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SEASONAL VARIATIONS IN CALORIMETER BASELINES

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ABSTRACT

Calorimetric assay, combined calorimeter measurement and gamma ray isotopic determination, can be the most precise and accurate non destructive assay method. However, for small quantities of nuclear material, the error in the calorimeter measurement can be quite large. The largest component of error for a calorimeter measurement of a low wattage item is often the error in the measurement of the baseline. We present baseline data going back several years for the production calorimeters at the Los Alamos Plutonium Facility. The baseline data show a remarkable seasonal variation that is present in several sizes and designs of calorimeter. We discuss the possible causes of this variation.

INTRODUCTION

The calorimeters used at the Los Alamos National Laboratory Plutonium Facility, TA-55, are water bath calorimeters built by EG&G Mound Applied Technologies. (A detailed description of calorimeter theory, design and construction can be found in Reference 1.) The instruments are either

"twin" or "over-under" design. The twin design calorimeters employ a water bath as the equilibration medium and the over-under instruments use circulating water for that purpose. The water baths or jackets are operated at approximately 25 degrees C and the temperature is controlled to one millidegree.

The Plutonium Facility calorimeters are designed to measure items which fall in the wattage range of one to fifteen watts. The sensitivity of a typical instrument is approximately 10 millivolts/watt. The baseline voltages are obtained by the measurement of an empty sample container and vary from instrument to instrument from twenty millivolts to less than one millivolt. The voltage measured for a sample is obtained from the difference of the voltage measured on the instrument and the baseline voltage. The baseline can vary over the course of a few weeks by as much as a millivolt and this can lead to a large error for a low wattage item.

RESULTS

The baseline voltages of the Plutonium Facility calorimeters have been measured over a number of year as a part of routine operations. When these voltages are plotted versus time a cyclic variation in the baseline voltage becomes apparent for all of the TA-55 calorimeters. Calorimeter, K3, is an over-under calorimeter with a five inch diameter by seven inch high cylindrical measurement chamber. The data for calorimeter, K3, are presented (Figure 1) because the effect was most pronounced for this instrument and there are data taken over a large time period. The large break in the baseline, shown in Figure 1, in mid 1989 is due repair of the water bath temperature controller.

The variation in calorimeter baseline follows a yearly trend, with maxima occurring in Fall and minima in Spring. Several hypotheses have been advanced to account for this effect: variations in

Figure 1. Variation of the baseline voltage of calorimeter, K3, with time.

bath temperature, variations in humidity or variations in the room temperature. These assumptions are difficult to test without sophisticated monitoring equipment in the laboratory rooms. The opportunity arose to evaluate the effects of environmental parameters on the calorimeter baselines when a new set of calorimeters equipped with humidity, room temperature, and bath temperature measurement capability. The data that are presented in the next group of figures are for calorimeter, K8. Calorimeter K8 is a twin design with a ten inch diameter by fourteen inch high measurement chamber. The data relating baseline measurements and bath temperature, room temperature, and humidity are presented in Figures 2, 3, and 4. Figure 2 shows the relationship between bath temperature, baseline and time for calorimeter, K8. There appears to be no long term effect of the bath temperature on the baseline.

Figure 2. Effect of the room temperature on the baseline of calorimeter K8.

An apparent relationship between the baseline voltage and relative humidity is shown in Figure 3. The baseline voltage appears to lag the changes in relative humidity by about three months. The baseline voltage of calorimeter, K8, is clearly related to the room temperature. This effect is shown in Figure 4.

CONCLUSIONS

There appears to be a correlation between the baseline voltage of the calorimeters in the Los Alamos Plutonium Facility and the relative humidity and room temperature of the laboratory in

which the instruments are kept. The room temperature and humidity are parameters which are coupled and change with the seasons. Both of these parameters could be expected to change the thermal conductivity of the calorimeter and its working environment.

Figure 3. Variation of the baseline voltage and relative humidity for calorimeter, K8.

Figure 4. Variation of the baseline voltage and room temperature for calorimeter, K8.

REFERENCES

1. Reilly, D., Ensslin, N., and Smith, H., *Passive Nondestructive Assay of Nuclear Materials*, U.S. Nuclear Regulatory Commission, NRC FIN A7241, Washington, D.C., 1991.

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