RECORD #88

TITLE: Corrections for Sample Conditions for Air and Gas Monitoring

FICHE: 16628-191

This seems to imply that a sample chamber pressure correction is needed. Not so. The problem is merely to determine the correct flow rate in order to: (1) ensure isokinetic flow and (2) to determine the flow ratio of effluent to sample streams.

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IN 82-49

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D. C. 20555

December 16, 1982

John: Thoughts? Bill

Bill — Include item in Insp Proc? See attached note. HW

T-(F)

IE INFORMATION NOTICE NO. 82-49: CORRECTION FOR SAMPLE CONDITIONS FOR AIR AND GAS MONITORING

Addressees:

All nuclear power plant facilities holding an operating license (OL) or construction permit (CP), research and test reactors, fuel facilities, and Priority I material licensees.

Purpose:

This information notice is provided as notification of errors in radioactive gaseous effluent monitoring. Regional surveys of equipment and practices at selected light water reactors (LWRs) revealed that a number of LWRs were not routinely correcting for pressure differentials between main vent effluent streams and associated offline sampling systems. Failure to correct for this pressure differential can introduce errors (both in direct-reading gas monitoring and in flow indication) in monitoring gaseous effluents with offline sampling systems. These sampling errors can cause a significant underestimation when quantifying effluent releases.

The potential also exists for systematic errors in occupational air monitoring programs. Failure to apply pressure correction factors for flow measuring devices when calibrating air samplers could lead to erroneous determinations of airborne radioactivity levels.

It is expected that recipients will review the information for applicability to their facilities. No specific action or response is required at this time.

Description of Circumstances:

A problem of pressure differentials in gas monitoring systems was identified by the licensee at the Diablo Canyon nuclear power plant. At Diablo Canyon the gas monitor takes suction through an isokinetic sampling head about 100 feet up the plant vent stack. In maintaining a flow of 10 cfm, necessary to ensure isokinetic sampling, it was found that the gas monitor chamber pressure was approximately 12 inches of Hg below atmospheric pressure (30 inches of Hg). This resulted in a reduction in the density of the sample chamber gas by approximately 40 percent.

The licensee has found that the reduced pressure phenomenon is most pronounced in systems with long sample lines and is less noticeable where sample lines are short. The licensee plans to incorporate pressure or ΔP gauges on the gas monitoring equipment and to include corrections for pressure variations in calculation of gaseous activity.

As a result of this reported sampling deficiency, each Region conducted a survey of selected operating LWRs to determine whether licensees were making the necessary pressure differential corrections for effluent monitoring. Results of these Regional surveys indicate that a generic deficiency does exist. Twenty plants were surveyed and eleven facilities reported they made no pressure differential corrections.

Discussion:

Since calibration of normal range noble gas detectors (sensors) is usually done at atmospheric pressure using Kr-85 gas, it is essential that calibration and operational readouts be automatically corrected for the reduced pressure conditions encountered in system operation, or procedures specify the application of appropriate correction factors. Current models of effluent air monitoring systems provided by major vendors usually incorporate such correction factors.

Particulate and iodine effluent release determinations also are sensitive to sample flowrate which may be affected by system pressure variations. Errors in the order of 10 percent to 50 percent in the calculation of particulates and iodine can result if no compensation is provided for measurement of actual gas flow in the sampling system at reduced pressure.

One of the simplest and most commonly used gas flow measurement devices is the variable area flow meter, commonly known as the rotameter. A rotameter calibrated at atmospheric pressure will not read correctly at either higher or lower pressure, unless properly compensated. (D. K. Craig, See Attachment 1). Pressure correction factors for specific rotameters are available from the various manufacturers as part of the instruction manuals supplied with the equipment.

Operating variables such as the length of sample run, and variations in ΔP across a particulate filter can affect operating pressure. In addition to long sample runs, another significant factor is the increase in pressure drop across a particulate filter caused by dust loading. Craig cites an example involving dust buildup on a filter where ΔP increased from 5.9 inches of Hg to 10.7 inches of Hg while the rotameter float reading was kept constant. The initial flow rate was measured at 5.08 liters/minute and the end flow was 4.02 liters/minute.

Assuming linear change in flow rate, the true mean value would have been 4.55 liters/minute. A determination of total volume flow made on the assumption that the 5.08 liters/minute initial value prevailed over the entire sampling period would have been 11.7% too high, and air contaminant concentrations obtained using the initial flow rate would have been too low, by the same percentage.

Manufacturers of sampling/monitoring systems are aware of the flow-measurement discrepancies just discussed. Current systems provide built-in compensation of air flow rate indication for operation at less-than-atmospheric pressure through the use of pressure and temperature transducers and computer software algorithms. Older analog systems may require application of manual correction factors for given conditions of ΔP and flow. Instruction manuals provided to licensees by the vendors of older sampling/monitoring systems describe the procedures for making the necessary corrections.

Independent verification of calibration of a flow rate measurement system can be accomplished by placing a calibrated rotameter in series at the sample intake end of the system and comparing readings of the system rotameter under various system pressure conditions with those of the calibrated rotameter. Since the verification rotameter operates at ambient pressure, the only corrections needed for the calibration procedure are the correction for ambient pressure (relative to standard) and a small correction for temperature (the latter is only necessary for high precision work--the error in assuming a standard condition of 70°F is less than 5% for the temperature range 24°F to 116°F which encompasses most plant effluent streams).

Existing NRC regulations require the control of radioactive releases from nuclear facilities and require measurements of radioactive materials in effluents. It is implicit in all requirements for effluent monitoring that these measurements be reasonably accurate. Licensees are expected to review their facility's effluent monitoring program to determine the applicability of the information provided in this notice.

No written response to this information notice is required. If you need additional information about this matter, please contact the Regional Administrator of the appropriate NRC Regional Office or this Office.

Reference:

Craig, D. K., "The Interpretation of Rotameter Air Flow Readings," Health Physics. Pergamon Press 1971. Vol. 21 (August) pp. 328-332.

RC DeYoung

Richard C. DeYoung, Director
Office of Inspection and Enforcement

Technical Contact: J. E. Wigginton
301-492-4967

P. G. Stoddart
301-492-7633

Attachments:
1. Article by D. K. Craig, "The Interpretation of Rotameter Air Flow Readings."
2. List of Recently Issued IE Information Notices