U.S. Department of Energy
Office of Inspector General
Office of Audit Services

Audit Report

Modernization of Tritium Requirements Systems

DOE/IG-0632

December 2003

Department of Energy
Washington, DC 20585

December 16, 2003

MEMORANDUM FOR THE SECRETARY

FROM: Gregory H. Friedman
Inspector General

SUBJECT: INFORMATION: Audit Report on "Modernization of Tritium Requirements Systems"

BACKGROUND

The Department of Energy's National Nuclear Security Administration (NNSA) maintains the nation's nuclear weapons stockpile, of which tritium is a vital component. The tritium in certain weapon components must be periodically replaced due to decay. Since halting production in 1988, the Department has met its tritium requirements through a recycling process at the Savannah River Site. However, plans are in place to have newly produced tritium ready for use as early as Fiscal Year 2007. To establish an optimal production schedule, an accurate projection of the amount of tritium required is necessary.

The Department developed the Tritium Simulation System (TSS) in the early 1990s to model its demand for and supply of tritium. The TSS uses data from at least three separate NNSA database systems to define the Department's tritium requirements. Management recently embarked on modernization initiatives to upgrade and improve these systems that, together, will cost more than $6 million and take several years to complete. The objective of the audit was to determine whether NNSA's efforts to modernize the TSS and related systems would result in accurate estimates.

RESULTS OF AUDIT

NNSA's modernization efforts, if executed as anticipated, should significantly improve the current tritium requirements systems. However, we determined that, even after modernization, the TSS would lack direct access to the real-time data needed to effectively model future requirements. Further, the TSS, as currently designed, will not account for tritium lost during processing at the Savannah River Site. Moreover, TSS would duplicate modeling capabilities which will be available in a separate database after the completion of the modernization activities.

We concluded that NNSA had not provided adequate oversight of the modernization efforts, and that, as a result, it risked developing a tritium requirements model which would be both incomplete and redundant. The software system modernization projects were being managed by separate offices, lacked concurrence by the Department's Chief

Information Officer, and, in one case, lacked approved plans and project baselines. As a result, NNSA's estimate of future tritium requirements may not be as accurate as possible. Additionally, NNSA could spend at least $650,000 for unnecessary upgrades for the TSS and associated systems. However, in comments on a draft of this report, NNSA informed the Office of Inspector General that current plans do not call for any additional TSS upgrades.

The report includes several recommendations designed to strengthen project management controls and improve the accuracy of the official tritium requirements model.

The Office of Inspector General issued a related report, *The Department of Energy's Tritium Extraction Facility* (DOE/IG-0560, June 2002), in which we discussed project management concerns regarding NNSA's construction of a new tritium facility at Savannah River.

MANAGEMENT REACTION

NNSA's Associate Administrator for Management and Administration generally concurred with our finding and recommendations, stating that the report accurately describes the situation related to the Tritium Requirements Systems Modernization initiative and makes recommendations that are useful to the overall project. The Associate Administrator added that NNSA's current plan will replace the TSS in its entirety with the upgraded MNS, thereby negating any additional TSS upgrades. Management stated that it will now concentrate on developing and implementing corrective actions for the programmatic weaknesses identified in the report. NNSA's verbatim comments have been included as Appendix 3.

Attachment

cc: Deputy Secretary
Administrator, National Nuclear Security Administration

MODERNIZATION OF TRITIUM REQUIREMENTS SYSTEMS

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ACCURACY AND RELIABILITY

Background

The Department of Energy uses a variety of automated systems to help model its demand for and supply of tritium.

- The Weapons Information System (WIS) contains information on each nuclear weapon in the stockpile, including specific type, location, status, and quantity of nuclear materials, including tritium-filled reservoirs.
- The Master Nuclear Schedule (MNS) generates a series of schedules and reports, known as "volumes," for the management of nuclear materials within the stockpile.
- The Stockpile Information Management System (SIMS) contains data from WIS and MNS as well as stockpile projection data from the annual Production and Planning Directive, which implements the Nuclear Weapons Stockpile Plan.
- The Tritium Simulation System (TSS), the official tritium requirements model, uses data from SIMS, together with manually entered data, to determine the impact that proposed tritium production schedules would have on the Department's ability to meet stockpile demands.

The National Nuclear Security Administration (NNSA) recently initiated modernization projects for the TSS, SIMS, WIS, and MNS to correct known shortcomings such as archaic programming codes and a lack of user-friendliness. The Department will spend about $570,000 to transcribe the current TSS system into Microsoft Access and, after TSS is transcribed, additional funding will be needed to make the system user-friendly and compatible with other information systems and to establish a work plan to upgrade SIMS. Meanwhile, the WIS and the MNS databases are being redeveloped at an estimated cost of $5.3 million. The WIS project should be completed by the end of FY 2004, and the MNS project should be completed by the end of FY 2005.

Opportunities for Improvement

Modernization efforts, as planned, will significantly improve the accuracy and reliability of current tritium requirements systems. For example, system documentation will be greatly improved, reducing the difficulty in maintaining and supporting the systems and expanding the user base. Additionally, much of the manual transcription of data, currently required, will be eliminated. Further, the upgraded WIS and MNS systems will provide real-time access to weapons planning information to selected users at research and production sites.

Despite these improvements, after modernization, TSS will not have direct access to the real-time data that will be contained in the WIS and MNS, nor will TSS account for tritium lost during processing at the Savannah River Site. Furthermore, TSS will duplicate modeling capabilities available in the rewritten MNS.

Real-time Data

The TSS and SIMS are maintained on classified stand-alone computers located in Germantown, Maryland, and NNSA Headquarters in Washington, D.C. The WIS and MNS are maintained on a classified mainframe at the Kansas City Plant and remotely operated by NNSA personnel in Albuquerque. After modernization, the TSS would continue to operate on stand-alone computers without direct access to real-time data, such as schedule changes for stockpile maintenance and reservoir change-outs that are entered daily into the WIS and MNS. The model will continue to use a snapshot of this and other data periodically taken from the WIS and MNS. While these data are supposed to be completely updated in the TSS at least annually, we noted that only sporadic, manual updates have been performed over the past several years. In fact, the last time the TSS received a complete update was in 1997. Also, tritium requirements for the Savannah River Site and the national laboratories are rarely updated in the TSS.

Tritium Losses

After modernization, the TSS will continue to use an estimate for the amount of tritium needed by the Savannah River Site that does not account for tritium lost during processing. Although DOE Order 5660.1B states that forecasts should identify and quantify nuclear material losses that result from processing, the estimate provided by the Savannah River Site does not include tritium released up the stacks to the environment during processing and tritium lost by absorption into the processing lines and valves. Since information from Savannah River's stack monitoring systems is readily available, this loss of about 4 grams of tritium per year could be included in the model. However, according to a management official, the NNSA Savannah River Site Office has neither calculated nor estimated the annual rate of tritium lost by absorption into the processing lines and valves.

Duplicative Systems

Both MNS and TSS rely on the same basic data and, following redevelopment, will provide nearly identical capabilities related to projecting tritium requirements. Software engineers from both modernization projects have stated that after modernization, the MNS could provide modeling capabilities nearly identical to those of the TSS. Despite this, NNSA has no plans to integrate or consolidate the systems. If the MNS were used instead of the TSS to project tritium requirements, additional TSS and SIMS upgrades could be avoided, and future system updates would be simpler.

System Management

NNSA risks developing an incomplete and redundant tritium requirements model because it has not provided adequate oversight of the modernization efforts for the software systems used in determining tritium requirements. Federal and Departmental Directives require that improvements to information systems be managed to support strategic and operational plans, integrate planning for resource allocation and use, and prevent duplication. However, NNSA has not properly coordinated the redevelopment efforts for the software systems to improve the accuracy of tritium projections. The projects were managed separately, lacked required concurrence by the Chief Information Officer (CIO), and in one case, lacked approved plans and project baselines.

NNSA did not coordinate the system redevelopment efforts to integrate planning or prevent duplication. Separate offices under NNSA's Office of Defense Programs owned and operated the systems and managed the redevelopment projects. The Office of Stockpile Technology managed the TSS and SIMS while the Office of Nuclear Weapons Stockpile managed the WIS and MNS. Separate redevelopment teams were established working independent of each other. Although the similarities between the two modeling systems were known, the redevelopment teams were not directed to combine or integrate the projects or systems. Thus, TSS, rewritten to operate only on stand-alone systems, will not be integrated with WIS and MNS, and will not have access to real-time data over the Department's classified network.

NNSA also did not reengineer work processes to improve the accuracy of tritium projections in support of operational plans. When the Department had an ample tritium supply, processing losses were not considered significant. However, now that the supply has diminished and NNSA is planning new tritium production, the replacement of tritium lost during processing must be taken into consideration. In

addition, although the projects should be considered major information systems in light of their importance to NNSA's mission, neither project was reviewed by the office of the CIO, or concurred with, as required by OMB Circular A-11. The CIO's review would have assessed project management plans and the status of work process reengineering likely disclosing weaknesses in the redevelopment efforts. For example, the WIS and MNS project does not have an approved project plan, nor has the project cost and scope been baselined. Further, the assigned project manager was not in full control of the project budget and could not provide assurance that the current project cost estimate was all-inclusive. After more than $2.3 million had been expended on the project, a review of the WIS and MNS project was finally initiated in May 2003, but had not yet been completed. A similar review of the TSS and SIMS project had not been initiated.

National Security

NNSA must be able to optimize production and prepare plans for long-term future use of nuclear materials such as tritium. Requirements need to be established several years in advance due to the long lead-time for building target rods, irradiating the rods, and extracting tritium from the irradiated rods. NNSA estimates that the current supply of tritium is sufficient to meet stockpile requirements until the Tritium Extraction Facility is operational. However, a significant portion of the Department's five-year reserve will be used, thereby reducing the flexibility of the tritium supply chain. In order to ensure that production levels are sufficient to sustain the stockpile, accurate models must be used to project future needs. On the other hand, over-production of tritium is also not desirable. Tritium costs in the range of $84,000 to $130,000 per gram, depending on the actual production requirement, and excess tritium would simply decay without being used.

Finally, duplicative modeling systems could result in unnecessary costs. For example, if MNS were used instead of TSS to develop the official tritium requirements, additional follow-on costs for the further upgrade to TSS and the redevelopment of SIMS might be avoidable. Although no formal cost analysis has yet been developed, NNSA and contractor personnel estimated that the additional effort would cost at least $650,000.

RECOMMENDATIONS

We recommend that the NNSA Deputy Administrator for Defense Programs:

1. Evaluate combining or integrating the TSS and MNS to develop a single tritium modeling system;

2. Defer further enhancements, beyond the current re-write, to the TSS and redevelopment of the SIMS until the evaluation of combining or integrating the systems is completed;

3. Strengthen project management controls and coordinate system development activities with the Office of the Chief Information Officer to ensure timely and efficient project completion; and,

4. Ensure that the official NNSA tritium requirements model:

   - Makes maximum use of real-time information to project tritium requirements; and,

   - Accounts for tritium lost during processing at the Savannah River Site, including tritium released up the stacks to the environment and tritium lost by absorption.

MANAGEMENT REACTION

NNSA Management generally concurred with our finding and recommendations stating that the report accurately describes the situation related to the Tritium Requirements Systems Modernization initiative and makes recommendations that are useful to the overall project.

However, management disagreed with how some issues in the report were portrayed. Specifically, management disagreed that TSS should use real-time data stating that it was neither practical nor cost effective. In addition, while management acknowledged that there are currently some redundancies between the two sets of systems, they felt that the redundancies provided for a validation of the results and were prudent given the magnitude of the decisions that are based on the models. Management also indicated that TSS would be the only planning tool available for at least the next two years until MNS has been proven to be capable of modeling tritium supply and demand. Finally, NNSA expressed concern with the conclusion that

tritium requirements may not be as accurate as possible, indicating that the last two percent of accuracy does not affect tritium plans and may be the most expensive to obtain.

AUDITOR COMMENTS

Management's comments are responsive to the intent of the report's recommendations. Since the upgraded MNS system will have access to real-time data, NNSA's stated plan to have the upgraded MNS replace the TSS in its entirety meets the intent of our recommendation to make maximum use of real-time information. Additionally, it appears that the plan will address our concerns regarding redundancies in the MNS and TSS modeling systems. However, management did not indicate the specific corrective actions it intends to take or when they will be initiated or completed.

With regard to the accuracy of projected tritium requirements, we acknowledge that there may be a point at which refining the accuracy becomes cost prohibitive; however, our recommendations are intended to improve the accuracy without significantly increasing the overall cost of the modernization efforts.

Appendix 1

PRIOR AUDIT REPORTS

Office of Inspector General

- *The Department of Energy's Tritium Extraction Facility* (DOE/IG-0560, June 2002). This audit found that completion of the TEF within its baseline cost, schedule, and scope was in jeopardy because the project team had not made full use of available project management controls. As a consequence, NNSA cannot be assured that the facility will be available when needed. Delays in completion of the TEF Project could also have the potential to impede performance of the Stockpile Stewardship Program.

- *Nuclear Materials Accounting Systems Modernization Initiative* (DOE/IG-0556, June 2002). This audit revealed that the Department had not adequately managed its activities to modernize its nuclear materials accounting systems. Specifically, the Department permitted organizations to continue to develop or upgrade site-specific systems that may not be capable of integration. Auditors concluded that at a minimum, the activities of field and Headquarters program elements need to be coordinated to avoid duplicative efforts; provide the greatest integration possible; and, ensure that the Department has appropriate control over its nuclear material inventory.

- *Corporate and Stand-Alone Information Systems Development* (DOE/IG-0485, September 2000). Auditors found that the Department had spent at least $38 million developing duplicative information systems. Despite efforts to implement several corporate-level applications, duplicative and/or redundant computer systems were under development at virtually all organizational levels within the Department despite Departmental guidance to the contrary.

- *The U.S. Department of Energy's Efforts to Preserve the Knowledge Base Needed to Operate a Downsized Nuclear Weapons Complex* (DOE/IG-0428, October 1998). This report noted that to preserve the knowledge base, the Department must assure user-friendly access to a comprehensive, well-organized archive of data regarding nuclear weapons. The auditors found that the Department had not developed a coordinated, integrated program to preserve the knowledge base. Although each of the sites included in the audit was archiving knowledge, there was little consistency among the sites. This occurred because the Office of Defense Programs had not assigned programmatic responsibility to integrate the site activities.

- *Review of the U.S. Department of Energy's Information Management Systems* (DOE/IG-0423, August 1998). This audit found that the Department had not developed an Information Technology Architecture, although it was a key goal of the Department's 1997 Strategic Plan to assure that the information management budget was not spent to develop and operate duplicative information systems. It further found that systems were under redevelopment with little consideration on how they would integrate with other systems.

General Accounting Office

- *Nuclear Weapons: Design Reviews of DOE's Tritium Extraction Facility* (GAO/RCED-98-75, 1998). GAO found that DOE has not produced tritium since 1988 and currently has no production capacity. DOE is using tritium removed from dismantled weapons to replace decayed tritium in active weapons. That supply is limited, however, and new tritium capacity will be needed by 2005.

- *Effects of Stockpile Reductions on Tritium Requirements* (Classified Report 1992). The audit examined changes to tritium demand in relation to when and at what scale tritium production would need to resume. At that time, their analysis concluded that basic tritium needs could be met until about fiscal year 2003 without producing more tritium.

- *Nuclear Weapons: A Model for Evaluating the Tritium Reservoir Exchange* (GAO/NSIAD-91-86, 1991). While gathering and analyzing data for a June 1990 classified report on management of tritium supplies, GAO developed a computer based model to support data comparison. The model was used to examine the feasibility of reducing the amount of "tritium overhead" carried in the supply pipeline, and identified the extent the reduction could extend the time period which tritium supplies will support the nation's nuclear arsenal.

- *Nuclear Weapons: Decreasing Tritium Requirements and Their Effect on DOE Programs* (GAO/RCED-91-100, 1991). GAO found that DOE obtained most of its tritium from reactors currently shut down and since 1988 the number of weapons in the stockpile has decreased significantly resulting in reduced tritium requirements.

Appendix 2

OBJECTIVE

The objective of the audit was to determine whether the National Nuclear Security Administration's efforts to modernize the Tritium Simulation System and related systems would result in accurate estimates.

SCOPE

The audit was performed between December 4, 2002, and June 19, 2003, at the Savannah River Site in Aiken, South Carolina; NNSA Headquarters in Washington D.C.; the Albuquerque Service Center in Albuquerque, New Mexico; and the Kansas City Area Office in Kansas City, Missouri. The scope of the audit included NNSA's efforts to modernize information systems used to project tritium requirements from March 2000 to June 2003 and their planned efforts through September 2005.

METHODOLOGY

To accomplish the audit objective, the audit team:

- Researched Federal and Departmental regulations applicable to the redevelopment of tritium information systems;
- Reviewed prior Office of Inspector General and General Accounting Office audit reports related to tritium and information systems;
- Identified and compared information systems containing data related to tritium requirements;
- Evaluated current and planned system interoperability, source and completeness of input data and users of output data;
- Evaluated plans for the modernization of NNSA's information systems related to modeling tritium requirements; and,
- Reviewed contract documentation, analyzed funding efforts and cost estimates, and evaluated performance measures for the system redevelopment projects.

The audit was conducted in accordance with generally accepted Government auditing standards for performance audits and included tests of internal controls and compliance with laws and regulations to the extent necessary to satisfy the audit objective. Accordingly, we assessed internal controls and performance measures established under the *Government Performance and Results Act of 1993* related to tritium requirements. Because our review was limited, it would not necessarily

have disclosed all internal control deficiencies that may have existed at the time of our audit. We did not rely extensively on computer-based data; therefore, we performed only limited tests to assess reliability.

We held an exit conference with National Nuclear Security Administration officials on October 29, 2003.

Department of Energy
National Nuclear Security Administration
Washington, DC 20585

OCT 31 2003

MEMORANDUM FOR Frederick D. Doggett
Assistant Inspector General
for Audit Services

FROM: Michael C. Kane
Associate Administrator
for Management and Administration

SUBJECT: Comments to Draft Report on Tritium Requirements Systems Modernization

NNSA appreciated the opportunity to have reviewed the Inspector General's (IG) draft report, "Modernization of Tritium Requirements Systems." NNSA appreciates the IG's contention that NNSA's efforts to modernize the Tritium requirements systems are expected to make significant improvements to the current systems. The report concludes, however, that after modernization the Tritium Simulation System would not have direct access to real-time data; nor account for tritium lost during processing; and, would duplicate modeling capabilities available in the Master Nuclear Schedule database. Further, the report concludes that NNSA risks developing an incomplete and redundant tritium requirements model because it has not provided adequate oversight of the modernization efforts.

The draft report accurately describes the situation related to the Tritium Requirements Systems Modernization initiative and makes recommendations that are useful to the overall project. NNSA generally agrees with the report and the associated recommendations. NNSA does acknowledge that omissions were made in the past related to not having current data in the TSS model (not aware of its availability), we have not been accounting for SRS tritium losses (considered negligible impact), and there certainly are opportunities to strengthen the integration between TSS and MNS (current planning). While we may disagree with how some issues are portrayed, overall we concur with the report and recommendations and will concentrate on developing and implementing corrective actions for those programmatic weaknesses identified.

The below portion of this memorandum provides some specific comments that may clarify or mitigate comments included in the report and the accompanying letter to the Secretary:

* **"Not have direct access to real-time..."** The most notable finding was that the Tritium Simulation Systems' (TSS) tritium inventory has not been updated since 1997 (report, page 2). This is a true statement and we agree that there is a need to rebaseline TSS inventories. This is one of the reasons for the rewrite - to permit regular TSS updates. We also agree

that more should be done to ensure that TSS is up-to-date on supply or demand changes. However, we disagree that TSS should use real-time data. TSS is a planning tool and must be able to run "what-if" scenarios long before any real-time data is available. In addition, while the report states that TSS should work off of real-time data, running real-time data would dictate that it reside on NNSA's Secure Network. The use of this network, while problematic, would have escalated the cost of TSS substantially. Rough estimates put the cost at approximately $2 million, far above the current upgrade price of $650k. As a result, it is neither practical nor cost effective to include real-time data inputs to the interim TSS.

* **"Not account for tritium lost..."** This is a true statement, although considered a relatively minor issue given the purpose of the TSS. This will require some investigation, as we were unaware that information on losses was available. However, if it is, this data will certainly be added into the new, interim TSS. While the actual benefit to our tritium prediction capability would be minimal, it should nevertheless be incorporated.

* **"Duplicate modeling capabilities..."** The models being referred to are not duplicates and therefore could mislead the reader. Stockpile Information Management System (SIMS)/TSS are planning tools, while Weapons Information System (WIS)/Master Nuclear Schedule (MNS) are operational models. There are currently some redundancies between these two systems that allow for validation of results, but given the level and magnitude of the decisions based on these models, we feel the redundancies are prudent. Second, the modernized MNS is not expected to be operational until FY05 or later. Until MNS is proven to be capable of modeling tritium supply and demand, the TSS will be the only planning tool available for the next two years. We believe that it is important to note that our current plan - established prior to the IG audit - was to have the upgraded MNS replace the TSS in its entirety, thereby negating any additional TSS upgrades. The MNS modernization effort does include a tritium supply-and-demand prediction capability that will be capable of replacing TSS. Therefore, there are no further plans to upgrade the TSS.

* **"We concluded that NNSA risks developing an incomplete and redundant tritium requirements model because it has not provided adequate oversight of the modernization efforts."** There appears to be an inaccurate implication that TSS was developed to run as a stand-alone application because of lack of coordination between offices. This statement is not an accurate conclusion. A number of factors went into this decision including the availability of the Secure Network, overall cost/time to complete the system, security requirements, ability of WIS/MNS to export needed data, etc. The decision was then made to initially develop TSS as a stand-alone application, with built in ability to facilitate the transitioning to a network application in the future. Since the rewritten MNS does not exist, there is no current redundant tritium requirements model. Current planning is to have the rewritten MNS available by the end of FY05, but given the delays on WIS, it could be longer. If NNSA were to wait for the rewritten MNS, it would

lose a valuable and essential evaluation tool. Complicating the issue is the fact that there is a lack of skilled system personnel which is why the reverse engineering effort of the TSS was absolutely essential. Only with this understanding can serious efforts be made at combining and integrating TSS with other modeling efforts. The rigor of building an executable model based on the reverse engineering, and the ability to compare the results of both models, is the best way to ensure we have really captured the essence of TSS.

NNSA is not clear as to what is meant in the report when it states that the requirements model is at risk of being incomplete, except, perhaps that the current model does not account for minor losses. As we previously stated, if this data is truly available, it will be incorporated into the revised TSS model.

* **"As a result, NNSA's estimate of tritium requirements may not be as accurate as possible."** NNSA is concerned about this sentence. While it is not an inaccurate statement, it may be misleading. For planning purposes of what-if studies, the last two percent of accuracy does not change any tritium plans, but may be the most expensive to obtain.

cc: Dr. Beckner, Deputy Administrator for Defense Programs, NA-10
Edwin Wilmot, Manager, SRS/NNSA Site Office

IG Report No.:DOE/IG-0632

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