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ACCOUNTABILITY MEASUREMENT PRECISION & ACCURACY VALUES: HOW GOOD IS GOOD ENOUGH?

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DISCLAIMER

ACCOUNTABILITY MEASUREMENT PRECISION & ACCURACY VALUES: HOW GOOD IS GOOD ENOUGH?*

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ABSTRACT

The Department of Energy (DOE) Order 5633.3A requires that the desired levels of precision and accuracy be established for accountability measurements, that the magnitude of these uncertainties be minimized for major contributors to the limit of error for inventory differences (LEID), and that methods be selected, validated, and qualified that are capable of providing the desired levels. These requirements often lead to the question of "How Good is Good Enough?" To validate the current uncertainties as the goals, variance-propagated LEID models for several processing facilities were used to determine the sensitivity of the LEID to each uncertainty value, using a nominal increase in the LEID as a figure-of-merit. These sensitivity studies provided the threshold values that each uncertainty needs to be held below. This provides the answer to "How bad can it be before it hurts?" Engineering judgment and operational experiences were combined to qualitatively determine the need for improvement for each uncertainty, to answer the question of "How good should it be?" This paper describes the methodology of the sensitivity study, gives examples of the threshold values generated, and discusses the benefits of this approach in the approval process for proposed method changes.

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INTRODUCTION

The measurement control portion of the Department of Energy (DOE) Order 5633.3A requires that the desired levels of precision and accuracy be established for accountability measurements and that methods be selected, validated and qualified that are capable of providing the desired levels. Furthermore, the magnitude of these uncertainties is to be minimized for major contributors to the LEID

Order 5633.3A recommends the use of external performance values such as the IAEA target values[1] to set the goals. The target values are useful as general indicators of measurement capabilities but do not take into account the specific application of the method within a given facility. The guidance document on variance propagation[2] notes that measurements need to be reviewed in light of their contribution to the LEID. The specific application may require more (or less) precise measurements than the expected values listed in the target value tables.

In an effort to consistently determine the desired precision and accuracy levels for measurements within each of the nuclear material processing facilities at the Savannah River Site (SRS), a series of sensitivity studies were performed.

METHODOLOGY

The sensitivity studies were performed on each material balance area (MBA) that uses a variance-propagated LEID for evaluating the inventory difference when the physical inventory is performed.

Each LEID model has a "benchmark" processing scenario for inputs, outputs, and inventory amounts. The uncertainties for each measurement were propagated using the MAWST code from Los Alamos National Laboratory[3].

A figure-of-merit was arbitrarily set at a one per cent relative increase in the magnitude of the LEID. This conservative criterion was selected to allow only a small increase if several uncertainties increased simultaneously.

The benchmark scenario was run to establish the benchmark LEID. Each uncertainty was then individually incremented and the LEID recalculated using MAWST until the LEID increased to 1.01 times the benchmark. This value is termed the "threshold value" for that uncertainty.

The benchmark LEID value for one MBA was submitted to the DOE Savannah River Operations Office (DOE-SR) for approval of the complete set of uncertainties that propagated to yield that benchmark. For Category I and II facilities, DOE Order 5633.3A provides a performance requirement for new facilities of the smaller of either a Category II quantity or two per cent of the throughput and active inventory.

Table 1 - Portion of Bias and Precision Specifications for a Dynamic LEID at an SRS facility.

Measurement Component	Estimate Basis	Percent Relative Standard Deviations		Potential Improvement
		Current	Threshold	
Tank C-7B (Drexelbrook)				
Systematic	CAL	6.67	NS	Not Needed
Random	CAL	1.34	2.00	Not Needed
Sampling	INFER	1.21	6.00	Not Needed
Diode Array (Gravimetric)				
Bias	QC	0.13	0.60	Moderate
Systematic	QC	0.18	0.60	Improvement
Random	QC	1.34	2.40	Possible
Total Alpha				
Bias	QC	3.73	28.00	Not Needed
Systematic	QC	0.33	28.00	Not Needed
Random	QC	3.29	NS	Not Needed

CAL = Calibration Data Used to Determine Uncertainty
INFER = Uncertainty Inferred from a Similar System
QC = Quality Control Data Used to Determine Uncertainty

RESULTS

A portion of the precision and bias specifications table for one of the SRS nuclear material processing facilities is shown in Table 1 above. Each measurement point is listed with the applicable random, systematic, and sampling variability uncertainties. The uncertainties are shown in units of per cent relative standard deviation (%RSD). The benchmark LEID is classified and was transmitted to DOE-SR separately. The table shows the goal uncertainties (listed as the "current" values), the basis for the values, the threshold values for each, and the qualitative conclusions regarding the impact of potential improvement.

To illustrate the information contained in the table, three examples will be described below:

The volume measurement random uncertainty value for tank C-7B could increase from 1.34 % up to 2.00 % before it would increase the LEID to the 1.01 figure-of-merit. The systematic uncertainty for the volumetric measurement could increase to over 100 % (listed as NS), showing that the LEID is insensitive to this uncertainty. The sampling variability could increase from 1.21 % to 6.00 % before increasing the LEID to the 1.01 figure-of-merit. The random and systematic uncertainties were derived from the tank volume calibration. The sampling variability was inferred from an experimental study performed on a similar tank. The potential improvement would be to recalibrate the tank. However, upon review, the potential improvement was judged to be "Not Needed", since a recalibration would likely address the insensitive systematic uncertainties and not necessarily improve the random uncertainties that the LEID is sensitive to.

The diode array spectrophotometry (DAS) method (gravimetric aliquot) shows "Moderate Improvement Possible" for the long-term bias, random, and systematic uncertainties. Each value is relatively close to the threshold, due to the propagated effect of the various samples taken from different tanks within the facility that are all analyzed by this technique. An increase in the DAS uncertainties causes a unilateral increase in the uncertainties in the calculated quantities of nuclear material in each of the affected tanks.

The total alpha technique is used for measuring very low levels of material in waste streams and rinse solutions. The insensitivity of the LEID to this measurement is demonstrated by the high thresholds. The measurement uncertainties correspond to a relatively small amount of material.

Tables in the format of Table 1 are being compiled for the other SRS MBAs that use variance-propagated LEIDs.

DISCUSSION

The use of the benchmark LEID as the overall performance indicator provides an internally consistent approach to material control. The performance of each measurement is judged by how it impacts the LEID. The submission to the DOE Operations Office of the current values as the desired values establishes an initial performance baseline for the change control of the measurement systems.

Additionally, the threshold values provide a quantitative basis for the decision-making regarding change control at the measurement points. A "stop-loss" value is provided for use when evaluating proposed substitution of techniques. This provides more flexibility than the traditional "at least as good as before" approach, while still maintaining a comparable overall level of control.

Strategically, the relative difference between the current uncertainty and its threshold quantifies the major contributors to the LEID. Where Pareto charts graphically show the order of contribution, this numerical approach can provide the "benefit" side of the cost-benefit analyses of proposed measurement improvement.

SUMMARY

A numerical approach has been developed for defining internally-consistent desired values for accountability measurement precision and accuracy values, identifying the major contributors to the LEID, quantifying the impact of changes, and qualitatively assessing the potential improvement to the LEID.

This *in situ* approach to measurement performance and the use of the LEID as an overall performance indicator provides a useful facility-specific tool.

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REFERENCES

1. C. E. Pietri, "United States Role in the Formulation of the 1992 International Target Values for Uncertainty Components in Fissile Isotope and Element Assay of Nuclear Materials", *Proceedings of the INMM 33rd Annual Meeting*, Orlando, FL, 1992.

2. J. Sanborn, "Guidance Document on the Variance Propagation Requirements in DOE Order 5633.3", Brookhaven National Laboratory report BNL 52315, Revised October 1991.

3. R. R. Picard and J. F. Hafer, "MAWST: Materials Accounting with Sequential Testing Version 2.0", Los Alamos National Laboratory report N-4/91-633, June 1991.

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