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QUARTERLY STATUS REPORT

**FAST-RESPONSE ISOTOPIC ALPHA
CONTINUOUS AIR MONITOR (CAM)**

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Project objective

The objective of this effort is to develop and test a novel Continuous Air Monitor (CAM) instrument for monitoring alpha-emitting radionuclides, using a technology that can be applied to Continuous Emission Monitoring (CEM) of thermal treatment system off gas streams. The CAM instrument will have very high alpha spectral resolution and provide real-time, on-line monitoring suitable for alerting workers of high concentrations of alpha-emitting radionuclides in the ambient air and for improved control of decontamination, dismantlement, and air emission control equipment.

Base Phase I involves the design, development, and preliminary testing of a laboratory-scale instrument. Testing will initially be conducted using naturally-occurring radon progeny in ambient air. In the Optional Phase II, the Base Phase I instrument will be critically evaluated at the Lovelace Respiratory Research Institute (LRRI) with characterized plutonium aerosols; then an improved instrument will be built and field-tested at a suitable DOE site.

Major milestones

- Design criteria and specifications defined — Completed on schedule
- Prototype unit operational — Completed on schedule
- Performance of prototype unit demonstrated

Accomplishments and technical progressOctober 1999

In May, the prototype CAM instrument became operational, and initial data was taken using the instrument. Modifications to improve the prototype CAM instrument's performance that were begun during June were completed in August. This work included an improved detector mount for enhanced alignment of the detectors to the film, and an enhanced film tracking system to improve alignment of the film to both the ESP and the detectors. Several changes to the

film transport system were also made to accommodate the enhanced film tracking system.

The prototype CAM instrument was operated this month to obtain additional performance and reliability data. These data were obtained for the improved, parallel-flow airflow arrangement described last month. With the improved, parallel-flow air inlet, signal response of the prototype CAM instrument remained within 6% of that reported last month.

Analysis results indicate that there was no degradation in CAM system performance during several hours of instrument operation. This provides initial confirmation that the use of a moving collection film by the prototype ESP CAM instrument provides superior spectral resolution, when compared to the use of fixed filters in a conventional CAM system. Such an improvement in performance was predicted due to the ever-increasing accumulation of collected particulate material that builds up on a fixed filter system. This increase in collected material will increase the attenuation of alpha emissions as time passes, decreasing the spectroscopic resolution of such fixed filter CAM systems.

In addition, analysis of the results to date indicates the possibility that the current prototype CAM system might be twice as big as is necessary to meet regulatory and end-user requirements. This is due to one-half of the prototype CAM system being 6.8 times more sensitive than that required by U.S. regulations (a required sensitivity of detecting Pu-238-contaminated 1 DAC air (0.0020 pCi/l) in 8 hours).

Figure 1 illustrates how a typical, well-defined Po-214 peak is visible after a 10 minute sample/count period using only one of the two ESP CAM system's detectors. This spectrum represents a Po-214 concentration of 0.014 pCi/l, which is comparable to 7.1 DAC air. The relative sensitivity of the single detector prototype CAM system is calculated by the following ratio:

$$\frac{(DAC_{\text{Required}}) \times \text{hours}_{\text{Required}}}{(DAC_{\text{Actual}}) \times \text{hours}_{\text{Actual}}} = \frac{1 \text{ DAC} \times 8 \text{ hr.}}{7.1 \text{ DAC} \times \frac{10 \text{ min.}}{60 \text{ min./hr.}}} = 6.8$$

Figure 1 Sensitivity of ESP CAM is 6.8 Times Greater than U.S. Regulations

In other words, the sensitivity of the single detector prototype CAM system is 6.8 times greater than the required sensitivity of measuring 1 DAC in 8 hours. Thus, the prototype CAM system is not required to be a foot wide and use two detectors, but will operate quite well with a single detector and a six inch wide unit.

Additional testing will be conducted in order to provide additional characterization of the prototype CAM system's operation and performance. For example, a determination will be made of the response of the CAM system to various changes in sample air flow rate.

A Poster Paper presentation titled "Development of a Fast-Response Isotopic Air Monitor" was made at the Industry Partnership for Environmental Technology Development and Deployment, Federal Energy Technology Center (FETC), Morgantown, WV, October 12-14, 1999.

November 1999

In May, the prototype CAM instrument became operational, and initial data was taken using the instrument. Modifications to improve the prototype CAM instrument's performance that were begun during June were completed in August. This work included an improved detector mount for enhanced alignment of the detectors to the film, and an enhanced film tracking system to improve alignment of the film to both the ESP and the detectors. Several changes to the film transport system were also made to accommodate the enhanced film tracking system.

A test was performed to determine the response of the ESP CAM system to a quadrupling in sample air flow rate. During the test, the instrument was operated until steady-state conditions were reached at a sample air flow rate that was 25% of normal. Next, the air flow rate was quadrupled, and increased to the normal reading. Operation was continued at this new, higher flow rate until steady-state conditions were again reached. Readings were taken to determine if the indicated measurement also quadrupled, in ratio to the amount of radon progeny that was sampled.

Analysis results (Figure 2) illustrate that the response of the prototype ESP CAM instrument almost exactly quadrupled in response to the increase in sample air flow. This response ratio of 4.01 represents an error of 0.25%, well within the accuracy of the flow measurement. In conclusion, the ESP CAM instrument operates over a flow variation of 4:1 without a change in the indicated measurement.

Additional testing will be conducted in order to provide additional characterization of the prototype CAM system's operation and performance. For example, a determination will be made of the accuracy and the stability of the complete ESP CAM system.

Figure 2 Prototype ESP CAM Compares Favorably to Conventional Filter Analysis

December 1999

In May, the prototype CAM instrument became operational, and initial data was taken using the instrument. Modifications to improve the prototype CAM instrument's performance that were begun during June were completed in August. This work included an improved detector mount for enhanced alignment of the detectors to the film, and an enhanced film tracking system to improve alignment of the film to both the ESP and the detectors. Several changes to the film transport system were also made to accommodate the enhanced film tracking system.

The complete prototype ESP CAM instrument was successfully operated this month to obtain additional performance and reliability data. Unit operation included initial tests using two large area silicon detectors, to maximize instrument sensitivity. In brief, these were tests that included all the major operational features of the instrument:

- Two large area diodes, to maximize instrument sensitivity;
- The improved, parallel-flow airflow arrangement described recently;
- Automatic libration of the instrument, to provide a sub-one minute response time for acute alarms of radionuclide levels;
- Automatic film feeding, to provide an archival record of radionuclide levels.

Analysis results (Figure 3) illustrate that the results obtained with the prototype ESP CAM instrument compare quite favorably with the concentration of radon progeny determined with a conventional filter analysis. For example, the final radon daughter level determined with the ESP CAM system was 0.0411 pCi/l, while the filter-analyzed radon progeny level that was determined 13 minutes later was 0.0412 pCi/l, a difference of 0.3%.

Figure 3 **Prototype ESP CAM Compares Favorably to Conventional Filter Analysis**

In addition to the excellent agreement between the two analytical methods, the figure illustrates a gradual trend of decreasing radon progeny levels as the four hour-long test progressed. Specifically, measured radon daughter levels dropped by 24 percent between the second and the fourth hour of this test. This type of trend would be expected, as indoor radon levels are known to have a strong diurnal behavior. Generally, radon levels are at a peak in the morning,

due to overnight accumulation of radon in an unventilated building, then decrease during the day, as people open and close doors -- the infiltrating fresh air tends to dilute indoor radon levels. Accordingly, radon progeny levels would have been expected to decrease as the test progressed from the second to the fourth hour, which is exactly the analysis result of the test.

Additional testing will be conducted in order to provide additional characterization of the prototype CAM system's operation and performance. For example, a determination will be made of the response of the CAM system to various changes in sample air flow rate.

Assessment of current status

The project is on schedule and underspent. Measures are being put into place that will correct the spending discrepancy in the near future.

Plans for the next two months

The Laboratory Prototype Testing Task will continue.

A Topical Report will be submitted that summarizes the work conducted during the Design Criteria and Specifications Task.

A paper copy of the LRRI NEPA Application will be submitted.

The Phase I NEPA approval will be received for Phase I activity by LRRI.

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