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Author(s): David D. Wilkey
Scott Demuth
Victoria Longmire
Barbara Sinkule
Richard Strittmater
Rebecca Stevens
Pamela Dawson
Lynne Preston

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Evaluation of Effectiveness for MC&A Programs

Authors:

David D. Wilkey, Scott Demuth, Victoria Longmire, Barbara Sinkule, Richard Strittmater, Rebecca Stevens
Los Alamos National Laboratory, Group N-4

Pamela Dawson
Sandia National Laboratory

Lynne Preston
US Department of Energy, SO-20.3

Abstract

This paper is a progress report on a joint Los Alamos and Sandia National Laboratories effort to develop tools to evaluate MC&A system effectiveness and perform vulnerability assessments based on the system effectiveness metrics. It summarizes the work that the two labs have completed to date and provides an overview of the work remaining. The Department of Energy Office of Technology Development, SO-20.3, is presently considering whether it is possible to model MC&A programs at DOE facilities in order to better determine the need for and prioritize potential technology development projects. The intent is to develop an objective method of evaluating MC&A programs, to model the effect of changes to the systems used by the programs, and to quantify the extent to which these changes improve the effectiveness and efficiency of the programs. Project milestones include a review of the risk analysis tool developed at Sandia, ATLAS, to determine how MC&A system elements could be incorporated, identification of MC&A system elements and activities for which effectiveness metrics can be developed, and developing the metrics for these system elements. In addition, the milestones include validation of the system elements and effectiveness metrics by potential users. Upon completion of the development of MC&A system effectiveness metrics, we will determine the feasibility of integrating the data elements and process required for evaluation of MC&A effectiveness metrics into ATLAS.

Introduction

For the past year, Los Alamos (LANL) and Sandia (SNL) National Laboratories personnel have been working to develop a methodology for evaluating the effectiveness of nuclear material control and accountability (MC&A) programs within the DOE complex. The goal of this project is two-fold: 1) to develop a set of metrics that allows quantitative evaluation of MC&A system effectiveness, and 2) to apply these metrics, or a subset of them, as input to the SNL developed vulnerability assessment tool, Adversary Time-Line Analysis System (ATLAS).

Defining a set of quantifiable metrics will allow consistent analysis of MC&A effectiveness and a clearer evaluation of what technologies or changes in procedures

would provide the greatest benefits toward achieving the objectives of an effective MC&A system. Developing input to vulnerability assessment for appropriate MC&A system elements will credit those elements for the loss prevention/detection that they provide, and provide a better integrated evaluation of the overall protection provided to nuclear materials.

The following two sections describe the project team's approaches to meeting these two goals.

Evaluation of MC&A System Effectiveness

This task is being performed in three steps:

1. Analysis of MC&A systems and identification of important activities
2. Identification of MC&A activities that are amenable to quantified evaluation
3. Selection of a set of MC&A activities from step 2 that are sufficiently representative of the MC&A program to allow their metrics to be used to evaluate the MC&A program as a whole
4. Development of quantitative metrics for the MC&A activities selected in step 3 and an algorithm for using the metrics to calculate the overall system effectiveness

Steps 1 through 3 have been completed and the team is in the final stages of step 4, development of quantitative metrics.

The process of selecting MC&A activities for metrics development was loosely based on the following criteria that were developed by the project team:

- Concentrate on MC&A activities rather than plans and procedures
- Metrics for selected activities should be performance based
- Choose activities that are scaleable – avoid those that have a yes/no answer

Figure 1 shows a conceptual view of the results of this selection process. As shown in the diagram, the team has structured the MC&A system as four main areas of: nuclear material (NM) accounting, NM measurements, NM control, and system design. The structure shown in this representation is intended to show that the metrics for individual activities, or sets of activities, will roll up to an overall value for the MC&A system, although how that will be done has not yet been determined.

In addition to the selection criteria, above, MC&A activities for development of metrics were selected with a set of working objectives for the MC&A system and the four main areas. These working objectives were drawn from the work on the "Objective Based

MC&A Program Effectiveness Metrics



Figure 1. Main Elements of an MC&A Program

Model” of an MC&A system developed under the lead of Cindy Murdock, Los Alamos Site Office (LASO), and are shown in Table 1.

Table 1. Objectives of MC&A Program Elements

MC&A Area	Objectives
MC&A Program	<i>The objective of the MC&A program is to control and account for nuclear materials according to their strategic importance and the consequence of their loss. The MC&A program must deter and detect theft and diversion of nuclear materials.</i>
Nuclear Material Accounting:	<i>The objective of NM accounting is to provide a complete, accurate, and timely record of the nuclear material inventory.</i>
Nuclear Material Measurements	<i>The objective of NM measurements is to quantify the nuclear material inventory.</i>
Nuclear Material Control	<i>The objective of NM control is to establish controls to verify location and use of NM.</i>

System Design	<i>The objectives of system design are to plan, develop, and implement an effective MC&A program including assuring the basic requirements are met, establishing the accountability structure, and categorizing strategic nuclear materials.</i>
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Table 2 shows a more detailed outline of the MC&A activities selected for development of metrics. In addition to the activities listed, we anticipate that others will be added as we receive feedback from project sponsors and potential users. A meeting has been scheduled in conjunction with the 45th Annual INMM Meeting to present the current status of the project and discuss future work.

Table 2. MC&A Activities for Metrics Development

MC&A Area	Activities Amenable to designing Metrics
NM Accounting	<ul style="list-style-type: none"> • Accounting data <ul style="list-style-type: none"> ○ Accuracy ○ Timeliness ○ Security <ul style="list-style-type: none"> ▪ Change control ▪ Access
	<ul style="list-style-type: none"> • Material tracking (audit trail) <ul style="list-style-type: none"> ○ Item accounting ○ Bulk material tracking ○ Material in process ○ Material in storage ○ Transfers – internal/external
	<ul style="list-style-type: none"> • Physical inventories <ul style="list-style-type: none"> ○ Frequency ○ Planning ○ Performance ○ Reconciliation
Nuclear Material Measurements	<ul style="list-style-type: none"> • Measurement performance <ul style="list-style-type: none"> ○ Shipments/receipts ○ Physical inventories ○ Process ○ Transfers
	<ul style="list-style-type: none"> • Measurement control <ul style="list-style-type: none"> ○ Measurement uncertainties/control limits ○ Method/Equipment calibrations ○ Standards ○ Tracking/trend analysis/control charting

<p>Nuclear Material Control</p>	<ul style="list-style-type: none"> • Access control <ul style="list-style-type: none"> ○ Material ○ Data ○ Equipment
	<ul style="list-style-type: none"> • Surveillance <ul style="list-style-type: none"> ○ Material in storage ○ Material in process ○ Transfers
	<ul style="list-style-type: none"> • Detection & assessment <ul style="list-style-type: none"> ○ Tamper-indicating devices ○ Portal monitors ○ Waste Monitoring ○ Daily Administrative Checks (DACs) ○ Automated technologies
<p>System Design</p>	<ul style="list-style-type: none"> • Material balance areas (MBAs) <ul style="list-style-type: none"> ○ NM location ○ Localization of inventory differences ○ Key measurement points (measure NM input/output for MBAs)
	<ul style="list-style-type: none"> • Graded safeguards <ul style="list-style-type: none"> ○ NM attractiveness level determination (Items) ○ MBA category determination ○ MBA limit controls ○ Material containment ○ Reduced safeguards
	<ul style="list-style-type: none"> • MC&A program planning and management <ul style="list-style-type: none"> ○ Definition of roles and responsibilities <ul style="list-style-type: none"> ▪ Performance of MC&A functions ▪ MC&A oversight ▪ Quality assurance and control ▪ Training program ○ Completeness of program elements ○ Timeliness and adequacy of reviews ○ Timeliness and adequacy of improvements based on results of reviews
	<ul style="list-style-type: none"> • Loss detection <ul style="list-style-type: none"> ○ Inventory Difference/Loss Localization <ul style="list-style-type: none"> ▪ MBA structure ▪ Key Measurement Points ○ Inventory Difference evaluation ○ Shipper/receiver difference evaluation ○ Anomaly evaluation

The final step in this process is to develop a set of metrics for the selected activities, and to develop an algorithm for evaluating the effectiveness of MC&A program as a whole. This effort is in process at the time of this writing. The results are scheduled to be presented and discussed at the meeting described above. It is not possible to predict the results of this phase of the task; however, it is likely that they will reflect the DOE's MC&A Technology Development Program focus on capitalizing on continuing advancements in instrumentation and computing to utilize developing technologies such as automated, real-time nuclear materials tracking systems and portable or at-line verification measurement systems.

Application of MC&A Metrics to Vulnerability Assessment

The aim of this task is to develop a way to include major MC&A activities in the performance of vulnerability assessments to ensure that all protective measures are appropriately considered in the risk evaluation. From the vulnerability assessment perspective, many MC&A detection elements have not been given credit in the overall protection system. Some elements of a MC&A system, if not overlooked, will provide greater support for the mitigation of the risk insider threat.

This task is related to the development of MC&A effectiveness metrics; however, we recognize that the form of the data needed for input to the ATLAS vulnerability assessment tool is likely to differ from that for measuring MC&A effectiveness. In addition, only those MC&A activities that can play a role in preventing, detecting, and/or assessing NM losses are appropriate as input. The end goal in developing an effectiveness methodology is to use the metrics as input to the ATLAS VA tool. Primarily for use in evaluation of risk from the insider threat

This task is only in the beginning stages and is not scheduled to be completed until the first quarter of FY 2005. The planned approach is to develop a new module for ATLAS to allow consideration of some MC&A protection elements in the assessment of the risk of loss of NM due to theft by an insider adversary. The model for developing the new module is based on development of an activity index based on frequency of handling/monitoring of NM items, and a verification index based on frequency of measurements. This model is described in more detail in reference 1.

It is proposed that the results of this approach be validated by application to an existing DOE facility.

Summary/Conclusion

Developing a methodology for evaluating the relative effectiveness of MC&A systems will allow a more systematic approach to determining the need for improvements. Incorporating this methodology into vulnerability assessments will provide a better measure of the protection provided to nuclear materials.

References

1. Evaluating the Effectiveness of the MC&A System to Verify that Nuclear Materials are Present, Pamela Dawson, et al., Proceedings of the 42nd Annual Meeting of the Institute of Nuclear Material Management, July 15-19, 2001