ANALYSIS OF THE ROLE OF AN
INTERFACILITY SNM ACCOUNTING SYSTEM

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ABSTRACT

Lawrence Livermore National Laboratory (LLNL) undertook the task of analyzing the actual and potential value of an interfacility NRC material accounting system in deterring and detecting both material diversion and facility material accounting data falsification. The most important conclusion is that only relatively minor changes are needed to upgrade the current NRC interfacility reporting system. The emphasis of the task was on evaluating the usefulness of an NRC-monitored material accounting information system in providing protection against accounting fraud at the plant management or corporate level.

The Nuclear Materials Management and Safeguards System (NMMSS) and the NRC Safeguards Status Report System (SSRS), the principal constituents of the current interfacility NRC material accounting information system, are described. Their relationship is shown in two information flow diagrams. Deterministic accounting checks and balances are discussed, both for the current NRC interfacility material accounting system and for an upgraded system. Detection mechanisms are described that would use currently available data and that could be exercised by the NRC in its safeguards management role. Additional checks and balances are recommended, with corresponding changes in data reporting requirements, to upgrade NRC interfacility material accounting system.

1.0 INTRODUCTION AND SUMMARY

1.1 BACKGROUND

On behalf of the Nuclear Regulatory Commission (NRC) Office of Nuclear Regulatory Research, Division of Safeguards Fuel Cycle and Environmental Research, Lawrence Livermore National Laboratory (LLNL) has analyzed the actual and potential capability of an NRC interfacility material accounting system to deter and detect both material diversion and facility material accounting data falsification.

NRC licensees are required by regulations and licensing conditions to periodically report to the NRC accounting data pertinent to special nuclear material (SNM) inventories and transactions. The required reporting involves information flows among licensed facilities, NRC Regional Inspection Offices (Regions) and the DOE/NRC Nuclear Materials Management and Safeguards System (NMMS) facility at Oak Ridge, Tennessee. Information flows also exist between Department of Energy (DOE) field offices and NMMS for those facilities which are both NRC licensees and DOE contractors (referred to as licensee/contractors).^{*} The various NRC recipients of the information constitute a de facto material accounting system and will be referred to here as the current NRC interfacility material accounting system.

The primary objectives of this task were:

- To characterize current national material control and accounting information flows and corresponding detection mechanisms,
- To identify deterministic accounting checks and balances that could be employed using currently available data,
- To determine additional data needs and corresponding safeguards checks and auditing mechanisms.

^{*}We will use the terminology licensee and licensee/contractors to distinguish between strictly NRC licensed facilities and facilities which are both NRC licensees and DOE contractors, respectively.

1.2 PRINCIPAL CONCLUSIONS AND RECOMMENDATIONS

The most important conclusion is that only relatively minor changes are needed to significantly upgrade the current NRC interfacility reporting system. Additional data needs and corresponding safeguards detection mechanisms were identified for an upgraded system. Recommendations which could lead to significant improvements in the safeguards effectiveness of the NRC interfacility material accounting system and which are consistent with a reasonable level of data reporting requirements include the following:

- 1) Require licensees and licensee/contractors to submit a Material Status Report (NRC Form 742) to NMMSS concurrently with each required physical inventory. The data for the 742 is readily available at inventory time and compliance should require very little additional effort. This step would allow frequent precise updating of the NMMSS and facilitate verification of individual, original 742 data entries with those received via the Safeguards Status Report System (NRC Form 327) prepared from facility inventory data by the Regions.
- 2) Eliminate the requirement for the 742 report now submitted each March 31 and September 30 by licensees and licensee/contractors. The NMMSS can provide this data from 742s submitted at physical inventory time together with information available from already required Material Transaction Reports (Form 741) submitted by each licensed facility.
- 3) Require submission of a "Book" 742 report to NMMSS each month not involving a physical inventory. Submissions should be made as of the same calendar day of physical inventories. The data for this 742 submission is essentially available, because it is used for (1) an informal, Monthly Material Balance report now provided to the Regions and (2) Monthly Loss and Discard reports, this requirement

would formalize some of the current informal reporting. This requirement would also provide an additional check and balance by making it possible to compare a NMMSS-created monthly material balance updated by 741 data with the data of each submitted 742.

- 4) Key the summary inventory difference data now submitted by the Regions to NMMSS to the dates of the 742's to facilitate verification of these separately obtained data.
- 5) Eliminate present requirements for separate Monthly Loss and Discard reports and separate Monthly Material Balance reports because this data will be reported in 742 submissions.
- 6) Provide for periodic data verification and data inconsistency checks with monitoring and review by Headquarters as part of the NRC safeguards management role.

The data needed for the additional reports should be readily available from a properly maintained set of licensee accounting records. Additional reporting, short of attempting to duplicate the licensee's ledgers and journals, probably would not provide any more vital data than the changes suggested here.

With these upgrades, NMMSS could provide the SNM material balance status of every licensee or licensee/contractor as timely as the entry into the system of data from submitted individual 741 reports and as accurately as the accounting records at the licensed facilities. Each 742 report received provides for a monthly update. The net effect on the licensee would be to standardize some present informal practices. If the NRC were to frequently check 741, 742, and 327 data, the NRC would identify and resolve mistakes sooner than at present. With suitable data analysis by NRC, a net benefit, therefore, would be assurance that the NMMSS data base is accurate and timely, thus providing improved safeguards effectiveness and confidence in NMMSS data.

Another significant conclusion is that currently available data provide apparently unused additional checks and balances. Of these, the most

important is comparing the SSRS 327 reports with the NMMSS 742 and 741 reports, which, even without upgrades, appear compatible twice each year.

This study concentrated on identifying checks and balances for detecting material accounting fraud. Clearly, knowing that checks and balances are being performed even at a late date may be a deterrent to a fraudulent person or colluding group.

Other concepts which have potential for deterring falsifiers were also identified. Detailed consideration of these concepts was not possible within the scope of this study; however, each would seem to offer some safeguards benefit. Without attempting to justify them or rank them by importance, they are:

- 1) Using serialized and accountable forms.
- 2) Using crypto keyed corrections to transactions.
- 3) Using encrypted data transmissions in general.
- 4) Performing unannounced audits of data which result in significant inventory differences as a function of the reported ID and the specific licensee situation. The extent of an audit could be varied, for example, depending on the ratio of ID to limit of error of inventory difference (LEID).
- 5) Varying responses to errors or inconsistencies. This could complicate the task of a falsifier as could unannounced audits. Some response to all errors or inconsistencies should always be made.

Internal material control and accounting procedures are also important because data falsification attempts and accounting fraud internal to a facility are best detected before external reporting occurs. Internal checks include unannounced audits of material control and accounting data and observation of internal procedures, including those for data generation and inventory verification. Clever insider colluders would have few problems with data inconsistency reporting to NMMSS or SSRS if they have successfully defeated well designed safeguards measures at a facility. The focus of this report is on external checks. An effective overall NRC monitoring program should incorporate both internal and external aspects, however.

1.3 SCOPE OF REPORT

The initial phase of this study involved collecting and reviewing narrative descriptions of the NMMSS and the NRC SSRS. NMMSS and SSRS are the principal constituents of the NRC interfacility material accounting system. Whereas NMMSS is a shared DOE/NRC material accounting data base system, SSRS is an exclusive NRC data base system, and the primary means of transmitting information of licensed facilities from the Regions to NRC Headquarters Office of Inspection and Enforcement.

In Chapter 2 of this report, we provide abbreviated descriptions of both NMMSS and SSRS and show their relationship in two information flow diagrams. Informal data flows provided by licensees, but not required by regulation, are also included in the information flow diagrams.

Chapter 3 focuses upon a discussion of deterministic accounting checks and balances, both for the current NRC interfacility material accounting system and for an upgraded system. Detection mechanisms are described that would use current available data and that could be exercised by the NRC in its safeguards management role. We then recommend some additional checks and balances with corresponding changes in data reporting requirements, which if implemented, should result in an upgraded NRC interfacility material accounting system.

In Chapter 4 we state without detailed discussion some additional safeguards procedures which we believe merit further consideration, as well as some concluding remarks.

2.0 SUMMARY OF THE CURRENT NRC INTERFACILITY MATERIAL ACCOUNTING SYSTEM

2.1 INTRODUCTION

One purpose of this study was to characterize the checks and balances in the current interfacility material accounting system which offer protection against accounting fraud. Before we could achieve this objective, we had to first study the current system and identify its various constituents. In this chapter we discuss the components of the current system. The primary components are NMMSS and SSRS. However, for the purposes of this report, the mechanisms for data flow between licensees and licensee/contractors, and the NRC system are also considered as components.

The NRC provided us with several documents for background information on the current system. Principal among them were two NRC reports, User Manual NMMSS-1¹ and Report of the Material Control and Material Accounting Task Force,² and two Boeing Company reports, Enhancement of the Nuclear Reporting and Analysis System³ and USNRC Integrated Safeguards Information System.⁴

We also conducted extensive interviews with personnel at the NRC Office of Nuclear Material Safety and Safeguards⁵ and Office of Inspection and Enforcement,⁶ at Region V,⁷ at the NMMSS facility located at Oak Ridge, Tennessee,⁸ and at Boeing Computer Services.⁹

Information flow diagrams depicting our understanding of the current interfacility material accounting system are shown in Figs. 1, 2, and 3. Fig. 1 applies to NRC licensees, Figs. 2 and 3 apply to licensee/contractors. Table 1 is an accompanying set of notes which are keyed to the numbered blocks in the figures. Although the diagrams in Figs. 1 and 2 appear quite similar, there are important differences. These differences principally reflect the different ways licensees enter data to NMMSS from licensee/contractors. Since Figs. 1 and 2 and Table 1 are designed to help the reader interpret this chapter, they will be referenced frequently. For easy reference, fold-out copies of Figs. 1 and 2 are located at the end of this document.

Fig. 1. Information flow diagram of the current interfacility material accounting system for licensees.

Fig. 2. Information flow diagram of the current interfacility material accounting system for licensee/contractors.

Fig. 3. Information flow diagram for licensee/contractors who submit data directly to NMMSS.

TABLE 1. Information flow diagram notes for Figs. 1-3.

1. Form 741. Contains shipper/receiver difference data.
Send day of transaction to receiver and NMSS or to DOE Field Office and NRC at Oak Ridge.
Send within ten days of receipt to sender and as above.
Contains identification, weight % of isotope, isotope weight, limits of error of element and of isotope, nature of transaction.
2. Form 742. Currently used for Mar. 31 and Sept. 30 book inventories (Last physical inventory prior to Mar. 31 and Sept. 30 + subsequent transactions up to Mar. 31 or Sept. 30).
Contains weights by element & isotope of the following: beginning inventory, receipts, removals, degradation to other materials (i.e., result of blending) decay, fission and transmutation, normal operational losses, measured discards, accidental losses, approved writeoffs, inventory differences, ending inventory, composition of ending inventory (in process, in scrap, in reactors, etc).
742 Courtesy copy sent to Regions but not formally used by them. Required by CFR 70.53.
3. Monthly loss and discard report. Informal report to Regions and NMSS. Used by Regions at inspections. Unknown use by NRC/HQ, required by licensee conditions.
4. Informal monthly material balance. As informal as a phone call to Regions. Information can be reconciled with physical inventory and monthly book at NMSS.
5. Results of licensee physical inventories.
May use any date as anniversary. Primary input for Form 327.

TABLE 1. Information flow diagram notes for Figs. 1-3 (continued).

6. Abnormal operating loss data reported when observed by fastest possible means.
7. NMSS Data Input Group. Resolve errors informally with licensee. May result in new 741 and 742 submittal. Old data maintained.
8. NRC Regions. Regions audit facilities nominally three times per year (inspections). Resolve inventory data errors with licensee informally before preparing final 327. Region sends 327 at every inspection and every physical inventory.
9. NMSS Data Control Group represents principal NMSS personnel. They are organizationally a part of the Computer Sciences Division, Union Carbide Corporation, Oak Ridge, Tennessee. They resolve some errors informally with licensees. New 741 and 742 prepared but old data saved.
10. Summary NRC licensee ID data by Report Identification Symbol (RIS)*. Taken from 327. Current principal ID data source for NMSS.
11. Form 327. By RIS:QTY at start, receipts, shipments, measured discards, QTY at end, ID, bias adjusted ID (measurement bias), calculated LEID, cumulative ID, ID as % of additions to process to removals from process, LEID as % of additions to process to removals from process, cumulative ID last 12 months, (also ID prior period, ID current period, used to explain differences but not included in White book).

*NRC licensees have three letter reporting identification symbols (RIS) beginning with X, Y or Z. Licensee/contractors have three letter reporting identification symbols beginning with A-Q, with the third letter being an L-Z.

TABLE 1. Information flow diagram notes for Figs. 1-3 (Continued).

12. Loss Alert Report. NRC messages to HQ responding to abnormal operating losses.
13. NRC IE Headquarters. Produce White book. Coordinate Regions.
14. White Book. Safeguards Status Report is limited distribution, classified report containing data compiled from 327 forms. The report contains historical data. The most recent data are 4-6 mos. old at printing.
15. Inventory Data Base. NMMS data base containing 742 data.
16. Transaction Data Base. NMMS data base containing 741 data.
17. NRC Headquarters. Various NRC headquarters elements, including NMMS, are recipients of White book and NMMS reports. NRC Regions also receive White book and selected NMMS reports.
18. Material Balance Data Base. NMMS data base derived from received data.
19. Quarterly XYZ RIS ID report. Quarterly summary of ID data by RIS as derived from NMMS data.
20. Monthly Material Balance Report (M742). A NMMS book balance completed by the 10th of each month for the previous month. Depends on receipt of 741's. Flagged errors assigned a processing date for subsequent month. Data corrected and entered into NMMS data bases. Notations are made to the data base such that an audit trail is preserved and the records of the previous months can be resolved.

TABLE 1. Information Flow diagram notes for Figs. 1-3 (continued).

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21. Safeguards Monitor Report. Customer requests within capability of NMMS.
 22. Various NMMS Reports. About 150 different reports currently.
 23. DOE Field Offices. DOE field offices are responsible for the integrity and accuracy of data entering NMMS for licensee/contractors. Generally the field offices enter data using Forms 733 and 740, however for some licensee/contractors the contractor enters the required data directly into NMMS.
 24. Form 740. DOE input to NMMS of material transactions are made using the DOE automatic data processing (ADP) Form 740. Form 740 contains all the data required by the Code of Federal Regulations (CFR) to report material transactions (i.e., NRC Form 741) plus additional data as required by DOE instructions.
 25. Form 733. DOE input to NMMS of material status are made using the DOE automatic data processing Form 733. Form 733 contains all the data required by the Code of Federal Regulations (CFR) to report material status (i.e., NRC Form 742) plus additional data as required by DOE instructions.
 26. NRC Oak Ridge. Distribution of a copy of each 741 and 742 prepared by licensee/contractors in accordance with the Federal Code includes an archival office at Oak Ridge. Although not used for data entry into NMMS, these copies of original 741 and 742 forms are available to NMMS.
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The remainder of Chapter 2 consists of two sections devoted to discussing attributes of NMMSS and SSRS. In each case the format we follow is: (1) a description of formal data flows, (2) a description of informal data flows, and (3) a description of data processing and output reports to the NRC. For our purposes we have categorized the data provided by licensees and licensee/contractors to the NRC as formal if it is required by the Code of Federal Regulations.⁹ All other data is categorized as informal even though it may be required as a licensing condition.

2.2 NUCLEAR MATERIALS MANAGEMENT SAFEGUARDS SYSTEM SUMMARY

The NMMSS was developed to meet the materials management needs of the U. S. Atomic Energy Commission (now DOE). As originally conceived, NMMSS served primarily to satisfy the financial and contractual considerations involved in handling and processing large amounts of nuclear material. It was eventually expanded, however, to include safeguards accounting functions. Although NMMSS continues to serve both the NRC and DOE, this study is only concerned with NRC's application of NMMSS as it applies to safeguards and specifically with respect to providing protection against facility accounting fraud which may involve falsification of material accounting data.

2.2.1 Nuclear Materials Management Safeguards Safeguards System Formal Input Data Flows

NMMSS receives formal data from the licensee in two ways. The licensee reports data resulting from SNM transfers on an NRC Material Transaction Form 741 (Fig. 1, block 1). Book inventory data quantifying the status of material on hand as well as that processed during a six month period is reported on a semiannual basis using an NRC Material Status Form 742 (Fig. 1, block 2). In each case NMMSS personnel prepare and enter data from the submitted reports to the NMMSS data base.

Fig. 2 on the other hand shows a flow of 741 and 742 reports from licensee/contractors to DOE field offices where Automatic Data Processing

(ADP) forms are prepared and transmitted to Oak Ridge for NMMSS data entry (Fig. 2, blocks 23-25). ADPs are prepared from DOE Forms 740 and 733 which contain the same data found on the NRC 741 material transactions and 742 material status forms, respectively, plus other DOE-required data. For some DOE facilities the data input to NMMSS is made directly by the licensee/contractor using DOE Forms 740 and 733 (Fig. 3, blocks 24 and 25). An important point is that the accuracy and integrity of data inputted into the NMMSS for licensee/contractors is a responsibility of the inputting organization, and is not checked or adjusted by the NMMSS personnel.

Copies of the original 741 and 742 forms submitted by licensee/contractors to the DOE field offices are always forwarded to NRC at Oak Ridge (Fig. 2, block 26) and are available to NMMSS personnel although these copies are not now used. For the purposes of this study, the deterministic checks and balances which we identify are strictly based upon those data which are consistent with the NRC 741 material transactions and 742 material status reports.

NMMSS also receives data about a licensee indirectly through the Regions (Fig. 1, block 5). Namely, the Regions assemble summarized physical ID data by licensee (Fig. 1, block 10) and forward it to NMMSS under a licensee Reporting Identification Symbol (RIS) identifier. The actual mechanics of acquiring the inventory data are discussed later in the information flow description of the SSRS. Note that the above action is performed only for licensees with XYZ RISs.

Material Transaction Report (Form 741): Licensed facilities submit under their RIS numbers material accounting data on a formal basis per regulatory requirement (10CFR 70.54). This requires timely reporting of materials transaction data on transfers involving one gram or more of SNM in which an NRC licensee is either the shipper or receiver. These materials transfer data are reported on a 741 form, a form which is used to monitor transfers of material across RIS boundaries.

The Material Transaction Report contains information on the measured quantities of SNM transferred for each transaction. Both shipper and receiver values are recorded on the same form (741), and from these data

shipper-receiver differences can be computed. The information on the report includes the RIS identifications of shipper and receiver, the kind of transaction, account information, material type description, gross and net weights, element and isotope weights and weight-percent isotope, limits of measurement error for both element and isotope, and other information pertinent to providing transaction descriptions. Recorded transactions data not only signify the physical transfer of material from shipper to receiver, but may also indicate the transfer of material from one RIS to another at the same facility.

The 741 is executed in several copies for each material transfer. On the day of shipment, a copy is sent to the receiver, a copy is retained by the shipper, and a copy is sent to NMMSS or a DOE field office for subsequent NMMSS data entry. Within ten days of receiving the material, the receiver should have performed the necessary measurements, filled out the relevant portions of the 741, and sent one copy of the completed form to the shipper, one copy to NMMSS, and retained one copy. The 741 also may contain ID data (space 24 or 25 H, Use-Code 77), although it is not an NRC requirement. The NMMSS may instead receive ID data from the 742 form and from the summary data submitted by the Regions and discussed later.

So-called one party transfers of material (decay, transmutation, fission) are reported on the 741, as are other changes (financial, etc), even if no physical movement was involved. Such transfers may be on the Material Status Report (Form 742).

Material Status Report (Form 742): The Material Status Report (Fig. 1, block 2) is also required by regulation (10CFR 70.53). The 742 report contains book inventory data, which provides SNM status at a facility as of the six month periods ending March 31 and September 30. A Material Status Report must be submitted within 30 days of these dates. The basic information contained on the 742 is the quantity of material on hand at the end of the previous physical inventory, transactions (receipts and removals), and the quantity of material on hand at the end of the book inventory period.

The licensee or licensee/contractor is identified on the 742, as is each material type for which an inventory is being reported. Information necessary

to determine the book inventory as of the date of the report includes: beginning inventory (last ending physical inventory), production, receipts (recorded on 741s), removals (i.e., shipments, process losses, accidental losses, decay, fission and transmutation), shipper-receiver differences, other inventory differences, and ending book inventory. These data are sent by facilities directly to NMSS or to a DOE field office. A courtesy copy of the 742 may also be sent by licensees to the Regions. The 742 reports are not used by the Regions for formal input into material accounting determinations (physical inventories, inspections, etc.).

2.2.2 Informal Reports Sent To Nuclear Materials Management Safeguards System

Licensees communicate with NMSS on a monthly basis informally also to report their materials holdings statuses through a Monthly Loss and Discard Report (Fig. 1, block 3). Although there usually is no formal structure, reporting monthly loss and discards may be required by NRC as a licensing condition. Communication may be a simple letter or a licensee-generated form. It itemizes book losses and discards occurring from processing material, accidents, or relegating material to scrap (which may be recovered at some other date). Licensee/contractors also submit informal data to NRC Regions but this data may not necessarily be forwarded to NMSS.

2.2.3 Nuclear Materials Management Safeguards System Data Processing and Output Reports

The licensee information contained in the 741, the 742, and the informal reports are received by the NMSS Data Input Group (Fig. 1, block 7), who perform initial data edits to resolve any clerical errors in these data with the licensees. This error resolution process is itself informal, although audit trails are preserved by requiring the licensees to submit corrected 741s and 742s and by preserving the original records.

The Data Input Group sends licensee data to the Data Control Group (Fig. 1, block 9), who perform additional edits on the data and who resolve any

discovered errors in the same way as the Data Input Group. The edited 741 and 742 data then are prepared for input into the NMMSS Inventory Data Base (Fig. 1, block 15) and Transaction Data Base (Fig. 1, block 16).

On the other hand, data from DOE licensee/contractors are directly sent to the NMMSS Data Control Group who input it into the NMMSS data bases. Data editing, if any, will have been done at DOE field offices. As previously noted, DOE is solely responsible for the integrity and accuracy of licensee/contractor data input into NMMSS.

Approximately 150 output reports are available from the NMMSS data bases.^{3,9} There are three, however, that are potentially important to safeguards. Two of these are the Quarterly Inventory Difference Report and the Monthly Material Balance Report (Fig. 1, blocks 19 and 20, respectively) both of which are routinely forwarded to NRC Headquarters. The latter report is executed on the tenth day of each month for the previous month. The third is the Safeguards Monitor Report (Fig. 1, block 21). It may be requested by NRC Headquarters at any time for information or for analysis to address particular safeguards concerns. The Regions may also request from NMMSS a variety of reports to assist them in their inspection and audits of licensed facilities.

2.3 SAFEGUARDS STATUS REPORT SYSTEM SUMMARY

The SSRS was developed with a purpose different from NMMSS. It was developed to help assure the NRC that SNM in the possession of a licensed facility is properly and satisfactorily accounted for according to the provisions of 10CFR.

SSRS is important to safeguards as a data base in the role of assurance. Because its contributions to safeguards are made through confirming the materials status of licensed facilities, SSRS data may be used to:

- 1) Provide evidence of licensee capabilities to account for materials,
- 2) Validate the continued effectiveness of licensee safeguards measures, and
- 3) Establish bases for compliance inspection.

The SSRS is not particularly well suited to detecting accounting fraud, because facility data forwarded to NRC Headquarters by the Regions has been filtered by the Regions.

2.3.1 SSRS Formal Input Data Flows

Licensees and licensee/contractors possessing more than 350 grams of SNM are required by regulation to conduct a physical inventory of their SNM periodically depending on the amounts and kinds of nuclear materials possessed: every two calendar months [10CFR 70.51 (e)(3)(i)], six calendar months [10CFR 70.51 (e)(3)(ii)] or annually [10CFR 70.51 (d)]. These physical inventories are conducted for each affected RIS at a facility, and the results of the bimonthly and semiannual inventories are submitted by the licensed facilities to their respective Regions (Fig. 1, block 5). No formal document for reporting the inventory results is required, however. Because the dates of a physical inventory and of a Regional audit (inspection) of a facility do not necessarily coincide, the data from an audit cannot be used as a check or balance of the reported physical inventory data without adjustment.

SNM Inventory Balance Report (Form 327): The SNM Inventory Balance Report (Fig. 1, block 11) is prepared by the Regions and input into the SSRS. It includes the identification of the license holder and the RIS, the physical inventory start date, and the following information for both nuclear material element and isotope: beginning inventory, receipts, shipments, measured discards, ending inventory (same as previous beginning inventory), inventory difference, inventory difference adjusted for system biases (measurement instrumentation biases, etc.), calculated limit of error of inventory difference, cumulative inventory difference (total from some prior date), additions to process, removals from process, inventory difference as a percent of the additions to or removals from process, limits of error of inventory difference as a percent of the same ratio, cumulative inventory difference for the past twelve months, the contribution to reported inventory difference arising from prior periods, and contributions to reported inventory difference due to the current period. The next-to-last category is used, among other

purposes, to account for inventory differences caused by relegating SNM to scrap during one inventory period, then recovering the SNM from that scrap during a later inventory period.

2.3.2 Informal Data Flows for Input to the SSRS

The basic data for the SSRS, as well as a considerable amount of supplementary data more or less peripherally related to the SSRS, is acquired by the Regions from facilities informally. The major facility input into the SSRS is derived from facility-conducted physical inventories of their materials. These data are collected and forwarded by the facilities to their respective Regions. The specificity of the data requirements and mode of transmittal of this informal data are not specified in the Code of Federal Regulations, but may be specified by NRC Headquarters as individual license conditions.

The Monthly Loss and Discard Report (Fig. 1, block 3), an input element of both NMMSS and SSRS, is an informal report, as previously mentioned, which may be required as a licensing condition. In the SSRS, it is submitted to the Regions where it may be subsequently used in facility inspections.

The informal Monthly Material Book Balance, (Fig. 1, block 4), also has no standard report format. Required as a licensing condition, the information may even be reported by facilities to the Regions by telephone. Note, however, that these data should be reconcilable with the required physical inventories.

Licensees and licensee/contractors are required by regulation to report losses from operations or processes due to theft or suspected theft upon discovery (10CFR 70.52). There is, however, no formal form for the Abnormal Operating Losses Data Report (Fig. 1, block 6). Licensed facilities must notify NRC Regions and Headquarters of such an occurrence quickly by "...telephone and telegraph, mailgram, or facsimile..."⁹ After notifying the NRC the facility is required to submit a written report concerning the details of the incident and the results of investigations concerning it to both the relevant Regional Office and to NRC Headquarters within 15 days.¹⁰

Similar requirements exist for lost or unaccounted-for shipments of materials. The facility is further required in these incidents to immediately furnish the relevant Regional Office with written reports concerning any new information about the incident.

2.3.3 SRSS Data Processing and Output Reports

After 327s are executed by the Regions, they are forwarded to the NRC Office of Inspection and Enforcement where the data are then incorporated line item by line item (with the exception of the inventory difference adjustments due to prior periods previously mentioned) as updated data for each RIS into the classified Safeguards Status Report, commonly called the White book (Fig. 1, block 14).

The Regions prepare a 327 for every physical inventory of a licensed facility, whether scheduled or not, and for every inspection (audit) of such a facility. Regular inspections usually occur at least three times a year (they are required at least twice), with inspection frequencies depending in part on facility throughput, abnormal occurrences in materials balance (e.g., excessive inventory differences), and on the practices of individual Regions. The inventory difference data for all XYZ RISs are summarized from the 327s and forwarded by the Regions to the NMMSS Data Input Group at Oak Ridge for eventual input into the NMMSS data base.

The NRC Office of Inspection and Enforcement (Headquarters) typically receives the 327s between 45 and 60 days after the end of a physical inventory or an inspection. The quarterly White book is thus updated with data which is four to six months old at publication. Copies of the updated White book are sent to several NRC Headquarters organizations as well as forwarded to the Regions. No other distribution of this publication is made.

3.0 DETERMINISTIC MATERIAL ACCOUNTING CHECKS AND BALANCES TO IMPROVE SAFEGUARDS EFFECTIVENESS

3.1 INTRODUCTION

A great deal of material accounting data flows between licensees and licensee/contractors and the NRC (Figs. 1 and 2) and many opportunities exist to inspect the data for accounting fraud. From our perspective, very limited cross-checking of NMMSS and SSRS data occurs even though both systems acquire, process, store, and report data independently of each other.

Checks and balances procedures were first added to NMMSS in 1974. These procedures made up the Safeguards Monitor Report (Fig. 1, block 21), which was originally used to compare shipper-receiver data. The checks and balances which have been added since have been primarily stochastic and limited to analyzing inventory differences; few to our knowledge were deterministic. Deterministic checks and balances could be used to detect clues to accounting fraud by inspecting data for accuracy, acceptability, consistency, and continuity. A number of deterministic checks and balances can be performed on the current system; a great deal more will be possible if only minor changes are made.

In our task, we initially identify potential checks and balances that could be used with the current, formal NRC interfacility material accounting system. We will limit our discussion to the formal aspects of the current system, because informal data are not always verifiable (such as telephone calls) and requirements differ among licensees. Thus, we will be centering our discussion around the following three data sets: 327, 741, and 742 for both licensees and licensee/contractors.

The assumption is made that the data reported directly to NMMSS for licensee/contractors using DOE Forms 740 and 733 are consistent with the data reported using NRC Forms 741 and 742. For NRC purposes the same checks and balances should result regardless of whether the 741/742 or 740/733 data set is used. In practice the assumption can be verified since copies of the originally submitted 741 and 742 forms are available to NMMSS at Oak Ridge.

The original 741 and 742 reports would be preferable to use if NRC wanted to refer back to a licensee/contractor, however.

To aid our discussion on checks and balances we have classified the data available from the 327, 741, and 742 data sets into non-vital and vital data. Non-vital data are defined in Table 2 and vital data in Table 3. Non-vital data would include licensee name; vital data would include information on SNM elements and isotopes. Although non-vital data may be readily checked to yield a clue to fraudulent activities (if treated in an uncustomary manner, for instance) a detection system consisting of a long list of readily-checked, non-vital data is not necessarily a safeguards effective system. Checks and balances on vital data are imperative while checks and balances on non-vital data are less important.

We have also classified checks and balances procedures into four classes, which are listed in Table 4. These are (1) compare data with same data of previous reports for continuity or consistency, (2) compare data with information found elsewhere in same report, (3) compare data with a master list of acceptable entries, and (4) compare data entry with same information obtained from other sources. In our context a check and balance procedure consists of a comparison of two sources of data to check for consistency, etc. For convenience in our discussions we denote the two sources as Data Set 1 and Data Set 2. For the four checks and balances procedures given in Table 4, Data Sets 1 and 2 for procedures A and B would be obtained from one data set, that is either Form 327, or Form 741, or Form 742. For procedure C, Data Set 2 is a master list and Data Set 1 is either Form 327, or Form 741, or Form 742. For procedure D, Data Sets 1 and 2 are taken from the entire 327, 741, and 742 data set.

The codes associated with Tables 2-4 will be used to describe the checks and balances for the current and for an upgraded material accounting system.

TABLE 2. Non-vital data codes.

<u>CODE</u>	<u>DATA DESCRIPTION</u>
01	Licensee Data - Name, address, license numbers, Region, plant, plant type, RIS number, material code (327, 741, 742)
02	Authorized Signatures and Date Signed - Prepared by, approved by, etc. (327, 741, 742)
03	Reporting Period and Physical Inventory Start Date (327, 742)
04	Transaction and Correction Numbers (741)
05	Processing and Action Codes (S & R) (741)
06	Number of Lines of Data (741)
07	Nature of Transaction (741)
08	Date of Shipment or Receipt (741)
09	Shipper's or Receiver's Correction (741)
10	Receiver's Measurement (741)
11	Shipped to/for Account of and RIS Number (741)
12	Transfer Authority (741)
13	Transportation Profile & Package Identification (741)
14	Export/Import Transfers - License numbers and U.S. Port of Export/Entry (741)
15	Project Numbers (741)
16	Composition Code for each Project Number - Identifies chemical and/or physical form of material (741) (blocks 17 & 24E)
17	Owner Code for each Project Number (741)
18	Use Code for each Project Number (741, 742)
19	Country Control Number (741) for each Project Number

TABLE 3. Vital data codes (for elements and isotopes).

<u>CODE</u>	<u>DATA DESCRIPTION</u>	<u>CODE</u>	<u>DATA DESCRIPTION</u>
20	Beginning Inventory (327, 742)	37	Bias Adjustment to Inventory Difference and Bias Adjusted Inventory Difference (327)
21	Purchases from DOE (741, 742)	38	Limit of Error on ID (327)
22	Production (741, 742)	39	Cumulative ID (327)
23	Additions from Other Materials (741, 742)	40	Additions to Process (ATP)
24	Receipts Reported on 741 Not Purchased (741, 742)	41	Removals from Process (RFP)
25	Total Receipts (327, 742)	42	ID as % of ATP/RFP (327)
26	Sales to DOE (741, 742)	43	LEID as % of ATP/RFP (327)
27	Sales to Others for Account of DOE (741, 742)	44	Cumulative ID - last 12 months (327)
28	Shipments Reported on 741 (741, 742)	45	ID - Prior Period (327)
29	Degradation to Other Materials (741, 742)	46	ID - Current Period (327)
30	Normal Operational Losses/Measured Discards and Decay (741, 742)	47	LEID Specifications (327)
31	Fission and Transmutation (741, 742)	48	Total Gross Weight of Shipment (741)
32	Accidental Losses (741, 742)	49	Total Volume of Shipment (741)
33	Approved Write-Offs (741, 742)	50	Gross Weight, Net Weight, Element Weight, and Isotope Weight for each DOE Project Number and each Shipment (741)
34	Inventory Difference (741, 742, 327)	51	LE for each Element and Isotope for each DOE Project Number and each Shipment (741)
35	Ending Inventory (327, 742)	52	Weight & Isotope for each DOE Project Number and each Shipment (741)
36	Total Shipments (327)		

TABLE 4. Checks and balances procedures.

<u>CODE</u>	<u>DESCRIPTION</u>
A	Compare data with same data of previous reports for continuity or consistency
B	Compare data with information found elsewhere in same report
C	Compare data with a master list of acceptable entries
D	Compare data entry with same information obtained from other sources

3.2 CHECKS AND BALANCES IN THE CURRENT, FORMAL MATERIAL ACCOUNTING SYSTEM

Figure 4 shows a simplified version of the formal aspects of the current NRC interfacility material accounting system (cf. Figs. 1 and 2)*. The deterministic checks and balances identified for this system are presented in Tables 5-7 in terms of the codes given in Tables 2, 3, and 4. As can be seen, numerous deterministic checks and balances, involving both vital and non-vital data, are possible. Any detected inconsistency could be the clue to discovering a falsification attempt or at least a mistake. A seemingly obvious error in an administrative entry could be important in uncovering reporting by an unauthorized individual. The task of the falsifier is made more complicated by requirements for alternative reporting forms and procedures. Vital data inconsistencies should receive particular attention. Having access to originally received data is important, since the filtering process at the Regions and NMMSS currently resolves errors that could be detection clues.

Several general comments about the checks and balances will aid in understanding Tables 5 through 7. These are appropriate to both the current and the upgraded systems.

1. When considering the possibility of a comparison of specific entries on different reports, recall that separate reports are made for each material identified with a RIS. Many non-vital entries should be identical. For Material Status Reports (Form 742), the last ending inventory must be the next beginning one.
2. Checks and balances identified will only be possible if the appropriate data are reported. If a form allows for reporting of particular items, we assume a check is possible.
3. Any suitably motivated group or organization could be tasked to perform the checks and balances which we suggest provided data are made available.

*As mentioned previously, we are only considering NRC 741 and 742 data for use in deterministic checks and balances.

Fig. 4. Information flow diagram of the current formal interfacility material accounting system.

Table 5. Checks and balances for current interfacility material accounting system: procedures A, B, and C.

	DATA SET		
	327	741	742
Procedure A - compare data with same data from previous report	03*	04	03
	--	10	--
	20	--	20
	39	--	--
	44	--	--
	45	--	--
	1		

NOTES

For each data set (327, 741 and 742) compare a piece of reported data with the same data as reported on a previous report for continuity or consistency. The types of data involved in this checks and balances procedure are mainly inventory start and stop dates, beginning and ending inventories, transaction and correction numbers data, and any data which accumulates from one report to the next.

Data Set 327

- Code 03. Compare "inventory period" on line 3 of current 327 report with previous reported "inventory period" to confirm continuity.
- Code 20. Compare "beginning inventory" data entered on line 2 of current report with "ending inventory" data entered on line 6 of the previous report.
- Code 39. Compare "cumulative inventory difference" data on line 11 of current report with the sum of the "cumulative inventory difference" data on line 11 of previous report and the "inventory difference" data for the current period found on line 18.
- Code 44. Compare last 12 months "cumulative inventory difference" data on line 16 of current report with "cumulative inventory difference" data on line 18 of the preceding 327 reports, which in combination with the current report, make up the twelve month period.
- Code 45. Compare "prior period inventory difference" data on line 17 of current report with "current period" data on line 18 of previous report.

Data Set 741

- Code 04. Compare "transaction and correction numbers" data on lines 3 and 4 of current report with other 741 forms issued to verify consecutive numbering.

Data Set 742

- Code 03. Compare "report period" at top of form (item 4) of current report with same data of previous report for continuity.
- Code 20. Compare "beginning inventory" on lines 8 and 9 of current report with "ending inventory" on lines 80 and 81 of previous report.

*Codes are specified in Tables 2-4; italicized and non-italicized numbers refer to non-vital and vital data respectively.

Table 5. Checks and balances for current interfacility material accounting systems: Procedures A, B, and C
(continued).

	DATA SET		
	327	741	742
Procedure B - compare data with information found elsewhere in same report	--	06	--
	--	16	--
	34	--	25
	42	48	--
	43	--	--
	45	--	--

NOTES

Many data entries on each form (327, 741 and 742) are repeated at other locations on the same form, or can be derived from other data entries on the same form. It is easy to verify the consistency of these data entries.

Data Set 327

- Code 34. "Inventory difference" data on line 7 should be same as the sum of "inventory difference" data for current period of line 18 plus "inventory difference" data for prior period on line 17.
- Code 42. Compare "inventory difference as a percent of the ratio of process additions to removals" data on line 14 of current report with data on lines 7, 12, and 13.
- Code 43. Compare "limit of error" data on line 15 with data reported on lines 10, 12, and 13.
- Code 46. Verify "inventory difference" data for the current period on line 18 by subtracting prior period "inventory difference" on line 17 from that on line 7.

Data Set 741

- Code 06. Compare "number of lines on data" information on line 11 with actual number of lines of data in report on lines 24 and 25.
- Code 16. Compare data on lines 17, 44D and 24E; or 17, 25D and 25E for consistency.
- Code 48. Compare "total gross weight" data on line 22 with totals of line 24J and 25J.

Data Set 742

- Code 25. Resolve "total receipts" data on line 40 by adding entries on lines 11, 21, 22, and 30.

*Codes are specified in Tables 2-4; italicized and non-italicized numbers refer to non-vital and vital data respectively.

TABLE 5. Checks and balances for current interfacility material accounting system: procedures A, B, and C (continued).

	DATA SET		
	327	741	742
Procedure C - compare data with master list of acceptable entries	01	01	01
	02	02	02
	--	--	03
	--	12	--
	--	14	--
	--	15	--
	--	51	--

NOTES

Many data entries on the 741, 742 or 327 forms must comply with a standard format of acceptable data. Variations from the acceptable "list" are not tolerated. The "list" may contain items like licensee names, addresses, licensee numbers, licensee related inventory periods, material types handled, form preparers and approvers, telephone numbers, plant codes, regions, locations, etc. It is simple to compare these types of data with the acceptable list".

Data Set 327

Code 01. Licensee, license number, plant, location, material type code, region. (Top of form)

Code 01. Material type code, plant code. (Line 1)

Code 02. Signature of preparer, signature of approver, dates. (Top of form)

Code 03. Inventory start and stop dates. (Line 1)

Data Set 741

Code 01. Name, address, license numbers, telephone, identified individual attention, material type, etc. (Lines 9, 10, 17.)

Code 02. Signature of authorized official and date signed (Lines 24A and 25A).

Code 12. Transfer authority (Line 15).

Code 14. Export/import transfers, license numbers and U.S. port of export/entry (Line 16A and 16B).

Code 15. Project numbers (Lines 24C and 25C).

Code 51. Limit of error for each element and isotope for each DOE project number and each shipment (Line 24o, 24p, 25o, 25p).

Data Set 742

Code 01. Name, address, license numbers, material type code. (Found on line 1, 2, and 5.)

Code 02. Signature and associated date of signature and title of signer. (Found on bottom of report.)

Code 03. Report period (found on line 4).

*Codes are specified in Tables 2-4; italicized and non-italicized numbers refer to non-vital and vital data respectively.

TABLE 6. Procedure D-type checks and balances for current and upgraded systems using 327 data as data set 1.*

	Checks and Balances Number	Data Set 1 327	Data Set 2	
			741	742
Current System	6.1	25**	21-24	--
	6.2	34	34	--
	6.3	35	21-24 26-34	35
	6.4	36	26-33	--
Proposed Upgrades	6.5	20	--	20
	6.6	34	--	34
	6.7	44	34	34
	6.8	45	45	45
	6.9	46	34	34

* D Procedure - compare data entry from Data Set 1 with information from Data Set 2.

**Codes are specified in Tables 2 and 3.

Continued on next page.

TABLE 6. Procedure D-type checks and balances for current and upgraded systems using 327 data as data set 1+ (continued).

NOTES

Some data found on the 327 reports can be verified by combining data from previous 327, 741, and 742 reports and current 741 and 742 reports. Verifying these data against the entries in these reports can be the most important of the checks and balances on vital data. ("Current inventory" should equal the sum of "inventory" of the previous report plus "transfers.")

- Proc 6.1 Verify "total receipts" data on line 3 of 327 report (Code 25) with data on line 25 of the 741 reports (codes 21-24) filed during the inventory period reported at top of 327 form.
- Code 34. "Inventory difference" data for current period can be verified by summing "inventory difference" data reported on the 741 forms for the appropriate period. This data has a use code 77 found on line 246 of the 741 form.
- Code 35. Verify "ending inventory" on line 6 by: 1) adding to the "beginning inventory" on line 2 all receipts found on the 741 forms (for the inventory period on top of the 327 form) including purchases from DOE, production, additions from other materials, and other receipts reported on the 741, and 2) subtracting all shipments reported on 741 forms including sales to DOE, sales to others for account of DOE, other shipments reported on transmutation, accidental losses, and approved write-offs. (Codes 21-24 and 26-34). Twice a year, verify the "ending inventory" on the 327 using appropriate interim receipts and shipments reported on the 741 forms and the 742 "ending inventory" data previous to the 327.
- Code 36. Verify "total shipments" on line 4 by summing data found on the 741 forms filed during the appropriate period. These data include sales to DOE, sales to others for account of DOE, other shipments reported on 741, degradation to other materials, normal operating losses, discarded and decay, fission and transmutation, accidental losses, and approved write-offs. (Codes 26-33)
- Code 20. Check the "beginning inventory" data on line 2 with the 742 report issued for the same time period. This is always available.
- Code 34. Check "inventory difference" data on line 7 and 18 with entries on line 77 of the 742 form.
- Code 44. Check "cumulative inventory difference" on line 16 by summing inventory difference data on appropriate 742 forms of 741 forms issued for the period.
- Code 45. Check inventory difference for the prior period directly with previous 742 forms or 741 forms.
- Code 46. Check inventory difference for the current period directly with data on current 742 or with 741 forms.

TABLE 7. Procedure D-type checks and balances for current and upgraded systems using 742 data as data set 1.

	Checks and Balances Number	Data Set 1 742	Data Set 2	
			327	741
Current System	7.1	21	--	18,21
	7.2	22	--	18,22
	7.3	23	--	18,23
	7.4	24	--	18,24
	7.5	25	--	18,21-24
	7.6	26	--	18,26
	7.7	27	--	18,27
	7.8	28	--	18,28
	7.9	29	--	18,29
	7.10	30	--	18,30
	7.11	31	--	18,31
	7.12	32	--	18,32
	7.13	33	--	18,33
	7.14	34	--	18,34
	7.15	35	--	21-24, 26,34
<hr/>				
Proposed Upgrade	7.16	20	35	21-24, 26-34

Continued on next page.

TABLE 7. Procedure D-type checks and balances for current and upgraded systems using 742 data as data set 1 (continued).

- Code 20. The "beginning inventory" data on lines 8 and 9 can be obtained directly from the 327 report for each month that both reports are issued. When a 327 is not issued (every other month) the data can be obtained from the previous 327 plus data from 741 forms issued since the date of the previous 327.
- Code 21. Verify "production from DOE" on line 11 by summing the data on 741 forms for the period involved with use Code 11 on line 25G.
- Code 22. Verify "production" data on line 21 by summing the data on 742 for the period involved with use code 231 on line 25G.
- Code 23. Verify "additions from other materials" on line 22 by summing the data on 741 with use code 22 on line 25G.
- Code 24. Verify "receipts reported" on 741 form found on line 30 with use codes other than found in 1, 2, and 3 above on line 25G.
- Code 25. Verify "total receipts for the period" with use codes 11, 21, 22, and other entries on line 25G.
- Code 26. Verify "sales to DOE" on line 42 with 741 forms for period involved with use code 42 on line 24G.
- Code 27. Verify "sales to others for account of DOE" data on line 43 with appropriate 741 data with use code 43 on line 24G.
- Code 28. Verify "shipments reported" on 741 form, not listed elsewhere, found on line 51 with appropriate 741 forms for shipments not found in 6 or 7 above.
- Code 29. Verify "degradation to other materials" data on line 71 with appropriate 741 forms with use code 71 found on line 24G.
- Code 30. Verify "normal operational losses/measured discards" data on line 74 with appropriate 741 forms with use code 74 found on line 24G.
- Code 31. Verify "fission and transmutation" data on line 73 with appropriate 741 forms with use code 73 on line 24G.
- Code 32. Verify "accidental losses" data on line 75 with appropriate 741 forms with use code 75 found on line 24G.
- Code 33. Verify "approved write-offs" data on line 76 with appropriate 741 forms with use code 76 on line 24G.
- Code 34. Verify "inventory difference" data on line 77 with appropriate 741 forms with use code 77 on line 24G.
- Code 35. Verify "ending inventory" data on lines 80 and 81 with the sum of ending inventory data found on the previous 327 form plus receipts reported on interim 741 forms with use codes 11, 21, 22, and other entries on line 25G; minus removals reported on interim 741 forms with use codes 42, 43, 71, 72, 73, 74, 75, 76, and other entries other than 77 on line 24G.

4. Tables 6 and 7 emphasize that many data entries in the 327 and 742 reports can be verified with data from 741 reports. Namely, 327 physical inventory data should match with 742 book inventory data which has been augmented with 741 material transaction data. The opportunity to verify data in this manner is currently available twice each year.

3.3 DETERMINISTIC CHECKS AND BALANCES IN THE PROPOSED, UPGRADED MATERIAL ACCOUNTING SYSTEM

A proposed upgraded material accounting system is depicted in Fig. 5 and is based upon the following minor modifications to the current system:

1. A submission of a 742 report at the time of each physical inventory. This change will allow a comparison of NMMSS data with SSRS data.
2. A submission of a 742 report which would provide book inventory data for those months a physical inventory does not occur. Submission should coincide with the anniversary date of the scheduled physical inventories.
3. The elimination of the Monthly Loss and Discard Report and the Informal Material Monthly Balance Report, because with the above changes the information currently reported through these channels will now appear in the 741s and 742s.

The first change means that the date and data of 742s from NMMSS will coincide with the physical inventory 327 reports from SSRS. This change would provide an opportunity to resolve inconsistencies caused by the different reporting schedules of the two systems. The second change means there would now be six-times as many 742s, which contain valuable and easily-used data, than there are in the current system. The third change means that current informal reports (24 per year) would be assimilated into the formal 741 and 742 reports. Table 8 summarizes the reporting requirements for both the

Fig. 5. Information flow diagram of the proposed upgraded interfacility material accounting system.

TABLE 8. Comparison of reporting requirements for current upgraded systems.

Reports in Current System	Reports in Upgraded System	Proposed Additional Reports
2 Book 742s	6 Book 742s	+4 Book 742s
6 Physical Inventory	6 Physical Inventory 6 Physical Inventory 754s	+6 Physical Inventory 742s
12 Informal Monthly Balance	0	-12
12 Monthly Loss & Discard	0	-12

current and upgraded systems and suggests a net reduction. Note that the upgraded and current systems require the same reporting forms, namely the 741s, 742s, and 327s.

The deterministic checks and balances resulting from the proposed changes are also presented in Tables 6 and 7. Note that the proposed upgrades involve only the comparison of data from two sources (Table 4, Procedure D). The changes will allow for six additional checks and balances involving significant vital data; they also allow for more frequent application of the checks and balances.

4.0 CONCLUDING REMARKS

The most important conclusion is that only relatively minor changes are needed to significantly upgrade the current NRC interfacility reporting system.

In Chapter 2 we characterized the current national material control and accounting information flow and summarized the two existing reporting NRC systems, NMMSS and SSRS. In Chapter 3 we identified a number of checks and balances procedures that could be used with the current NRC interfacility material accounting system to detect clues to accounting fraud. Detecting any clues or inconsistencies could have significant safeguards value.

An upgraded reporting system was proposed in Chapter 3. Additional data needs and corresponding safeguards detection mechanisms were identified for the upgraded system. With the proposed changes, NMMSS could provide the SNM material balance status of every licensee or licensee/contractor as immediately as the receipt of the 741 reports and as accurately as the accounting records at the licensed facilities. Furthermore, each 742 report received would provide data for a monthly update. The net effect on the licensee or licensee/contractor would be to standardize some present informal practices. The net benefit to the NRC would be to assure that the NMMSS data base is accurate and timely, thus providing improved safeguards effectiveness.

The upgraded system is sufficiently restricted in scope to require only a reasonable level of data reporting requirements on the part of the licensee or licensee/contractor. Additional reporting requirements, short of attempting to externally duplicate facility ledgers and journals, probably would not provide any more vital data than is suggested here for the upgraded system.

Other concepts were identified which have potential for deterring falsifiers. Detailed consideration of these concepts was not possible within the scope of this study; however, each would seem to offer some safeguards benefit. Without attempting to justify them or rank them by importance, they are:

- 1) Using serialized and accountable forms
- 2) Using crypto-keyed corrections to transactions

- 3) Using encrypted data transmissions in general
- 4) Performing unannounced audits of data which result in significant inventory differences as a function of the reported ID and the specific facility situation. The extent of the audit could be varied depending on the ratio of ID to LEID
- 5) Varying responses to errors or inconsistencies could complicate the task of a falsifier as would unannounced audits. Some response to all errors or inconsistencies should always be made.

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