Study on Guidelines for Airborne Radioactive Effluents Monitoring -Centered Around ANSI N13.1-

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1. Introduction

The release of airborne radioactive effluent from nuclear facilities to the environment is generally monitored by radiation detection instrumentation and sampled for laboratory analyses during normal operation, and anticipated operational occurrences, and under post-accident conditions.

Sample extraction has been conducted with sampling system which is very useful facility, but there are a lot of complexities for getting representative samples. For example, temperature, effluent flowrate, duct geometry, effluent composition, particle size, etc.

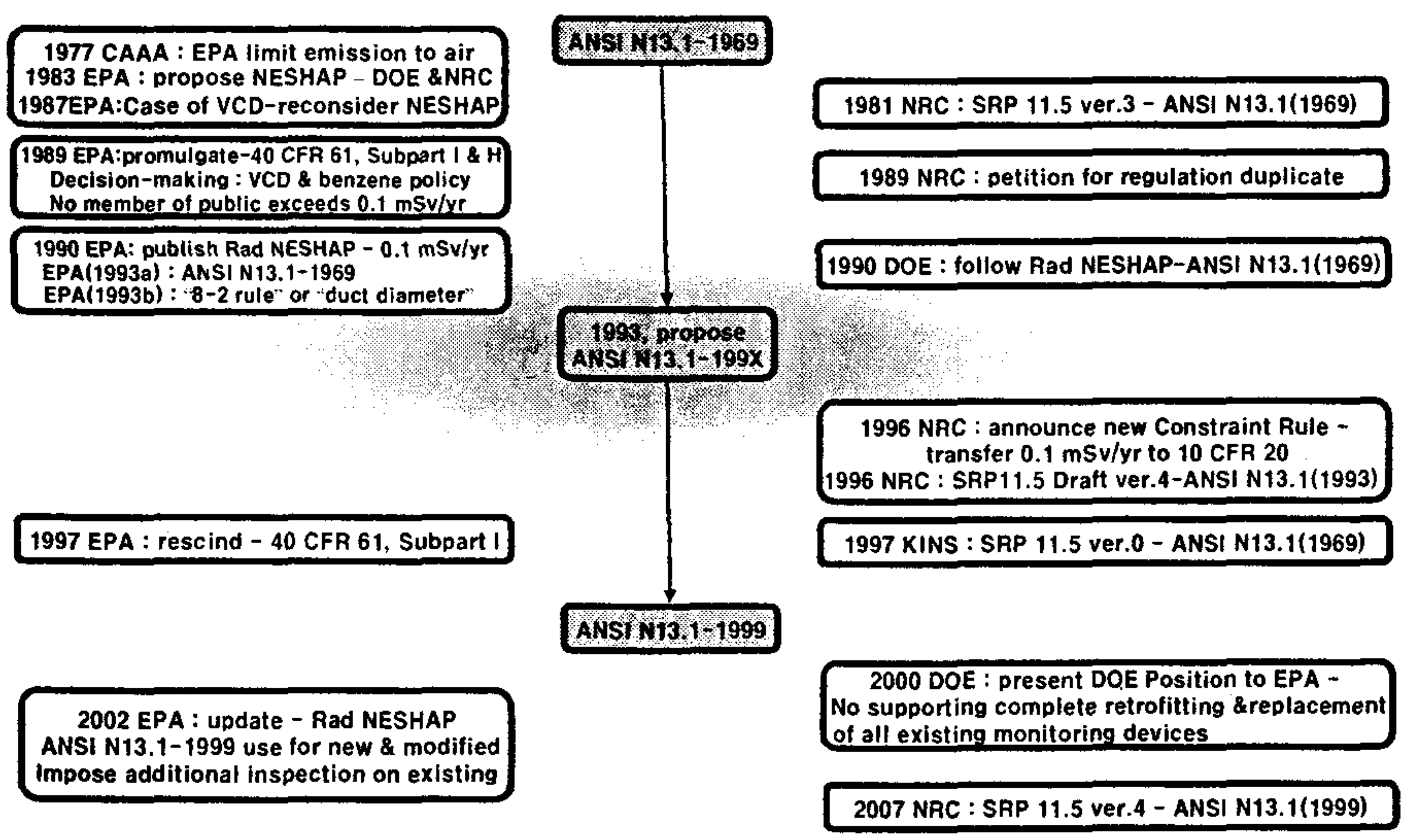
Since the construction permit for Kori-1 issued in 1972, 20 units of NPPs are under operation, and 6 units are under construction. All of operating NPPs in Korea have used stacks (and ducts) sampling system, which have used isokinetic sampling method with multiple small-diameter nozzles in accordance with the guidelines in ANSI N13.1-1969 in spite of various types of NPPs.

The design features of sampling system that includes the transport line and sampling flow rate are different in each facilities, because the various types of NPPs has different sampling circumstances and sampling location. Also, newly designed NPPs have much more number of stack than previous type of NPPs, and it caused to increase the number of sampling system in entire NPPs.

It is essential to use a uniform method for measuring, evaluating, recording, and reporting data on radioactive material in effluents. The uniform method can provide a uniform basis for data comparison from the different facilities. It allows the data summary by regulatory body, and can be used to assess the licensee's effluent controls and the potential environmental impact of radioactive materials in effluents.

2. Guidelines of Monitoring

2.1 Backgrounds



In 1981, the USNRC required the location of probes, detectors, sampling points, and sample stations, and the bases for the selection of these sampling or monitoring points are compared with the guides for sampling from ducts and stacks contained in ANSI N13.1-1969, in its SRP 11.5 - ver. 3.

In 1983, EPA proposed NESHAPs for DOE facilities and NRC-licensed facilities. In 1987, EPA concluded the NESHAPs should be reconsidered with the case of Vinyl Chloride Decision.

In 1989, EPA published NESHAPs for eight radionuclide source categories. The revised rule were more prescriptive, based primarily on the decision-making framework outlined in the vinyl chloride decision and the benzene policy. This regulation, an implement of the federal Clean Air Act (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAP), requires no member of the public would receive an effective dose in excess of 0.1 mSv (10 mrem) in a year from the release of radionuclides from DOE and NRC-licensed facilities via the air pathway.

The USNRC sued USEPA during the development of the radionuclide NESHAP promulgated in 1989, which regulation was contained in USEPA's 40 CFR Part 61, Subpart I. The USNRC petitioned for reconsideration of the NESHAP for NRC-licensed facilities, on the basis that this regulation duplicated USNRC's regulatory program. However, USNRC did not have data from these facilities to verify the emissions, and did not constrain emissions below the USEPA limit. Between 1992 and 1996, USEPA evaluated the USNRC program at thousands of facilities. Based on the data collected, USEPA concluded that radionuclide emissions from USNRC- and Agreement State-licensees did not exceed the 10 mrem/yr standard established in the NESHAP. USEPA found that USNRC's regulatory program protects the public health to a safe level with an ample margin of safety.

The USEPA and USNRC agreed to transfer the 0.1 mSv/yr (10 mrem/yr) limit on air emissions in USEPA's Subpart I to USNRC's Part 20 as a constraint on air emissions. This was achieved in two steps: USNRC announced its new constraint rule, incorporated into Part 20, in the Federal Register on December 10, 1996, to be effective January 9, 1997; and USEPA rescinded Part 61, Subpart I, for USNRC licensees, in a Federal Register notice on December 30, 1996.

In 1990, the Environmental Protection Agency's 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" (Rad NESHAP) became effective for DOE facilities. With the implementation of Rad NESHAP, the technical requirements for determining dose to the public became more rigidly defined. This regulation called out the requirements of the ANSI N13.1-1969. This guidance concentrates heavily on the ability of a sampling system to representatively collect large particles (greater than about 3-5 μm Aerodynamic Equivalent Diameter(AED)) through isokinetic sampling. In addition, sampling sites are required to be selected following procedures in USEPA(1993b).

In 1993, the ANSI N13.1-1969 is currently being revised. The proposed title for ANSI N13.1-199X is Guide to Sampling Airborne Radioactive Materials in Stacks and Ducts.

In 1997, the KINS issued its SRP to require the location of probes, detectors, sampling points, and sample stations, and the bases for the selection of these sampling or monitoring points are compared with the guides for sampling from ducts and stacks contained in ANSI N13.1-1969.

In 1999, the ANSI N13.1-1999 is issued.

In July 12, 2000, the USDOE presented DOE Position on ANSI 13.1-1999 to support the EPA's proposal to make the modifications for compliance with the ANSI standard apply primarily to new or modified facilities rather than require complete retrofitting of all DOE facilities.

In 2002, the USEPA updated its regulations at 40 CFR 61, Subparts H to require the use of ANSI N13.1-1999 for all applicable newly constructed or modified facilities and imposed additional inspection requirements on existing facilities consistent with the revised ANSI.

In March 2007, the USNRC also updated its SRP 11.5 at NUREG-0800 (version 4) to require the effluent monitoring instrumentation and sampling systems should be designed to automatically take representative samples at a known flow rate established in accordance with ANSI N13.1-1999.

2.2 Deficiencies in Rad NESHAP

The Rad NESHAP called out that sampling sites are required to be selected following procedures in USEPA(1993b). The reference method based on a general rule that sampling should be done at least 5 - 8 diameters downstream from a disturbance and at least 2 diameters upstream flow disturbances. The techniques for characterization are clearly provided, but the criteria for evaluation of the characterization are not. That is, although the velocity profile at the sampling site is determined, there are no numerical criteria for deciding if the profile is adequate. There is an assumption inherent in the site selection process that the degree of flow development and mixing are directly related to the distance from disturbance. This, unfortunately, is not necessarily true.

In addition, the implementation of Rad NESHAP called out the requirements of the ANSI N13.1-1969. This guidance concentrates heavily on the ability of a sampling system to representatively collect large particles (greater than about 3-5 μm Aerodynamic Equivalent Diameter(AED)) through isokinetic sampling. The reference method provides a strong basic framework for the concerns in sample probe design. The concept of isokinetic sampling is key in this framework. However, other characteristics of the bulk effluent (i.e., the degree of flow development and particulate mixing) are also critical to determine the design requirements of the probe.

Using the site characterization methodology prescribed by USEPA(1993b), no assumptions can be made about these characteristics. These methods provide measurement procedure but no criteria. Therefore, USEPA(1993a) assumes nothing about flow development and mixing and calls out ANSI recommendations for probe design.

ANSI N13.1(1969) provides guidance for particulate sampling probes that utilize a multinozzle array to accomodate any deficiencies in the flow development or mixing. This scheme has a significant drawback, however. As additional nozzles are added, the loss of particles increase due to impaction in the small nozzle inlet and tube bends. Depending upon the density of the particulates at a ratio 2.0, particulates are underestimated by 10 to 50%. (Density = 3D mass of particulate/volume of particulate.)

2.3 Performance Criteria of ANSI N13.1-1999

In 1999, ANSI N13.1 issued again as new version which compensate the deficiencies as described above. ANSI N13.1-1999 "Sampling and Monitoring Release of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities" is a performance-based standard rather than the prescriptive 1969 version.

To assure a representative sample is collected, the standard established required sampling system performance criteria. These criteria are listed below.

- Total transport of 10 μm AED particles and vaporous contaminants shall be 〉 50% from the free stream to the collector/analyzer.
- Sampler nozzle inlet shall have a transmission ratio between 80% and 130% for 10 μm AED particles.
- Sampler nozzle shall have an aspiration ratio that does not exceed 150% for 10 μm AED particles.
- Characteristics of a suitable sampling location are : a) coefficients of variation over the central 2/3 area of the cross section within ±20% for 10 μm AED particles, gaseous tracer, and gas velocity; b) flow angle 〈 20° relative to the long axis of the stack and nozzle inlet; and c) the tracer gas concentration shall not vary from the mean 〉 30% at any point on a 40 CFR 60, Appendix A, Method 1 velocity mapping grid.
- Continuous measurement of the required effluent flow rate variation is 〉 ± 20% in a year.
- Effluent and sample flow rate shall be measured within ±10%.
- Continuous measurement and control of the required sample flow rate if flow varies 〉 ±20% during a sample interval. Flow control shall be within ±15%.

3. Under Tasks

New plants under construction in Korea are planning to use ANSI N13.1-1999. And, the performance criteria of ANSI N13.1-1999 have been studied to impose on the existing facilities for data comparison.