree to which a sample may be in error should be estimated
- A determination should be made whether estimated line loss is tolerable for the particular use of the data
- Long sample delivery lines should be avoided
- Possible sampling errors must be evaluated (presumed to include line-loss of particle and reactive gases or vapors)
- An evaluation of particle losses must be made
- Methods are provided to estimate particle losses

The revised standard requires that the penetration of 10 micron AD particles (or larger) and gases and vapors from the free stream to the collector or the detector be greater than, or equal to 50%. Considerable guidance is given for how this criterion can be met and up-to-date models for particle and radioiodine line-loss are given. This has been shown to be an achievable criterion and should provide near quantitative delivery of smaller particles.

2.3.4 Sample collection

There are several ways to collect samples of particles, gases and vapors. Most gas or vapor collectors specifically collect particular compounds. Particle collection at Hanford is typically done using filters which collect all particles, but there are also special collectors that can discriminate by particle size. The original standard describes a wide variety of sample collectors. The revised standard updates the descriptions, but provides less information for types that are seldom used.

For particles, the original standard recommended that:

- The particles, gases or vapors should be initially characterized by size and chemical properties
- The characterization should be repeated at regular intervals or when any change is anticipated

- It is necessary to know the filter efficiency for the particle size and flowrate
- It is necessary to know the collection characteristics of size selective collectors
- Filter holders should be checked to insure leak tightness and they should be easy to use and be corrosion resistant
- Specific requirements and recommendations are given for the use of solid adsorbents, liquid absorbers, condensation traps, and flow-through chambers

Most of the guidance on this subject is the same in the revised standard. Some of the recommendations are made requirements. The main changes include:

- Contaminant characterization requirements are addressed under the sampling program, sampling location, and quality assurance discussions
- Added a minimum collection efficiency for filters and a method for verification
- Added a requirement to make the collection side of filters easily identifiable
- Added specific guidance for radioiodine and tritium

2.35 Flow measurements

The requirements of the original standard for stack and sample flow measurements were:

- Sample flow must be measured with calibrated instruments
- Flow meters should be located downstream of the sample collectors and appropriate corrections applied for operating under non-standard conditions
- Automatic sample flow control should be considered where the flowrate will vary significantly with time
- The flow in the duct or stack must be known and direct measurements are preferred

In the revised standard, these are supplemented with the following:

- For the highest potential impact stacks, the sample flow is required to be controlled in proportion to the stack flow
- Requirements for when continuous recording of sample and stack flow are needed
- Specific requirements for maintenance and calibration of sample and stack flow instrumentation

2.4 Quality assurance/control

Quality assurance/control issues were not addressed in the original standard. The revision devotes an entire major clause to the topic. This clause contains 64 requirements (about 1/3 of all the requirements in the standard) and 23 recommendations, although many of these are restatements of requirements noted earlier in the standard. The material covered and key requirements include:

- Quality assurance plan
- Required documentation
- Training
- Maintenance and inspection
- Calibration
- Summary of performance criteria

3.0 Changes in the Regulations

Presently the wording to the amendment to 40 CFR 61 Subpart H is under consideration by EPA.

4.0 Consequences of these Changes

At present the amendment to 40 CFR 61 Subpart H has not been promulgated. However, facilities have an organization that is responsible for environmental compliance. Within that organization individual/s responsible for NESHAP compliance. It is recommended that these individuals need to review the new standard and understand how their existing program will or will not meet the standard When the standard is required either at the Federal, State or local level, the manager will be aware of changes needed to meet the new requirements. This includes new design and QA requirements, new operating and maintenance procedures.

4.1 Design

Managers should recognize that the new requirements apply even before the sampling system is constructed. Within the new standard, there are more stringent requirements for the design of new sampling system. Statements on in the design section 7.3.3 include: "The rationale and any supporting evidence for sampling at a particular location along the duct or stack shall be documented. Similarly, the rationale for sampling at a particular point(s) within (across) the stack or duct shall be documented. Documentation that explains the rationale for the design of the sampling system shall be available. This includes documentation regarding the choice of the transport system, the material, diameter and configuration of the sampling lines, the choice of filters or absorbers, the selection of flowmeters, etc. Also, there should be a means for allowing verification that the installed sampling equipment is that described in the documentation. This can be accomplished by identification marks on the installed components. An evaluation of particulate losses in the sampling lines shall be documented. Other design documents that shall be maintained include engineering change control documents, equipment manuals and vendor supplied information." Because of these additional requirements, additional budgeting for installation of new systems will be required. The recommendation here is to involve knowledgeable individual/s on what is required in the design phase of a new system.

4.2 Maintenance

The new standard lists requirements for maintenance and inspection requirements. These are summarized in Table 5 of the new standard. In the past visual inspections have not generally been required. Since the requirements have added visual inspections of probes for deposits and damage as well as inspecting transport lines , additional costs may be expected.

5.0 Effects on Existing Systems

The graded approach used in designing new systems could also be applied to the decision process for upgrading existing systems. The potential effective dose equivalent (PEDE) has already been computed for most existing and the corresponding PIC level can be assigned. Other determining factors include changing facility mission, the projected life of the facility, the maintainability of the existing system, the particle size distribution upstream of filtration, and the acceptability of the transmission of particles through the system.

The extent of the upgrade effort can vary depending on how closely a system comes to meeting the standard. The effort ranges from zero, to complete replacement and sample location qualification testing. In any case, we recommend that the sitewide stack sampling program quality control and maintenance procedures be upgraded and consistently applied to both new and existing systems.

6.0 Effects on Future Systems

Future air sampling systems will need to meet the requirements of the new version of the standard. Managers should be aware that the sampling system design effort begins early in the design of the ventilation system by defining the approach to be taken and the documentation of the decision making and design process as already described above. The sampling point qualification effort is expedited by choosing stack configurations already tested. The specification and design of new stack configurations should consider testability and contaminant mixing downstream of the fans. The design, fabrication, and acceptance testing schedules and budgets should allow for the compliance demonstration required by the revised standard. The quality assurance, quality control, and system maintenance processes also need to account for the new requirements of the standard.

7.0 Summary

The new ANSI N13.1 1999 standard represents a significant change from the old 1969 standard. Because of these changes and their expected incorporation into an amendment to 40 CFR 61 Subpart H, mangers involved in the design, maintenance, and use of stack sampling systems for radionuclides should become familiar with new standard and prepare for its implementation, and make adjustments as implementing regulations are promulgated. This begins with developing the graded approach for their facility or site, assessing how their existing and planned emission points and sampling systems fit into that approach. On this basis, strategies can be developed for assessing the compliance of existing systems, making upgrade decisions, updating the specification, design, acceptance testing, operation and maintenance processes.

References

40 CFR 61, Subpart H, U.S. Environmental Protection Agency, "National Emissions Standards for Emission of Radionuclides Other Than Radon from Department of Energy Facilities". U.S. Code of Federal Regulations 1989

ANSI N13.1. "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities". American National Standards Institute, New York; 1969 (Reaffirmed 1982)

ANSI/HPS N13.1 – 1999, "Sampling and Monitoring Releases of Airborne Radioactive Substances From the Stacks and Ducts of Nuclear Facilities". American National Standards Institute, New York; 1999