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AN INVESTIGATION OF INVENTORY DIFFERENCES (U)

by
C. Harvel
Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

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AN INVESTIGATION OF INVENTORY DIFFERENCES (U)

Chuck Harvel
Material Control and Accountability Section
Westinghouse Savannah River Company
Aiken, SC 29803

ABSTRACT

The derivation of applicable Limits of Error for Inventory Differences(LEIDs) has been a long-term challenge for some material storage tanks at the Savannah River Site. Several investigations have been unsuccessful in producing usable estimates of the LEIDs. An investigation conducted in November of 1991 revealed some significant inventory characteristics. The corrective action involved the implementation of a multi-case LEID based on historical information and a correction in the use of the tank calibration charts for two storage tanks.

INTRODUCTION

Material inventories stored in two tanks were studied. The inventory of material is static in both tanks and the tanks are blanked-off. These tanks are in separate Material Balance Areas(MBAs). These MBAs will be referred to as #1 and #2. Historically, the LEIDs have been based on variance propagation techniques.

In June of 1991, a warning condition occurred in MBA #1. The investigation revealed that adequate tank calibration data did not exist for either of the storage tanks. Therefore, variance propagation is not a valid approach for computing the LEIDs. The LEIDs were recalculated using historical ID information for the two storage tanks. In October of 1991, a warning condition occurred in MBA #2. The investigation of this warning condition is discussed in this paper.

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INVESTIGATION AND DATA ANALYSIS

As required by DOE orders, an investigation was promptly initiated. The investigation was conducted jointly by the facility and the Material Control and Accountability(MC&A) section.

Typically, ID investigations tend to focus on measurement control aspects of analytical laboratory methods. It is always important to validate the measurement quality of analytical methods. However, in this case, it was obvious some other mechanism was causing the problems. The investigation would have to go beyond measurement control considerations.

Historical weight factor, density, and concentration information was provided by the facility for analysis. Regression analysis and data plots were used to analyze the data.

A review of the liquid level weight factor information revealed that the in-tank liquid level of the process solution is continually decreasing due to evaporation. When the liquid level reaches a certain point, acid is added to increase the level. The density and concentration of the in-tank solution are continually changing as evaporation takes place and the tank is refilled.

Figure 1 is a residual plot of density as a function of liquid level. This figure also displays the behavior of density for several evaporation/fill cycles. A new cycle is begun each time acid is added to the tank. This plot shows a consistent decrease in density over several cycles.

Figure 2 is a residual plot of volume by liquid level. This plot clearly shows two tank sections over an historical liquid level range of approximately 24 to 52 inches. The section boundary is at 43.6 inches above the bottom of the tank. This discovery leads to the conclusion that the variability of the IDs may depend on the location of the beginning and ending inventory liquid levels with respect to the tank sections.

Further review of the historical information revealed that the facility was not using density measurements in the calculation of solution liquid levels and masses. A comparison was made between the facility and MC&A methods for computing IDs. The MC&A method incorporated density measurements in the calculation of liquid level and mass.

Figure 3 is a series of Box plots of the MC&A calculated IDs. These plots show a dependence of the ID variability on the location of the beginning and ending inventory liquid levels within the tank. Therefore, a multi-case LEID is required for material control.

Figures 4 and 5 are plots of the IDs as computed by the facility and MC&A, respectively. There are two differences worth noting between these two plots. The first difference is the smaller variability in the IDs over the first several inventory periods for the facility plot. As a result, the October 1991 warning condition is more noticeable on the facility plot. The facility's method for computing inventories resulted in IDs with artificially small variability over the first several inventory periods. The second difference is the magnitude of the ID for the January 1992 inventory period. The facility ID for this period exceeded the new LEID computed as a result of this investigation. The corresponding MC&A ID was within the new LEID.

The largest discrepancies between the facility and the MC&A IDs occurred when the beginning inventory liquid level was in the lower section of the tank and the ending inventory liquid level was in the upper section. These differences between the facility and the MC&A IDs were in the same direction and all were approximately 1,900 grams. Almost all other differences between the facility and MC&A IDs varied from approximately 200 to 800 grams with no consistency in direction.

INVESTIGATIVE RESULTS

The investigation produced the following results:

- The density of the in-tank solution is not considered when calculating the solution liquid level and mass using the tank calibration charts.

- The in-tank liquid level consistently crosses a tank section as evaporation takes place and as acid is added to the tank. The in-tank level can change by up to 25 inches over a period of several months.

DISCUSSION

A former MBA custodian revised the procedures for calculating in-tank liquid level and mass using the tank calibration charts. This change involved the elimination of density as part of the in-tank liquid level and mass calculation. The current MBA custodian inherited the incorrect procedures. After the density problem was discovered, the MBA custodian was able to find the old procedures that used the solution density in the calculation of in-tank liquid level and mass. The solution density was not being used in the calculation of in-tank liquid level and mass for several other tanks with other material types.

The tank calibration charts are in a poor format. A typical chart contains weight factor, pounds of water, and inches of water information. The pounds of water portion of the charts should be converted to liters of water. For a given liquid level, the mass of water is not equivalent to the mass of process solution. However, the volume of water is equivalent to the volume of process solution. An inexperienced person could assume that pounds of water corresponds to pounds of process solution. In general, this is an incorrect assumption.

RECOMMENDATIONS

The following actions were recommended or implemented as a result of this investigation:

- Incorporate density in the calculation of in-tank liquid levels and masses when using the tank calibration charts.

- The liquid level and mass calculations for all other tanks should be reviewed and, if necessary, modified to incorporate density.

- A multi-case LEID was implemented. There are three cases to consider. Both levels in the upper section, both levels in the lower section, and one level in the upper section and one level in the lower section.

- LEIDs should be implemented on a tank-by-tank basis.

FIGURES

Figure 1

Plot of Residual Density by Liquid Level

Plot Symbol Indicates Evaporation/Fill Cycles

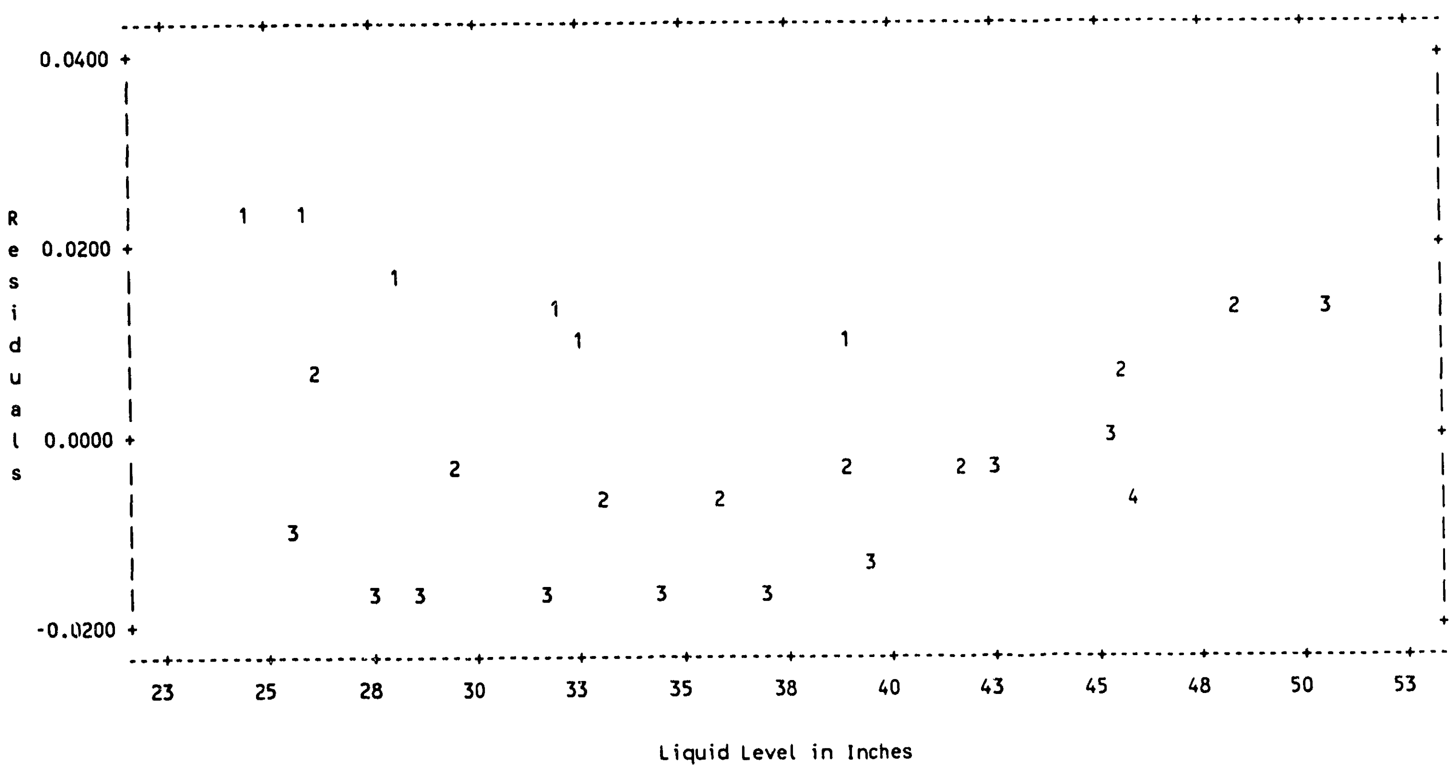


Figure 2
Plot of Residual Volume by Liquid Level

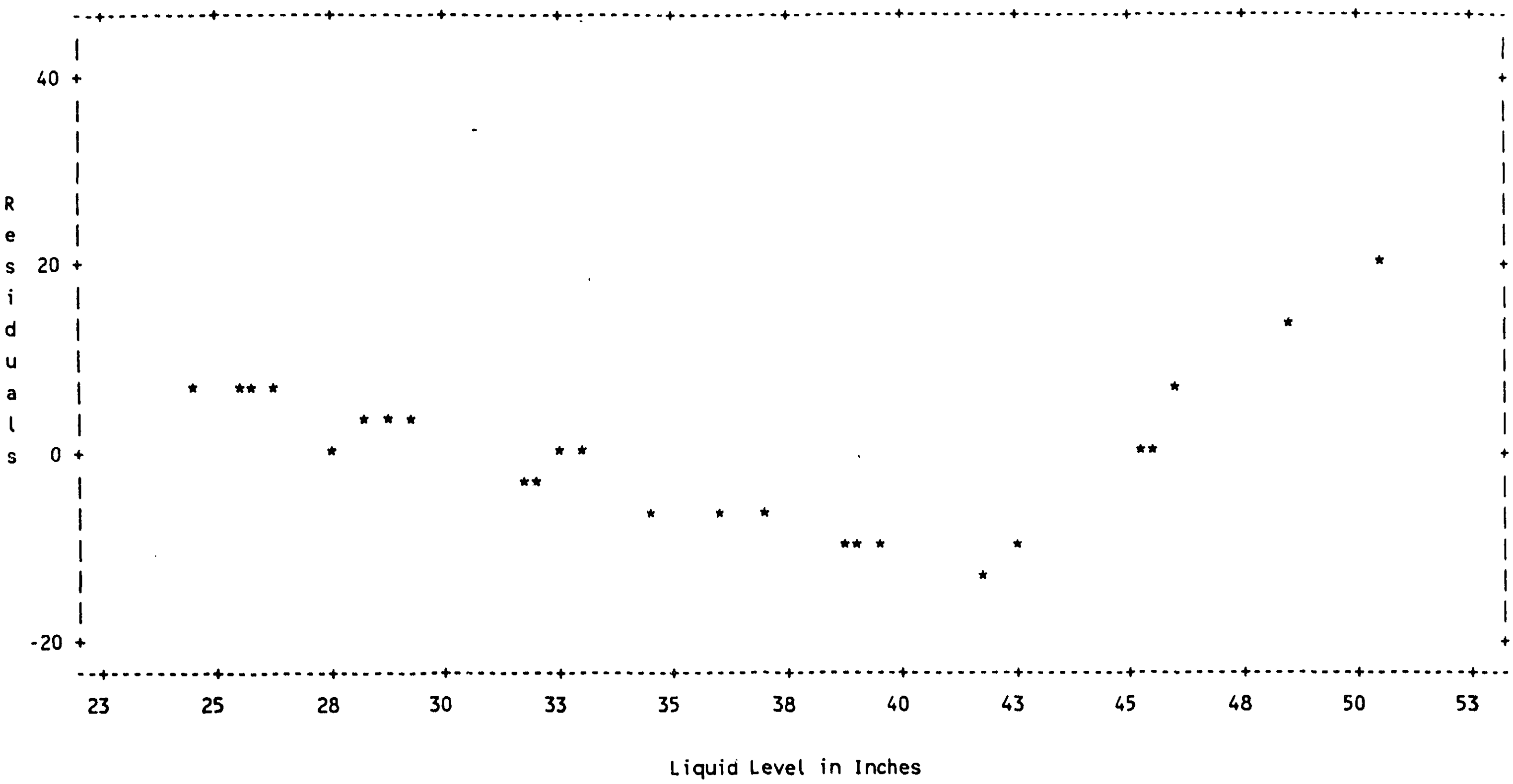


Figure 3
Box Plots of IDs for Liquid Level Cases
Case 1 ==> Both Liquid Levels in Tank Section 1
Case 2 ==> Both Liquid Levels in Tank Section 2
Case 3 ==> Liquid Levels in Different Tank Sections

UNIVARIATE PROCEDURE
Schematic Plots

Variable=ID Inventory Difference

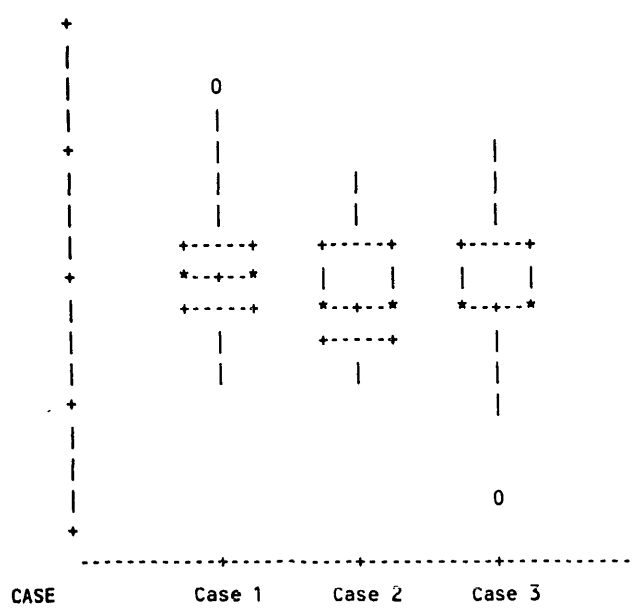


Figure 4
Plot of Facility Computed IDs
Solution Density Not Utilized

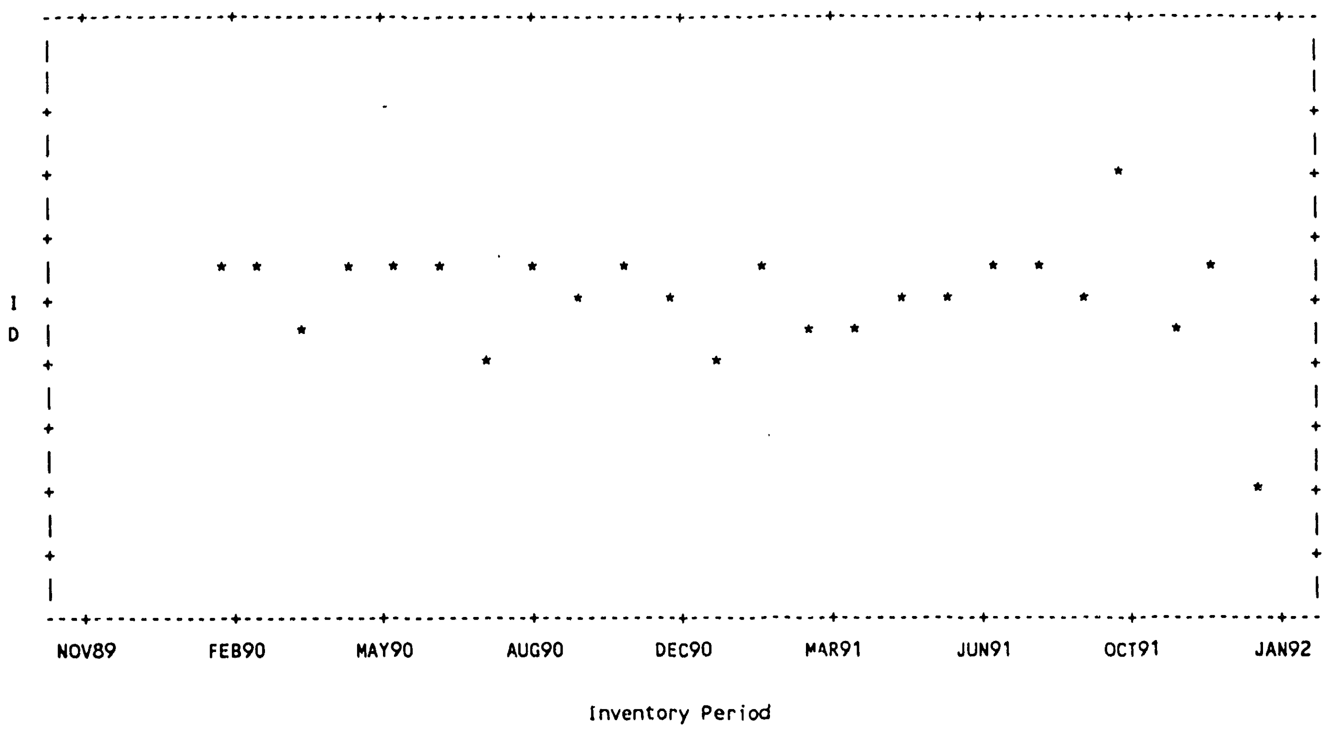
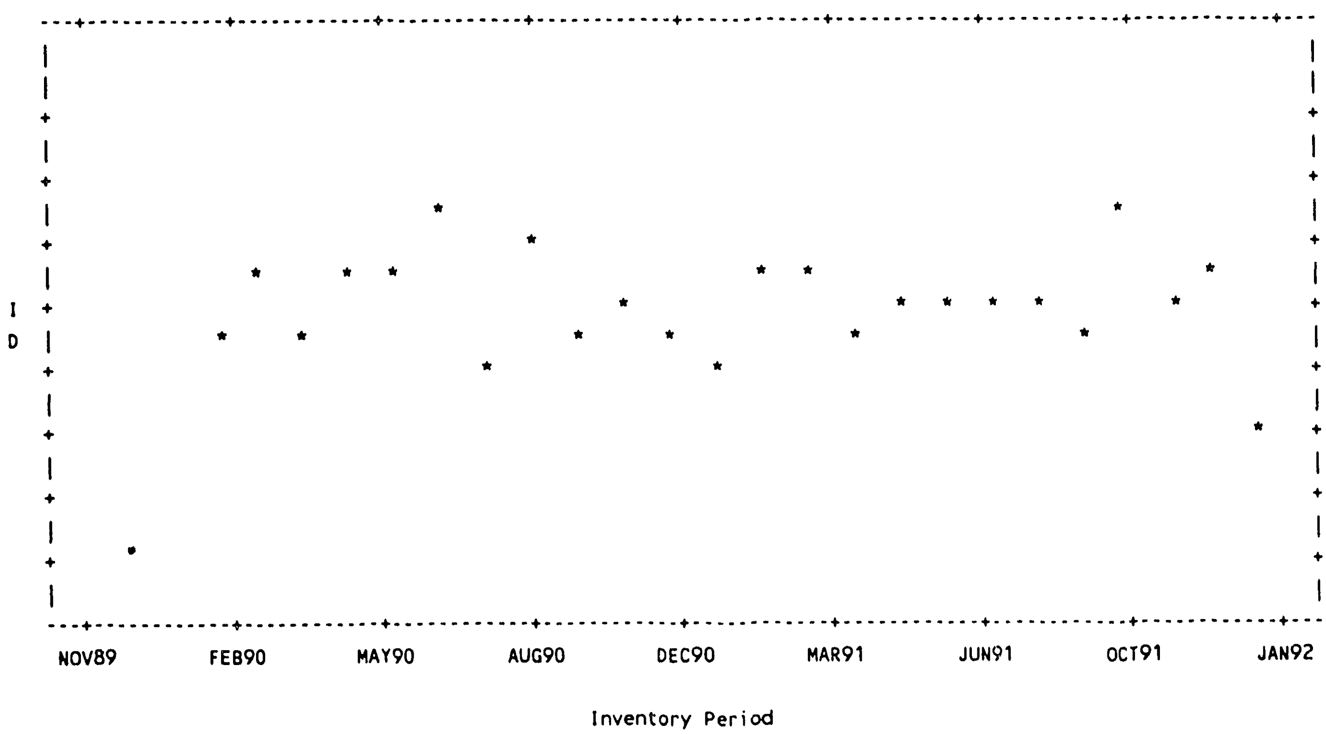


Figure 5
Plot of MC&A Computed IDs
Solution Density Utilized



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