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SNM MEASUREMENT UNCERTAINTIES: POTENTIAL IMPACTS FOR MATERIALS DISPOSITION

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ABSTRACT

A brief discussion of various issues relative to nuclear measurement uncertainties and impacts to the Materials Disposition (MD) program is presented. Today's nuclear measurement technology is well situated to handle most of materials analysis concerns while controlling uncertainties to a high degree of confidence. However many of the options under consideration by the disposition program will present new challenges. Some of these challenges include significant material processing throughputs, a variety of material forms, unique waste streams, and difficult to measure matrices. There are also some questions as to a facility's ability to achieve IAEA verification requirements and to maintain measurement uncertainties within the "significant quantity" level.

I. INTRODUCTION

This presentation focuses upon uncertainty concerns. Contributions to uncertainty include: counting statistics, calibration errors, instrumental uncertainties and errors. Often a significant source of error is from the variations of the samples themselves. The cause is because of differences in sample form from standards, as well as changes in matrix and heterogeneous effects.

Such measurement problems are typically addressed through scaling studies, but this does not capture all of the contributions to error. The missing element is the distribution of sample characteristics which contribute to errors and the assay technology.

II. BACKGROUND

A. Domestic Safeguards

In the U.S., the domestic safeguards encompasses an integrated system of physical protection, material accounting and material control measures which are designed to deter, prevent, detect, and respond to unauthorized possession, use, or sabotage of nuclear materials. The material control and accounting issues and regulations are covered primarily under DOE Order 5633.3B which discusses specific criteria and requirements for MC&A. The Materials Disposition program present some new and rather different issues which will need to addressed under increasingly intense scrutiny. On issue of particular concern for this paper is the measurement of and propagation of material measurement uncertainties such that fissile material is accounting for in the highest quality possible under the criteria established. The fact that many of the disposition processes are new and have in some cases, never been tested in a fully operation sense where material throughputs can exceed metric tons per year.

B. International Safeguards

The primary objective of IAEA safeguards "...is the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons, other nuclear explosive devices, or for unknown purposes, and the deterrence of such diversion by the risk of early detection."[1] IAEA safeguards are not designed to prevent or deter unauthorized possession of nuclear material. The two important components of IAEA safeguards to accomplish their primary objective are nuclear material accountancy, and containment and surveillance.[2]

Nuclear material accounting establishes the quantities of nuclear material present within defined areas and the changes in these quantities that take place within defined periods of time.[3] This means the accounting system of the IAEA is based on the mass of the material of each item in the inventory. To accomplish this activity, IAEA inspectors inspect the accounting records and material transactions reported by the operators of the facility being inspected. They make independent measurements of the safeguarded nuclear material. This measurement can either be a nondestructive assay of the material and/or a sample taken for chemical analysis at the Agency's Safeguards Analytical Laboratory. These activities are aimed at verifying the inventory. The accountancy verification goal is defined as the "minimum quantity of nuclear material which, if diverted at a facility, should... be detected by the application of nuclear material accountancy measures along with a low risk of false alarm.... [For] item facilities...the goal is equal to one significant quantity of nuclear material.... [For] bulk handling facilities...the goal depends on the nature of the facility, the quantities of material handled, and the effect of measurement uncertainties...."[2] For plutonium, the IAEA identifies 8 kilograms as one significant quantity.

III. FACILITY MEASUREMENT UNCERTAINTY ESTIMATION FOR MATERIAL DISPOSITION

Under the MD program the Nonproliferation, Safeguards and Security (NP/SS) team developed a set of very top level assessment of measurement uncertainties[4] which were based upon the "1993 International Target Values for Uncertainty Components in Measurements of Amount of Nuclear Material for Safeguards Purposes" developed the IAEA Standing Advisory Group on Safeguards Implementation (SAGSI)[5]. This established a preliminary baseline upon which to establish criteria to evaluate a variety of concerns related to MC&A for the MD program. However, the analysis was quite top level and not entirely satisfactory. We have begun to develop a more structured analysis of these uncertainties based upon more precise flow diagrams. One issue which we recognized as being deficient is the optimal handling of sample distribution within a facility. This particular issue is especially important where a facility will handle a large variety of material types. Although just in the formative stages, we are attempting to provide a top level demonstration of the impacts of sample distributions on measurement uncertainty for some of the MD options. In general, our effort will follow much previous work best illustrated by the uncertainty analysis by Harker *et al.* [6]. In future presentations, we hope to provide details and data following our approach for some Materials Disposition options.

IV. DISCUSSION AND SUMMARY

In summary, the calculation of measurement accuracy depends largely upon the variation of samples and the disparity between samples and calibration standards. An important issue for the determination of the level of operational accuracy is how routine or consistent are the samples to be measured. In fact, much of the present focus of NDA technology efforts is on the development of techniques that mitigate and minimize assay variation caused by matrix and heterogeneous effects.

Future activities include the assessment of the discussed impacts on materials disposition and to demonstrate explicitly the anticipated effects on uncertainties within various MD options. We hope to develop methodologies to minimize these impacts, as well as to share the results to improve overall materials measurement assurance.

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