

SEPTEMBER 28, 2007

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AUDIT REPORT

OFFICE OF AUDITS

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SYSTEM INTEGRATION TESTING OF THE SYSTEMS,  
APPLICATIONS, AND PRODUCTS VERSION UPDATE  
PROJECT NEEDED IMPROVEMENT

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OFFICE OF INSPECTOR GENERAL

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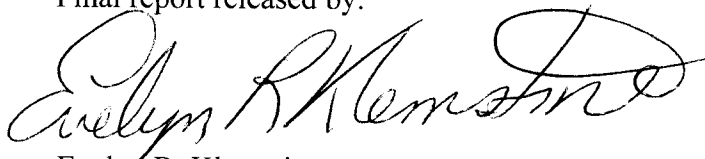
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National Aeronautics and  
Space Administration

REPORT No. IG-07-031 (ASSIGNMENT No. A-06-017-00)

Final report released by:



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## Acronyms

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FY	Fiscal Year
IA	Independent Assessment
IEEE	Institute of Electronic and Electrical Engineers
IEM	Integrated Enterprise Management
IEMP	Integrated Enterprise Management Program
IV&V	Independent Verification and Validation
MOA	Memorandum of Agreement
NPD	NASA Procedural Directive
NPR	NASA Procedural Requirements
OIG	Office of Inspector General
ORR	Operational Readiness Review
SAP	Systems Applications and Products
SIT	System Integration Testing
SVU	SAP Version Update
TRR	Test Readiness Review

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## OVERVIEW

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# SYSTEM INTEGRATION TESTING OF THE SYSTEMS, APPLICATIONS, AND PRODUCTS VERSION UPDATE PROJECT NEEDED IMPROVEMENT

## The Issue

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NASA has made substantial investments of both time and money in developing and implementing the Core Financial system—the backbone of the Integrated Enterprise Management Program (IEMP). NASA estimates the cost of this effort, through fiscal year 2008, to be about \$998 million. IEMP initiated the Systems Applications and Products' (SAP) Version Update (SVU) Project in September 2005 to update from SAP R/3 SAP 4.6c to mySAP Enterprise Resource Planning 2005/Enterprise Core Component 6.0 (mySAP ERP 2005/ECC 6.0).

System integration testing (SIT) is done to ensure that related systems (such as the Core Financial system, Contract Management Module, Travel Manager, Business Warehouse, and the Bank Card system) operate in accordance with the process design specifications for all business functions and that the parts of the system work together as an integrated whole. The SVU Project Office developed the 7.1 System Integration Test Plan (Test Plan), May 18, 2006, to provide guidance on conducting SIT for the SVU and began SIT in May 2006. For the SVU project, SIT tests business processes, system functions (standard and custom), application security, and user procedures. Paragraph 5.1 of the Test Plan sets up SIT for SVU in three “Passes” or iterations of testing to validate that the software correctly implements the software requirements and design as each software component is incrementally integrated with each other.

The overall objective of our audit, which began in May 2006, was to determine whether testing for the SVU Project was adequately planned and performed. During the audit, we attended key SVU Project meetings including all Test Readiness Reviews (TRR), Operational Readiness Reviews (ORR), Authority to Proceed decision meetings, and defect management meetings. Details of the audit's scope and methodology are in Appendix A.

## Results

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During the audit, we maintained continuous communication with the Integrated Enterprise Management (IEM) Program Director, the SVU Project Manager, and the

Competency Center Director<sup>1</sup> and informed them of issues we identified as the SVU went through its three SIT Passes. Specifically, between June and October 2006, we informed the IEM Program Director, SVU Project Manager, and the Competency Center Director of 14 issues that might negatively impact SVU testing and implementation. Of the 14 issues identified, they agreed or partially agreed with 12 issues.

Of the 12 issues agreed with, they took action on 1 issue and took partial action on 2 issues. Specifically, the SVU Project Office took action to incorporate a backout plan<sup>2</sup> into their contingency planning requirements. The SVU Project Office took partial action by reporting deviations in testing to stakeholders and reporting test procedures that were not completed. The SVU Project Office did not take action on the other 9 issues because there was either insufficient time or they did not fully agree with our concerns.

The IEM Program Director, the SVU Project Manager, and the Competency Center Director did not agree with 2 issues. Specifically, they did not agree with our assessments concerning the adequacy of the independent assessment performed by the Independent Assurance contractor or whether a successful regression test was conducted. (Appendix B provides a more detailed explanation of the issues and management's responses.)

In summary, we found that although the SVU Project Office developed a Test Plan in May 2006 to provide guidance for conducting SITs, that plan was inadequate and the execution of the plan was undisciplined. Specifically, we found the following:

- SVU software requirements were not adequately stabilized before the SVU Project Office developed the Test Plan and test procedures. According to NASA Procedural Requirements (NPR) 7150.2, "NASA Software Engineering Requirements," September 27, 2004, paragraph 3.4, testing should verify code against requirements and design to ensure that the requirements are implemented. Although a baseline of SVU requirements was established in May 2006, those software requirements were not stabilized until September 2006, 4 months after SIT began in May 2006.
- The Test Plan did not include a baseline of test procedures to be tested during each SIT, as required by NPR 7123.1, "NASA Systems Engineering Processes and Requirements," March 13, 2006, Table G-6, and NPR 7150.2, paragraph 5.3.2.1. The SVU Project Manager never established a baseline of test procedures to be executed during each SIT. Because a baseline of test procedures was not established for each SIT, we were not able to determine whether all testing that should have been completed was completed during each SIT Pass.

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<sup>1</sup> The Competency Center Director's official title is Deputy Director, Office of the Marshall SpaceFlight Center Chief Information Officer.

<sup>2</sup> A backout plan is a documented plan to restore the system to the state it was in prior to installation of new software, including assuring the restoration is complete and accurate. The plan usually involves re-installing the previous versions of the software.

- The SVU Project Office did not develop an adequate process for assigning and changing defect severity levels or accurately report the number of very high defects, as required by NPR 7150.2, paragraph 3.4.5, and the Test Plan, paragraph 9.1.
- SIT Pass Three—regression testing—was not successfully completed before the ORR, as required by NPR 7123.1, Table G-9. SIT Pass Three could not be considered a successful regression test because only 66.5 percent of the requirements had been successfully tested before the start of SIT Pass Three and because of the number of defects—at least 49—found during SIT Pass Three that required code changes to correct.
- The independent assessment performed by the Independent Verification and Validation Facility contractor was not adequate. Specifically, the contractor did not determine whether requirements adequately traced to test procedures; did not conduct sufficient analysis to provide confidence that all appropriate requirements were adequately tested, as required by the memorandum of agreement,<sup>3</sup> paragraph 6; and did not identify the increased risk to the project schedule, as required by the “IEMP Independent Assessment Task Plan,” February 17, 2006, paragraph 4.3. The contractor only analyzed a judgmental sample of 10 test procedures out of a total of 4,127 test procedures (0.002 percent) and concluded that “all selected tests appeared to adequately test the specified requirements.”

Because requirements were not stabilized, a baseline of test procedures could not be developed. Also, SIT was adversely impacted because defect management was inadequate, regression testing was unsuccessful, and the requirements were not adequately traced to test procedures. The combination of these factors delayed SVU system implementation until November 20, 2006,<sup>4</sup> and resulted in significant software deficiencies that had to be corrected after implementation. As of September 2007, the SVU Project Office was resolving system issues, and at least one Business Warehouse report was not expected to be corrected until October 2007.

## Management Action

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Throughout the course of our audit, management considered all of our recommendations and took action to improve the planning and execution of testing procedures for the SVU Project as they deemed appropriate. Given that the opportunity to address all of the issues we identified in the SVU Project has passed, the recommendations contained in this

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<sup>3</sup> The IEM Program Office and the Goddard Space Flight Center Independent Verification and Validation Facility entered into a memorandum of agreement, January 4, 2006, for the independent assessment of various systems, including the SVU.

<sup>4</sup> The Core Financial system was available to a limited number of users for limited processing on November 15, 2006, but was not available to all users for all types of processing until November 20, 2006.

report are intended to improve the planning and execution of testing procedures for future IEMP projects.

For future IEMP projects, we recommend that the IEM Program Director and the Project Manager comply with NPR 7150.2, NPR 7123.1, and the Independent Assessment Task Plan by (1) stabilizing software requirements prior to beginning testing; (2) establishing a baseline of test procedures to be completed during each SIT before testing begins; (3) implementing policies and procedures establishing the management, assignment, and change controls of defect severity levels; (4) reporting all deviations from test procedures; (5) successfully completing a regression test; (6) not holding the ORR until testing is completed and defects are resolved; and (7) ensuring that all independent assessment analysis is performed and all independent assessment reports are complete. (See the Results section for our evaluation and disposition of management's comments.)

In response to a draft of this report, the IEM Program Director concurred with the recommendations to stabilize software requirements prior to beginning testing; establish a baseline of test procedures to be completed during each SIT Pass before testing begins; implement policies and procedures for managing, assigning, and changing defect severity levels; report all deviations from test procedures; complete a successful regression test; and ensure all Independent Assessment analysis is performed and all independent assessment reports are complete.

The IEM Program Director partially concurred with Recommendation 6 to complete all testing and resolve all defects prior to holding the ORR, stating that he agrees that an ORR should not be held until testing is completed but disagreed with the NPR 7123.1 requirement to resolve all defects prior to entering the ORR. Specifically, the Competency Center understands the intent of the regulation but believes it is not feasible or cost effective to force resolution of every individual defect related to an administrative software application prior to conducting the ORR. Although we agree that it may not be cost effective to resolve all defects prior to the ORR, we maintain that all high<sup>5</sup> and very high<sup>6</sup> severity defects should be resolved or have documented workarounds that are successfully tested prior to the ORR, as required by NPR 7123.1, Table G-9.

We have closed Recommendations 1, 2, 4, 5, and 7. Recommendation 3 will remain open until all actions have been completed and verified. We request that the IEM Program Director provide us with additional comments for Recommendation 6.

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<sup>5</sup> A high severity defect is a problem that would materially affect testing, causing an immediate and substantial impact; it requires that a change be made by a specific date.

<sup>6</sup> A very high severity defect is a problem that cannot be circumvented, i.e., there is no workaround available, and that impacts the operation of the affected application; it requires that a change be made on an immediate-response basis.

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## INTRODUCTION

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### Background

Over the last decade, NASA has invested significant resources to modernize its business systems and to implement the Integrated Enterprise Management Program (IEMP). Through incremental implementation of commercial software packages and related hardware and software components, IEMP is expected to produce an integrated NASA-wide business and financial management system. (See Appendix C for a glossary of system and programmatic terminologies.) Systems Applications and Products' (SAP) R/3 is the software foundation for NASA's Core Financial system. The Core Financial system is the IEMP backbone for implementing standard processes and systems needed to support NASA's financial management activities.

**President's Management Agenda.** The President's Management Agenda was initiated in 2001 to improve management and performance in Federal agencies. The Agenda includes five Government-wide goals—one of which is to improve financial performance. Improved financial performance would provide Federal managers accurate and timely financial information to use to manage costs. The Office of Management and Budget updates the status of the five Government-wide goals quarterly. Since June 2002, NASA has had an unsatisfactory rating in the "improve financial performance" goal. By updating the Core Financial system, NASA hopes to improve compliance with Federal regulations and change its rating to satisfactory.

**SAP Version Update Project.** The Integrated Enterprise Management (IEM) Program Office initiated the SAP Version Update (SVU) Project in September 2005 to update from SAP R/3 SAP 4.6c to mySAP Enterprise Resource Planning 2005/Enterprise Core Component 6.0 (mySAP ERP 2005/ECC 6.0). MySAP ERP 2005/ECC 6.0 contains source code fixes and redesigns that have been based on issues seen in previous versions of SAP, including SAP R/3 SAP 4.6c. According to the SVU "Initial Scope Document, Baseline," December 15, 2005, and the SVU "Scope Document, Revision A," Draft, April 5, 2006, benefits of the SVU, once implemented, are expected to include

- improved data integrity based on SAP funds management redesign;
- additional automation of adjustment accounting entries;
- improved support for the budget distribution process;
- improved program/project management information for decision making; and
- streamlined year-end processing (starting with FY 2007).

According to both Scope Documents, those benefits will contribute to NASA's financial tracking and reporting and its goal of achieving an unqualified audit opinion. The SVU Project Manager estimated that the SVU cost about \$70.1 million—\$48.2 million for the SVU Project and \$21.9 million for implementation at the Centers.

**System Integration Testing.** Software testing helps identify the correctness, completeness, security, and quality of developed and purchased computer software.<sup>7</sup> A subset of software testing is system integration testing (SIT),<sup>8</sup> a vitally important phase of the testing process. The SVU Project Office developed the 7.1 System Integration Test Plan (Test Plan), May 18, 2006, to provide guidance on conducting the SITs. SIT tests business processes, system functions (standard and custom), application security, and user procedures. Paragraph 5.1 of the Test Plan sets up each SIT in three "Passes" or iterations of testing to validate that the software correctly implements the software requirements and design as each software component is incrementally integrated with each other. The objectives of the SITs were to ensure that related systems (such as the Core Financial system, Contract Management Module, Travel Manager, Business Warehouse, and the Bank Card system) operated in accordance with the process design specifications for all business functions and that the parts of the system worked together as an integrated whole. According to the Test Plan, each SIT Pass is to be conducted independently within its own testing environment.

- SIT Pass One – integrated, end-to-end business functions. This pass covers the day-to-day key business activities that represent the heart of NASA's business. This pass includes testing of custom development components (all types), based on availability. During SIT Pass One, test defects<sup>9</sup> are identified and documented, but execution does not stop and wait for resolution. Execution continues using workarounds, if necessary, except in the situation where the error prevents any further action from taking place completely.
- SIT Pass Two – integrated, end-to-end business functions. As in Pass One, Pass Two covers the day-to-day key business activities that represent the heart of NASA's business and includes testing of custom development components (all types). In Pass Two, also, test defects are identified and documented and execution does not halt and wait for test defect resolution; execution continues with open test defects using workarounds where possible. In Pass Two, however, if execution cannot continue with workarounds, if the workaround does not support the objectives of the test, or if the error prevents any further action from taking place completely, execution is halted. However, by the end of SIT Pass Two, all significant defects should be ready to retest during SIT Pass Three.

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<sup>7</sup> NASA Technical Standard 8739.8, "Software Assurance Standard," July 28, 2004.

<sup>8</sup> IEEE Standard 610.12-1990, "IEEE Standard Glossary of Software Engineering Technology," September 28, 1990.

<sup>9</sup> A defect is a flaw in a system or system component that causes the system or component to fail to perform its required function. A defect, if encountered during execution, might cause failure of the system.

- SIT Pass Three – regression testing for test defects plus sequenced “close” activities (month-end/year-end). This pass is used to re-execute any test plan from Pass One or Pass Two that was completed (all steps/functions executed) with test defects outstanding. In this situation, the test condition status would be “failed” and the Test Plan status would note that execution was completed, but test defects were outstanding. As such, this test condition would need to be retested through one of its mapped test plans.

Test Plan, paragraph 5.3, states that test procedures will be organized by test sets. Test sets summarize a set of related business events that, when performed in sequence, represent an actual business function or transaction from start to finish. A test set will have one or more test procedures and each test procedure may have one or more detailed test steps. Test procedures were developed by the Integrated Process Team leads for the different functional areas. The Integrated Process Team leads are also generally the testing managers that organize and conduct the testing.

### **Objectives**

The overall objective of the audit was to determine whether testing for the SVU was adequately planned and performed. Specifically, we determined whether the SVU Project Office prepared adequate test plans, performed all testing in the test plans, and established procedures to address and resolve test failures. We also reviewed internal controls as they related to the overall objective. See Appendix A for details of the audit’s scope and methodology, our review of internal controls, and a list of prior coverage.

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## **SYSTEM INTEGRATION TESTING WAS NOT ADEQUATE**

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System integration testing was inadequate because NASA managers did not take a sufficiently disciplined approach to testing SVU software. The SVU Project Manager did not

- stabilize software requirements before developing the Test Plan and test procedures, as required by NPR 7150.2, “NASA Software Engineering Requirements,” September 27, 2004, paragraph 3.4;
- prepare adequate test plans to include a baseline of test procedures to be tested during each SIT and test contingency plans that incorporated a backout plan, as required by NPR 7123.1, “NASA Systems Engineering Processes and Requirements,” March 13, 2006, Table G-6, and NPR 7150.2, paragraph 5.3.2.1, nor adequately report on deviations from the Test Plan during SIT Pass One, as required by NPR 7150.2, paragraph 5.3.2.1;
- develop an adequate process for assigning and changing defect severity levels or accurately report the number of very high defects, as required by NPR 7150.2, paragraph 3.4.5, and Test Plan, paragraph 9.1;
- complete SIT Pass Three—regression testing—before the Operational Readiness Review (ORR), as required by NPR 7123.1, Table G-9; or
- ensure that reports from the independent assessment (IA) contractor were adequate and complete.

As a result, system implementation was delayed until November 20, 2006,<sup>10</sup> and the SVU Project Manager did not identify significant software deficiencies that had to be corrected after the system was implemented. As of September 5, 2007, the SVU Project Office was still resolving system issues.

### **Concerns Raised During the Audit, and Action Taken**

During the audit, we maintained continuous communication with the IEM Program Director, the SVU Project Manager, and the Competency Center Director and informed them of issues we identified as the SVU went through its three SIT Passes. Specifically, between June and October 2006, we provided the IEM Program Director, the SVU

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<sup>10</sup> The Core Financial system was available to a limited number of users for limited processing on November 15, 2006, but was not available to all users for all types of processing until November 20, 2006.

Project Manager, and the Competency Center Director with 14 issues that might negatively impact SVU testing and implementation. Of the 14 issues identified, they agreed or partially agreed with 12 issues.

Of the 12 issues management agreed with, they took action on 1 issue and took partial action on 2 issues. Specifically, the SVU Project Office took action to incorporate a backout plan into their contingency planning requirements. The SVU Project Office took partial action by reporting deviations of testing to stakeholders and reporting test procedures that were not completed. However, the SVU Project Office did not report that they created, modified, and deleted test procedures during testing. In addition, the SVU Project Office took partial action by improving controls for assigning and changing defect severity levels; however, they did not make the process a formal policy and did not implement a process to escalate high severity defects to very high in compliance with the Test Plan. The SVU Project Office did not take action on the other 9 issues because there was either insufficient time or they did not fully agree with our concerns.

The IEM Program Director, the SVU Project Manager, and the Competency Center Director did not agree with 2 issues. Specifically, they did not agree with our assessments concerning the adequacy of the IA work performed by the Independent Verification and Validation Facility contractor or whether a successful regression test was conducted. (Appendix B provides a more detailed explanation of the issues and management's responses.)

## Testing Guidance

**Institute of Electronic and Electrical Engineers Standards.** The Institute of Electronic and Electrical Engineers (IEEE), a nonprofit organization, publishes nearly a third of the world's technical literature on electrical engineering, computer science, and electronics. NASA Procedural Directive (NPD) 2820.1C, "NASA Software Policy," August 30, 2005, recommends using IEEE Standards for software development and implementation. IEEE Standard 1012, "IEEE Standard for Software Verification and Validation," June 8, 2005, provides guidance for a SIT. A SIT validates that the software correctly implements the requirements and design as each software component is incrementally integrated into the overall system. To realize the full benefits of the SIT, IEEE Standard 1012, table 1, sections 5 and 6, recommend tracing requirements to test procedures and to test results and documenting test execution and results.

**NASA Software Testing Requirements.** NPR 7150.2 establishes a minimum set of requirements for NASA software acquisition, development, maintenance, operations, and management. NPR 7150.2, paragraph 5.1.3, requires, for software created for or acquired by NASA, a test plan to describe the software test environment to be used for testing; identify the tests to be performed; and provide schedules for environment, development, and test activities. The test plan should provide an overview of software testing, test schedules, and test management procedures. NPR 7150.2, paragraph 3.4.5, requires the project office to document defects identified during testing and track defects to closure.

NPR 7123.1, Table G-6, establishes entry criteria for a Test Readiness Review (TRR) and Table G-9 establishes entry criteria for the ORR. According to Table G-6, a TRR is intended to ensure that the system, facility, personnel, and procedures are ready for testing. According to Table G-9, an ORR should result in reporting the actual system characteristics and procedures used in the system and that all system and support hardware, software, personnel, procedures, and user documentation accurately reflect the deployed state of the system.

## **Software Requirements Had Not Been Stabilized**

The SVU Project Office did not stabilize software requirements before developing the Test Plan or test procedures.<sup>11</sup> According to NPR 7150.2, paragraph 5.2.1.1, software requirements are the specifications that system developers and program managers use to acquire, implement, and test the software within a system. According to NPR 7150.2, paragraph 3.4, testing verifies the code against the requirements and the design to ensure that the requirements are implemented. Because testing determines a system's viability, verifying test procedures against requirements that are not stable is not effective and cannot ensure the system will fulfill users' needs.

SVU Project management established five levels of requirements, addressing both system requirements and software requirements. System requirements are the high-level requirements that primarily entail (1) what the system or process must do to fulfill business needs and (2) how well—in terms of performance measures such as speed, security, or usability—the system or process fulfills those business needs. Software requirements, at a lower level, describe in detail the specifications that system developers and program managers use to acquire, implement, and test a system. For the purposes of this report, system requirements are Levels I through III and software requirements are Levels IV and V. The five levels of requirements are as follows:

- Level I – Agency drivers (IEMP guiding principles);
- Level II– functional drivers (critical business needs of NASA stakeholders for the specific IEMP project);
- Level III – high-level requirements (processes and software features needed to satisfy Level II and regulatory requirements);
- Level IV – acquisition requirements (detailed functional and technical requirements that specify how the application should work and that link to Level III requirements); and

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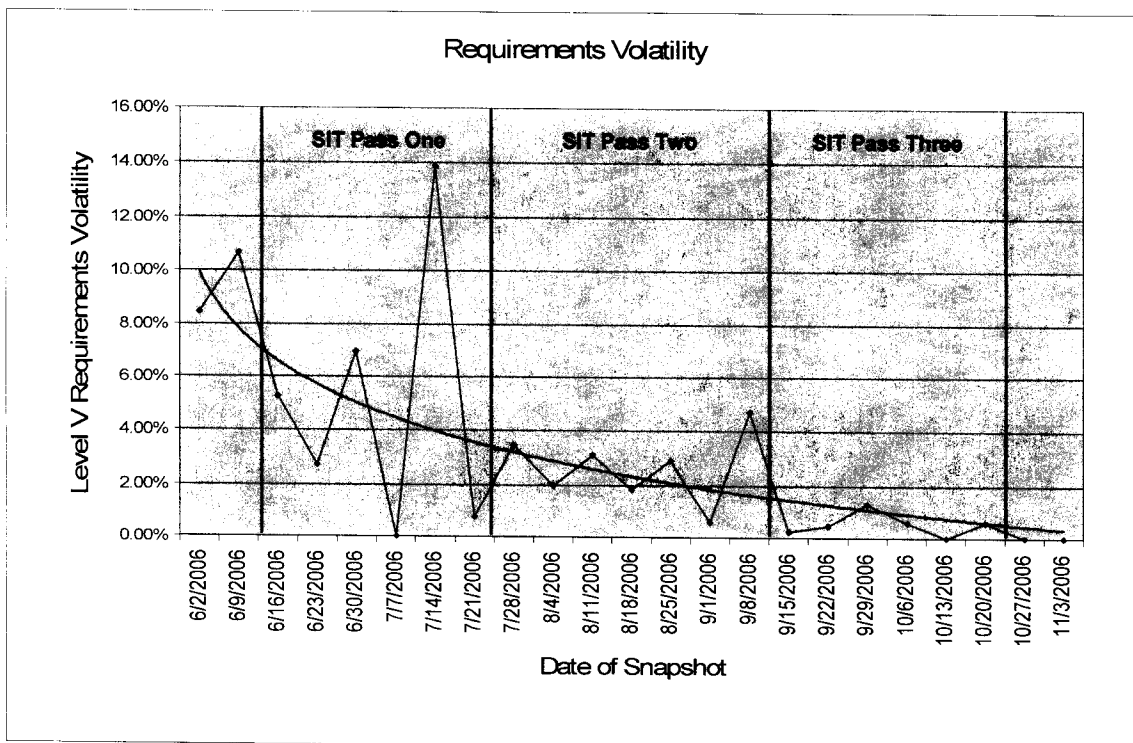
<sup>11</sup> The detailed steps used for testing software during each SIT.

## RESULTS

- Level V – implementation requirements (requirements related to individual system activities or information delivery components, and these requirements are defined in the use cases or functional specifications).

Test procedures—the specific steps for testing software—are based on Level V requirements, i.e., software requirements.

The SVU Project Office did not stabilize the Level V requirements until SIT Pass Three. On May 26, 2006, the SVU Project Office established a baseline of software requirements and tracked the changes to the baseline on a weekly basis. Although some volatility in requirements is expected, even after a successful technical requirements definition process, high volatility indicates that the system and its attributes are not well understood. From May 26, 2006, approximately 3 weeks before SIT Pass One began, through November 3, 2006, approximately 2 weeks after SIT Pass Three ended, the SVU Project Office created 3,321 new Level V requirements, changed 744 Level V requirements, and deleted 2,278 Level V requirements. On November 3, 2006, the SVU Project Office had a total of 7,898 Level V requirements documented. The figure shows the volatility of the Level V requirements on a weekly basis.



The volatility trend (sloped line in the figure) shows that the SVU Project Office was still identifying requirements well into testing and the requirements had not stabilized until SIT Pass Three. Stabilization should have occurred before SIT Pass One began. According to NPR 7150.2, paragraph 3.4, it is critical to have software requirements traced to test procedures to ensure that requirements are tested. By tracing software requirements to testing procedures, every time a requirement is changed due to

requirement volatility, the corresponding test procedures should be retraced and also changed to reflect the new requirement. Consequently, SIT Pass One and, to a lesser extent, SIT Pass Two were not as effective as they could have been if requirements had been stabilized and traced to test procedures and if corresponding test procedures had been kept updated as requirements changed. Therefore, the SIT Passes were performed with an increased risk that the tests developed did not address all of the SVU requirements.

We notified the IEM Program Director about our concerns regarding stabilizing requirements before beginning SIT testing in an e-mail on June 9, 2006. The IEM Program Director agreed with our assessment and responded,

We are striving to have all low-level design requirements (Level Vs) solidified and test . . . [procedures] created prior to testing, scheduled to start on June 26. We think we can achieve this goal. However, there are still a few remaining items to be worked out in the detailed design of some custom developed objects, as well as in some process areas (e.g., reimbursable); therefore, it may not be realistic for us to expect zero volatility in our detailed design requirements as we move into our first System Integration Test execution.

Although the IEM Program Director agreed with our assessment and we agree that some volatility is expected, requirements for custom developed objects and process areas should be stable before testing starts.

## **Documentation and Control of Test Procedures Was Inadequate**

The SVU Project Office management did not prepare an adequate test plan. Specifically, SVU Project management did not establish a baseline of test procedures to be tested during each SIT, did not adequately report on deviations from the Test Plan, and did not develop a backout plan as part of their contingency plans.

**Test Plan Did Not Include a Baseline of Test Procedures for Each SIT.** The SVU Project Manager did not adequately document a baseline of test procedures in the Test Plan. NPR 7123.1, Table G-6, requires that, prior to a TRR, “the objectives of the testing have been clearly defined and documented and all of the test plans, procedures, environment, and the configuration of the test item support those objectives.” For each SIT Pass to be effective, the test procedures should be identified prior to the start of testing so that the results can be objectively measured against specific criteria. Also, once a baseline of test procedures is established, changes to the baseline should be documented and reported to key decision makers, in accordance with NPR 7150.2, paragraph 5.3.2.1. Instead of a baseline of test procedures to be performed during each SIT Pass, the SVU Project Office established a baseline of test sets.<sup>12</sup> The test sets included only the name of the general area that would be tested during each SIT and did not clearly define or document the test procedures, as required by NPR 7123.1, Table G-6.

<sup>12</sup> A set of related business events. For SVU, a test set consists of the name of the general area that would be tested during each SIT.



During an August 23, 2006, meeting held with the Competency Center Director and the SVU Manager, the SVU Project Manager stated it was their practice not to establish a baseline of test procedures to be executed during each SIT. Because of that practice, we were not able to determine whether the SVU Project Office finalized the planning for each SIT Pass or whether all testing that should have been completed was completed during each SIT Pass. After the SVU was implemented, we were able to determine the actual number of test procedures that were tested during each SIT Pass. For example, we found that on June 26, 2006, the day that SIT Pass One was scheduled to start, only 56 percent of the 693 test procedures that were eventually completed during SIT Pass One were documented in the Quality Center,<sup>13</sup> thus preventing the SVU Project Office from establishing a baseline.

As a result of not establishing a baseline of test procedures before conducting each SIT Pass, SVU Project management could not ensure that testing adequately covered the system requirements and could not perform an objective review of the results of the testing. In addition, a comprehensive review of the test procedures could not be performed. In a comprehensive review, functional teams review other functional teams' test procedures to identify testing inadequacies or gaps that involve interfaces and mutual dependencies. A comprehensive review will also identify if the same test has been developed multiple times by various functional teams. Industry best practices support performing a comprehensive review of test procedures.

Also, the SVU Project Office could not identify all possible testing dependencies between test procedures that had not yet been completely defined. Identifying testing dependencies involves recognizing that some test procedures are dependent on the completion of a prior test. If testing dependencies had been fully identified, the SVU Project staff could have more accurately prioritized resources to fix test defects and rescheduled test procedure that were dependent on fixing a specific defect.

We notified the IEM Program Director about inadequately documenting the baseline of test procedures in an e-mail on June 9, 2006. In his June 19, 2006, response, the IEM Program Director agreed and stated,

We concur that it is a sound process to have all test . . . [procedures] developed and traced to project requirements prior to entering the TRR. While this may no longer be possible for SVU due to the schedule that has already been established, the IEM Program will take the action to adjust its standard Test Plan Approach to ensure that it requires test plan development and tracing to requirements to be completed prior to a project's TRR.

In another e-mail on June 9, 2006, we notified the IEM Program Director about the inability to adequately review the test procedures because the baseline of test procedures was not adequately documented. In his June 19, 2006, response, the IEM Program Director agreed and stated

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<sup>13</sup> Quality Center is an automated tool used by the SVU Project Office to document detailed test procedures that included steps and the expected results. Quality Center is also used to document the results of testing.

completing the test . . . [procedures] earlier would provide more time to locate testing gaps and correct them prior to the start of a System Integration Test. The IEM Program will take the action to adjust its standard Test Plan Approach to ensure that it requires test plan development and review to be completed prior to the TRR for future projects.

The IEM Program Director did not agree to improve either the documentation of test procedures baseline or the review of test procedures during SVU testing because of time constraints.

**Deviations from Test Plan During SIT Pass One Not Adequately Reported.** The SVU Project Office did not report deviations to the Test Plan during SIT Pass One. NPR 7150.2, paragraph 5.3.2.1, requires that detailed software test reporting must include deviations from test procedures in the Test Plan and the rationale for each deviation.

During SIT Pass One, the SVU Project Office marked 52 test procedures “N/A” within Quality Center but did not report those test procedures as deviations. In addition, although the name of the test was left in Quality Center, the text describing detailed test steps and results was deleted for 35 of the 52 test procedures marked N/A. The following table lists the test procedures that were marked N/A and detailed test steps that were deleted.

<b>Number of Test Procedures Deleted or Marked “N/A” from Established Test Sets for SIT Pass One</b>					
<b>Test Set Database Number</b>	<b>Title</b>	<b>Number of Test Procedures in Test Set</b>	<b>Number of Procedures Deleted and Marked N/A</b>	<b>Number of Procedures Only Marked N/A</b>	<b>Total Number of Procedures Not Run</b>
24	OPTIN-CCR-REIM	21	1	0	1
32	Deobs-Converted Lines	15	5	0	5
36	Bankcard	12	6	0	6
52	NSSC Working Capital Fund Activities with the Reimbursable Process	9	1	1	2
55	SGL Upward and Downward Adjustment Processing	26	4	7	11
59	Travel	67	14	7	21
72	AP Only	28	2	1	3
74	Data Migration Validation	12	0	1	1
75	BW Data Migration Validation	5	2	0	2
<b>Total</b>	<b>Total</b>	<b>195</b>	<b>35</b>	<b>17</b>	<b>52</b>

We interviewed the testing managers to understand their rationale for marking the test procedures N/A, because reasons were not reported or documented.

- Seven test procedures from test sets 24-OPTIN-CCR-REIM, 32-Deobs-Converted Lines, and 74-Data Migration Validation were not run because they were dependent on resolution of a defect identified in a prior test procedure.
- Two test procedures from test set 75-BW Data Migration Validation were not run because the Business Warehouse analysis was not completed.

The SVU Project Office completed at least 5 of the 52 test procedures marked N/A during SIT Pass One; however, those 5 test procedures failed and a defect report should have been generated for each failure. The other 47 test procedures marked N/A were not run and should have been reported as deviations to the test plan, as required by NPR 7150.2, paragraph 5.3.2.1. According to the SVU Project Office database administrator for Quality Center, he was directed by SVU Project Office management not to include any test procedures marked N/A when providing summary information to the SVU Project Office on the results of SIT Pass One. The effect of this omission is that inaccurate and incomplete test results for SIT Pass One were reported to key decision makers during the Delta TRR for SIT Pass Two.

We discussed the lack of effective controls over reporting deviations from the Test Plan during testing and the use of N/A with the SVU Project Manager during a meeting on August 23, 2006. We also identified these issues in an e-mail on September 29, 2006. The SVU Project Manager agreed to consider implementing controls over test procedures in future IEMP projects, and the SVU Project Office took action to eliminate the practice of marking test procedures N/A. Specifically, starting with SIT Pass Two (July 28 through September 12, 2006), the SVU Project Manager reported testing deviations and directed the SVU testing managers not to use the N/A status within Quality Center for SIT Pass Two or Three.

**Contingency Plans that Included a Backout Plan Not Developed.** During SIT Pass One, we found that the SVU Project Office had not developed test contingency plans that included a backout plan. NPR 7123.1, Table G-6, states that test contingency plans must be completed and documented before the TRR. Without test contingency plans or a backout plan, key personnel might not know what procedures to follow in the event of unanticipated scenarios or failures—for example, if the SVU experiences a major delay or cancellation. When we notified SVU Project management officials on June 5, 2006, they promptly added a backout plan, incorporated contingency planning into the technical review processes and modified the Competency Center Release 7.1 Cutover Plan to address steps to be taken in the event an issue prevented the SVU from being implemented.

## Defect Management Was Not Adequate

The SVU Project Office did not establish adequate controls for managing defects. NPR 7150.2, paragraph 3.4.5, requires a project office to document defects identified during testing and track closure of defects. “Defect severity level” refers to the importance assigned to a defect found during testing. Test Plan, paragraph 9.1, defines the severity levels of defects:

- Low severity level defect – a noncritical problem that may require a change to be made.
- Medium severity level defect – a materially damaging problem; it requires that a change be made by a requested date.
- High severity level defect – a problem that would materially affect testing, causing an immediate and substantial impact; it requires that a change be made by a specific date.
- Very high severity level defect – a problem that cannot be circumvented, i.e., there is no workaround available, and that impacts the operation of the affected application; it requires that a change be made on an immediate-response basis.

Test Plan, paragraph 9.1, also requires automatically elevating the severity of any defect from high to very high if the defect is not resolved (fixed or closed status) by a “specific date.” According to the Test Plan, test team members were responsible for identifying and documenting test defects and recommending a defect severity level. However, according to the SVU Project Office defect and testing managers, test team members often did not have the necessary expertise to determine appropriate defect severity levels because test team members were functional users. When they encountered a defect, they often rated the defect based on the impact on the function rather than rating the defect based on the impact on continued testing, as required by the Test Plan. In addition, the Test Plan did not include guidance requiring review of the defect severity level after the initial recommendation. Consequently, SVU Project management determined that test team members assigned inappropriate severity levels to defects, and changes in severity levels had to be made afterward. However, the reason for the change in the severity level of a defect was not always recorded.

We reviewed all 1,117 defects identified in Quality Center during the three SIT Passes and found that the severity levels were changed for 147 defects (13.2 percent). However, SVU Project staff adequately documented the reason for the change for only 21 of the 147 defects (14.3 percent).

In addition, the SVU Project Office identified a total of 86 high severity defects—60 during SIT Pass One, 15 during SIT Pass Two, and 11 during SIT Pass Three—none of which were fixed or closed during their respective SIT Passes. Consequently, testing associated with those defects was delayed and the defect was not resolved by a “specific date.” Therefore, the SVU Project Office should have elevated all 86 defects to very high

severity and notified key decision makers but did not do so. For example, on September 22, 2006, we identified defect 1106 as a defect that should have been elevated from high to very high, because the defect was not fixed by the end of SIT Pass Two, and reported to key decision makers. However, the IEM Project Director disagreed with our assessment and did not follow Project guidance established in the Test Plan. Defect 1106 was not fixed during testing. After SVU was implemented, SVU Project management determined that defect 1106 was concealing other software defects. Defect 1106 and the concealed additional software defects resulted in an unusually large number of transaction errors occurring in Travel Manager, which ultimately delayed reimbursement of travel expenses to NASA employees.

The Defect Manager stated that automatic promotion of high severity defects to very high was not done because the entry and exit criteria from the SIT Passes provide equivalent visibility and reporting of both the high and very high defects. While visibility is an important factor in reporting status, prioritizing resources to fix defects is also an important factor associated with defect severity. Although the SVU Project Office reported high and very high severity defects with equivalent visibility, reporting a defect as high severity did not communicate the same level of urgency as properly reporting that defect as very high severity. As SVU Project management reported during the SIT Pass Three Delta TRR, defect levels were often changed after developers had spent time trying to fix them. The lack of strict management of defect severity classification resulted in unresolved software defects that required costly and cumbersome manual workarounds after SVU implementation, or “go-live.”

During a meeting with the SVU Project Manager on August 23, 2006, we stated that it appeared that high and very high severity defect levels were being lowered in order to meet entry and exit criteria outlined in the Test Plan. Test Plan, paragraph 5.2, requires that all high or very high defects be in the “ready to retest” status before beginning SIT Pass Three. The SVU Project Manager agreed that the severity level could be improperly changed to meet entry and exit criteria. Subsequently, the SVU Project Manager presented proposed changes to defect severity levels to key decision makers for approval.

We notified the SVU Project Manager about inadequate defect management in an e-mail on September 29, 2006. The SVU Project Office took action by implementing additional informal procedures to assign and control defect severity levels. Specifically, the SVU Project Office made an informal change in the way defect severity levels were assigned and in who was authorized to change defect severity. The new process required that the tester label the severity level as “TBD” [To Be Determined]. Then, defect managers and test team managers met daily to discuss and assign the severity level for each new defect as well as discuss the status of existing defects. The severity level for each defect discussed was then updated in Quality Center. In addition, the SVU Project Office restricted access to changing the severity level. However, the SVU Project Manager did not agree with our concern about not accurately reporting the number of very high defects to key decision makers. The SVU Project Manager stated that the SVU Project Office reviewed the high and very high defects and reported all those defects during each SIT Pass. The SVU Project Manager did not implement a procedure to automatically elevate

the severity of any defect from high to very high if the defect was not resolved (fixed or closed status) by the “specific date,” as required by paragraph 9.1 of the Test Plan.

## **Testing Was Not Completed Before the ORR**

**Regression Testing Not Successfully Completed.** The SVU Project Office did not complete a successful regression test. IEEE Standard 610.12-1990, “IEEE Standard Glossary of Software Engineering Terminology,” September 28, 1990, defines regression testing as selective retesting of a system to verify that modifications have not caused unintended effects and that the system still complies with its specified requirements. Regression testing is used to reevaluate software requirements and software design issues whenever any significant code changes are made.

According to Test Plan, paragraph 5.1, SIT Pass Three was intended to be a regression test for previously identified defects. Test Plan, paragraph 5.2, contains entry criteria for SIT Pass Three testing requiring that, “Open defects in very high or high severity should be in ‘Ready to Retest’ status.” Test Plan, paragraph 5.6, contains exit criteria for SIT Pass Two and SIT Pass Three that requires that all test procedures be executed. However, the SVU Project Office did not complete 57 test procedures during SIT Pass Two and 32 test procedures during SIT Pass Three. Therefore, the exit criteria for SIT Pass Two and SIT Pass Three was not met.

In addition, according to the “Test Analysis Report (Revision A),” dated October 2, 2006, on September 11, 2006, after the end of SIT Pass Two and before the start of SIT Pass Three, the status of the testing of the 7,361 Level V requirements in Quality Center was as follows:

- Fifty-one (51) requirements were not covered by test procedures.
- Test procedures for 492 requirements were not run.
- Test procedures for 4,897 requirements were successfully run.
- Test procedures for 921 requirements failed.
- Test procedures for 1,000 requirements were not completed.

During SIT Pass Three, the SVU Project Office identified 182 defects,<sup>14</sup> which included 57 new high and very high severity defects, some of which required software coding changes to correct. Because only 66.5 percent of the Level V requirements had been successfully tested before the start of SIT Pass Three and because at least 49 defects found required code changes to correct, SIT Pass Three could not be considered a successful regression test.

On October 31, 2006, we informed the IEM Program Director that the SVU Project Office had not completed a successful regression test. Specifically, we stated that SIT Pass Three, which ended on October 25, 2006, could not be considered a successful

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<sup>14</sup> These defects include defects fixed or closed before SVU was implemented.

regression test because of the significant number of defects fixed during the SIT Pass. We recommended that the IEM Program Director require the SVU Project Manager to conduct a regression test to verify that the software modifications resulting from fixing the defects during SIT Pass Three did not introduce unintended errors and that the system still complied with its specified requirements.

On November 16, 2006, the Competency Center Director stated that he did not concur with conducting additional SIT Passes, stating that appropriate action had been taken to ensure that the SVU was ready for use and all known risks and issues had been clearly documented and accepted.

**ORR Held Prematurely.** The SVU Project held the ORR on October 11, 2006, even though testing was not complete and some defects were still unresolved. NPR 7123.1, Table G-9, establishes entry criteria for the ORR. Specifically, an ORR should report on the actual system characteristics and procedures used in the system and report whether all system and support hardware, software, personnel, procedures, and user documentation accurately reflect the deployed state of the system. At the time of the ORR, SIT Pass Three was still in progress, 32 test procedures had not been successfully run, and not all of the workarounds needed for go-live had been provided. Those workarounds were not provided until November 16, 2006. Without a successful execution of a valid ORR, key stakeholders might not be aware of or agree with the SVU Project Office's intended defect resolution, operational status, or new processes and procedures to be implemented. Lack of stakeholder awareness of or agreement with defect resolution could result in a lack of user confidence in the updated system and users not being aware of system limitations, operational controls, and/or user workarounds needed to perform required tasks.

Although the SVU Project Office held two Authority to Proceed decision meetings after the ORR, those meetings only presented potential or partial system characteristics. The purpose of the ORR was not fully realized because the SVU never presented an entire view of the system as it was to be implemented. That approach allowed the SVU Project Office more time to correct known defects; however, a presentation of the entire view of all actual system characteristics to be implemented was not accomplished.

On October 31, 2006, we notified the IEM Program Director and SVU Project Manager that the SVU Project Office had not completed testing and had unresolved defects as of October 26, 2006. We recommended that they conduct a second ORR.

The Competency Center Director stated that the SVU Project Manager had presented a complete status of open defects including severity, functionality impacted, business impact, and workaround in the event the defect was not fixed during the ORR. In addition, the team provided the status on a weekly basis leading up to the Authority to Proceed decision meetings on October 25, 2006, and November 10, 2006. The Competency Center Director stated that the Authority to Proceed decision meetings met the intent of the additional ORR that we recommended.

## Independent Assessment Was Not Adequate

The independent assessment (IA)<sup>15</sup> of the SVU was not adequate. IEMP and the Goddard Space Flight Center (Goddard) Independent Verification and Validation (IV&V) Facility entered into a memorandum of agreement (MOA), January 4, 2006, for IA of various systems including the SVU. The MOA, valued at \$480,000,<sup>16</sup> outlined work to be performed and deliverables for the SVU project, the Contract Management Module, e-Travel, and the Aircraft Maintenance Module. However, the contractor hired to conduct the IA (IA contractor) submitted inadequate and incomplete reports to the IV&V Project Manager who, in turn, submitted those reports to the SVU Project Office.

**Requirements Traceability Report Incomplete.** The Requirements Traceability Report, dated May 12, 2006, was not complete because it did not provide a determination of the adequacy of requirements traceability from Levels I through V or whether all requirements were objectively testable, as required by the MOA, paragraph 6. The IA contractor could not complete the requirements traceability analysis or the testability determination because the SVU Project Office did not provide him with the final Level V requirements. The SVU Project Office did not have stable Level V requirements until September 2006. However, the IA contractor did not report the impact of not having the Level V requirements documented before the development of test procedures in the conclusions presented in the Requirements Traceability Report.

What the contractor reported in the Requirements Traceability Report was that the traceability of the Level V requirements would be postponed until the Test Analysis Report was completed. The IA contractor did perform a traceability analysis of the Level I through Level IV requirements. However, the IA contractor only traced each system requirement to one software requirement and each software requirement to one system requirement. The process the IA contractor used did not consider all possible links that requirements could have. Without considering all possible links, the IA contractor could not show that system requirements were completely addressed by the software requirements. In addition, by not having the Level V requirements stabilized before the development of test procedures, there was an increased risk that testing would be inadequate and an increased risk that the SVU Project would not meet schedule milestones. According to "IEMP Independent Assessment Task Plan," February 17, 2006, paragraph 4.3, the IA contractor should have identified the increased risk to testing and the schedule risk in the Requirements Traceability Report, but did not.

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<sup>15</sup> NASA IV&V Facility IVV 09-2 "Independent Assessments," September 2002, paragraphs 3 and 6, state that an IA is an analysis of the software development and products to identify critical software risks that could jeopardize mission safety and success. IAs can range from the analysis of a specific subsystem performed at a specific time during the life cycle to assessments of several segments of the system over the entire life cycle of the development activity. IA includes system level assessments to evaluate specific requirements, testing, and review processes and associated risk management.

<sup>16</sup> IEMP provided \$350,000, and \$130,000 came from the Corporate general and administrative overhead account.



During our initial interview with the SVU Quality Assurance Manager and the IA contractor in September 2006, they stated that they did not determine the adequacy of requirements traceability between levels or whether all requirements were objectively testable. In a later interview in October 2006, the IV&V Project Manager stated that the IA contractor fulfilled the intent of the MOA. However, the documentation provided by the IV&V Project Manager did not support the assertion that the requirements were adequately traced from Levels I through V because the IA contractor only performed a traceability analysis of the Levels I through IV requirements. In addition, the IA contractor could not have determined whether all requirements were objectively testable because 4,065 of the 7,898 Level V requirements (51.5 percent) were either created or modified after the Requirements Traceability Report was issued.

**Test Analysis Report Inadequate.** The Test Analysis Report, dated September 22, 2006, and revised on October 2, 2006, was not adequate because the IA contractor did not conduct sufficient analysis to provide confidence that all appropriate requirements were adequately tested as required by the MOA, paragraph 6. The IA contractor only analyzed a judgmental sample of 10 test procedures out of a total of 4,127 test procedures (0.002 percent) and concluded that “all selected tests appeared to adequately test the specified requirements.”

During interviews in September 2006, the IA contractor stated, he did not determine whether all appropriate requirements were adequately tested and the IV&V Project Manager agreed that the sample taken did not provide adequate confidence that all appropriate requirements were adequately tested. In a later interview in October 2006, the IV&V Project Manager stated that the IA contractor fulfilled the intent of the MOA.

**Management Action on IA Issues.** During the course of our audit, we discussed our findings with the SVU Project Office. In addition, in an e-mail on September 7, 2006, we notified the IEM Program Director that the Requirements Traceability Report was incomplete and that the IA contractor was not planning to perform all analyses needed to produce the Test Analysis Report. We recommended that the SVU Project Office ensure that the IA contractor

- complete the analysis that should have been included in the Requirements Traceability Report—specifically, determine the adequacy of requirements traceability from Levels I through V and whether all requirements were objectively testable; and
- complete the analysis for the Test Analysis Report—specifically, conduct sufficient analysis to provide confidence that all appropriate requirements were adequately tested.

On September 18, 2006, the SVU Project Office responded that

- the IA contractor was including the review of traceability between Levels IV and V requirements in the Test Analysis Report,

- the IA contractor's test plan review was sufficient to ensure that they adequately covered requirements,
- there was "little value for further review to determine objective testability of requirements, since at the current time the project has now entered the final test cycle," and
- a close, proactive working relationship with the IV&V representative provided the greatest value to their efforts.

We agree that little value would have been gained by the IA contractor determining whether requirements were objectively testable in September 2006. (That the IA contractor did not determine objective testability of requirements before the project entered the final test cycle is an example of an IA benefit that was not realized.) However, the review of a judgmental sample of 10 out of a total of 4,127 test procedures could not provide confidence that all appropriate requirements were adequately tested. After reviewing management's response, we reiterated our findings in an e-mail on October 6, 2006, and suggested that the IEM Program Director should verify how much money was paid for work that the IA contractor did not perform and determine whether any of those funds could be recouped. The IEM Program Director did not comment on this suggestion.

## **Software Deficiencies Were Not Fully Identified**

Although the SVU Project Office implemented the SVU on November 20, 2006, Project staff failed to identify, prior to implementation, significant software deficiencies that had to be corrected after the system was implemented. Implementing the system with known software deficiencies increased the risk that as-yet unidentified software defects could impact financial reporting and management's ability to rely on this financial information.

**Travel Manager Interfaces.** The SVU Project Office did not identify software deficiencies concerning Travel Manager and SAP interfaces during testing. Travel Manager interfaces with SAP to record funds used for travel. The interface between Travel Manager and SAP should have been completely tested but was not. The SVU Project Office identified a high severity software defect concerning multiple vendor records in Travel Manager, but that defect was not fixed and retested prior to go-live. By not fixing and retesting that defect during the regression test, the SVU Project Office did not identify additional software deficiencies that resulted in an unusually large number of transaction errors in Travel Manager involving multiple vendor records and causing due dates to occur before the posting date. As a workaround, staff at each Center manually input travel data into SAP. However, payments of travel vouchers were significantly delayed because

- approximately 3,200 travel vouchers failed processing from November through December 2006,

- of the time spent waiting for a software fix prior to making the decision to implement the manual workaround and input the travel data, and
- of additional down-time<sup>17</sup> of SAP interfaces.

On January 18, 2007, the SVU Project Office fixed the interfaces affecting payment of travel vouchers.

**Business Warehouse Testing and Reporting.** The SVU Project Office did not identify software deficiencies involving data integrity issues within Business Warehouse. Business Warehouse is a Web-based application that provides reports using data from the Core Financial system database. Reports from Business Warehouse are used by NASA managers to assess and manage financial resources of NASA programs.

At an SAP industry conference in April 2007, the Competency Center Director stated that NASA had experienced a problem with Business Warehouse. Specifically, “Reliable capabilities available in 4.6C used to link FM [Funds Management] documents to originating documents in other modules (FI [Financial Accounting], MM [Materials Management], etc) were broken in 2005/ECC 6.0 . . . Required extensive effort by NASA to design and implement workaround (deployed 3/25).” The Competency Center Director acknowledged that this issue had a significant reporting impact and that SAP was investigating a long-term solution.

On January 18, 2007, Business Warehouse was not generating accurate reports for funded programs and cost centers.<sup>18</sup> Funded programs capture financial information by project, and cost centers capture financial information by organization. For both funded programs and cost centers, obligations and disbursements were not being reported correctly in Business Warehouse. Without accurate reporting, managers do not have accurate and timely financial information to manage costs. One organization at Goddard used QuickBooks to provide accurate information about their fund balances because they could not obtain needed reports from Business Warehouse. Another organization at Goddard used an Excel spreadsheet to control their accounts payable functions because they said they could not rely on the Payment History Report generated by Business Warehouse.

In February 2007, the SVU Project Office applied a fix and corrected labor and travel reporting in Business Warehouse. In March 2007, the SVU Project Office applied a fix and corrected procurement. However, according to the Competency Center Director, these fixes were temporary workarounds and SAP was still in the process of developing a final solution.

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<sup>17</sup> At the end of the fiscal year, SAP normally shuts down for approximately 2 weeks; however, SVU increased the down time to approximately 4 weeks. In addition, to the 4 weeks of down-time, the SVU interfaces were also shut down from December 12, 2006, through December 19, 2006, because the NASA Office of the Chief Financial Officer wanted to review the appropriation data.

<sup>18</sup> According to the Competency Center Director, this was fixed in March 2007.

**Other Issues.** As of September 2007, the SVU Project Office was still stabilizing the SVU and deploying system patches to resolve issues known before implementation and issues that surfaced after implementation.

- The process for transitioning approximately 9,500 sale orders to the new version of SAP was not completely validated prior to go-live. Center personnel stated that additional corrective actions were scheduled to take place during the third quarter of the fiscal year (FY 2007) to correct the reimbursable data. As of September 5, 2007, sales orders and other accounts receivable issues continued to be problematic. For example, bills with multiple line items were not posting correctly.
- As of July 18, 2007, Goddard, Langley Research Center, and Stennis Space Center could not distribute budget authority due to missing Budget Control System documents.
- Resource managers for one project at Goddard reported that, for several months after go-live they could not readily identify the amount of funds available for their project due to the delayed establishment of FY 2006 and FY 2007 reimbursable orders in SVU. The project's funds reconciliation was not completed until May 2007. As of September 2007, the project's funds were approximately \$328,000 out of balance. The project's resource managers were told by accounting personnel that the funds would remain out of balance because the Core Financial system was unable to adjust the prior year sales order.

**Testing Inadequacies Increased Risk.** By not stabilizing requirements prior to developing test procedures, the SVU Project Office increased the risk that software requirements were not validated during testing and that software and interfaces might not perform as anticipated. By not having policies and procedures to adequately manage defects and corrective actions, the SVU Project Office increased the risk that defect correction resources were inappropriately prioritized, which left performance-critical defects not fixed. Also, by not documenting the testing results and identifying key risk areas, such as deviations from the Test Plan, the SVU Project Office did not always present an accurate status of testing and the risks of implementing the system. Inadequacies of procedures, policies, documentation, and testing increased the risk that as-yet unidentified software defects could impact financial reporting and management's ability to rely on the financial information.

**SAP Escalation Team.** In January 2007, as the number of issues increased and their impact became apparent, the Competency Center Director and the IEM Program Office notified SAP that NASA was having significant problems with the upgrade. On March 15, 2007, SAP deployed an on-site escalation team to the Competency Center with the objective of better understanding NASA's issues and marshaling corporate resources to accelerate the development and delivery of solutions. The SAP Escalation Manager stated that SAP provides mission critical support whenever there are serious problems with serious impacts. According to the SAP escalation team, when they arrived on site at

the Competency Center, they found NASA had major issues with financial reporting and some of the SAP data correction tools. According to the Competency Center Director, the escalation team will continue to operate until NASA and SAP jointly agree that all priority issues have been resolved and that the Core Financial system is stable. As of September 5, 2007, NASA was still trying to stabilize the Core Financial system.

### **Management's Comments on the Finding and Evaluation of Management's Comments**

**Management's Comments on the Finding.** In response to a draft of this report, the IEM Program Director provided comments on various issues discussed in the finding. The IEM Program Director stated the following:

- The SVU implementation occurred on November 15, 2006, for existing funds and November 20, 2006, for FY 2007 funds and that those dates were in accordance with their established plan. The explanation for changes to the SVU implementation date was discussed with the Financial Steering Group as part of the Delta TRR on September 7-8, 2006.
- It is IEMP's standard practice to establish a baseline of test plans and sets as well as steps associated with each test plan prior to SIT. The auditors misinterpreted the SVU Project Manager's statement about not establishing a baseline of test procedures to be executed during each SIT. What she intended to communicate was that testers are encouraged to execute tests beyond the baseline if time permits.
- The project team provided all of the workarounds needed for go-live prior to November 16, 2006, as they were developed in the various reviews and at the Authority to Proceed checkpoints (October 25, 2006, and November 10, 2006).
- The OIG appears to interpret the MOA to require a detailed review of the contents of all test procedures and all Level V requirements, to verify that every test adequately addresses the requirements to which it is linked, and to verify that every Level V requirement is objectively testable. However, the costs of such a review may outweigh the benefits. The intent of the MOA was to leverage IA resources to ensure that the SVU project adhered to IEMP quality assurance processes. The IEM Program Director stated that he never expected the subject matter content of all tests and all requirements to be cross-validated.

**Evaluation of Management's Comments.** In response to the IEM Program Director's comments, we are providing clarification to address each of his concerns.

- Although, the IEM Program Director stated that the November 2006 implementation date was part the established plan, the implementation date in the project timeline presented at the Preliminary Design Review on March 8, 2006,

was October 30, 2006. For full implementation, November 20, 2006, is a more accurate date. Although the system was opened up on November 15, 2006, for existing funds, the users experienced problems processing transactions; therefore, corrections had to be made before the system could be opened to all users. Once the corrections were made and tested, the system was opened for all users on November 20, 2006. During SIT Pass One and SIT Pass Two (June to September 2006), the SVU Project experienced testing failures in migration activities, data validation, and sales orders. Because of those problems and the inability to resolve the issues by the scheduled implementation date, the SVU Project Manager asked the Financial Steering Group for approval to implement alternate solutions that ultimately delayed implementation.

- While it is IEMP's standard practice to establish a baseline of test plans and test sets prior to SIT, this was not done as required by NPR 7123.1. Prior to SIT Pass One, during the Delta TRR in June 2006, the SVU Project Manager informed participants that they did not have all the test plans and sets developed.
- Although the IEM Program Director stated that all of the workarounds were provided to the project teams prior to go-live, at least two Centers said they never received them. Specifically, we met with the SVU transition teams at Marshall Space Flight Center and Ames Research Center on October 27, 2006, and November 14, 2006, respectively. Both teams stated that they had not been provided with the workarounds. During a briefing on November 30, 2006, the SVU Project Manager informed the Financial Steering Group that the Centers were provided the workarounds on November 20, 2006.
- The MOA is specific about the tasks to be performed by the IA contractor. The MOA directs the IA contractor to "Review requirements to provide confidence that requirements exhibit adequate traceability between levels. . . . Review requirements to help ensure that they are objectively testable. . . . Review traceability of requirements from level I through level V." To accomplish that, the MOA requires the IA contractor to review requirements, test plans, test cases, traceability of requirements, and other tasks. The MOA does not require the IA contractor to ensure that the SVU Project adhered to the IEMP quality assurance process. The Competency Center currently has a staff dedicated to that function.

## **Recommendations, Management's Response, and Evaluation of Management's Response**

**Recommendation 1.** The IEM Program Director should require the project manager to stabilize software requirements prior to beginning testing.

**Management's Response.** The IEM Program Director concurred, stating that they have incorporated into their current project efforts a process called Agile Scrum,<sup>19</sup> which is designed to help identify requirements during recurring iterations of design, development, and testing. According to the IEM Program Director, the Competency Center Director is using this process in developing new projects and is tracking the volatility of requirements through the iterations to verify that the approach leads to stable requirements prior to the start of SIT. In addition, Agile Scrum includes full-scale functional testing of the components delivered during each iteration, further helping to validate and lock down requirements.

**Evaluation of Management's Response.** Management's comments are responsive. We will validate implementation of this recommendation when we perform future audits of IEMP projects. We consider this recommendation closed.

**Recommendation 2.** The IEM Program Director should require the project manager to establish a baseline of test procedures to be completed during each SIT before beginning testing.

**Management's Response.** The IEM Program Director concurred, stating that the Competency Center has always made a concerted effort to establish a baseline of test procedures prior to the start of each SIT pass. However, management agreed that schedule pressures had sometimes negatively impacted a team's ability to completely finalize all test procedures in a timely manner. The IEM Program Director also said that the Competency Center will examine its release planning procedures and, in conjunction with the benefits of testing early-and-often afforded by Agile Scrum, work on improving its ability to complete all test procedures and lock down the testing baseline prior to the start of each SIT pass.

**Evaluation of Management's Response.** Management's comments are responsive. We will validate implementation of this recommendation when we perform future audits of IEMP projects. We consider this recommendation closed.

**Recommendation 3.** The IEM Program Director should require the project manager to implement policies and procedures establishing the management, assignment, and change controls of defect severity levels.

**Management's Response.** The IEM Program Director concurred, stating that the Competency Center has taken steps to improve the controls surrounding the management of defect severity levels. Specifically, a new security role was established in Quality Center that permits only specific management personnel to change defect severities. The IEM Program Director stated that the Competency Center is in the process of establishing a set of standard policies to be used for defect severity management.

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<sup>19</sup> Scrum, according to the Competency Center, is a best practices methodology that has frequent intermediate deliveries enabling continuous customer reviews, interactive feedback, and more efficient testing. This methodology is intended to result in a more integrated, customer-focused product with greater overall quality.

**Evaluation of Management's Response.** Management's comments are responsive. We validated the existence of a new security role established in Quality Center. However, this recommendation will remain open until we evaluate the policies to be used for defect severity management.

**Recommendation 4.** The IEM Program Director should require the project manager to report all deviations from test procedures.

**Management's Response.** The IEM Program Director concurred, stating that the Competency Center Director agreed to include any test procedures marked as "Not Applicable" in the test metrics and report on deviations from the test baseline.

**Evaluation of Management's Response.** Management's comments are responsive. We will validate implementation of this recommendation when we perform future audits of IEMP projects. We consider this recommendation closed.

**Recommendation 5.** The IEM Program Director should require the project manager to successfully complete a regression test.

**Management's Response.** The IEM Program Director concurred, stating that the Competency Center Director will establish a baseline of test procedures prior to each SIT pass and will ensure that all procedures have been successfully tested, or ensure that a documented workaround exists for any failed tests, prior to system implementation.

**Evaluation of Management's Response.** Management's comments are responsive. We will validate implementation of this recommendation when we perform future audits of IEMP projects. We consider this recommendation closed.

**Recommendation 6.** The IEM Program Director should require the project manager to not hold the ORR until testing is completed and defects are resolved.

**Management's Response.** The IEM Program Director partially concurred, stating that the Competency Center Director agrees that an ORR should not be held until testing is completed. However, the IEM Program Director does not agree that all defects must be resolved prior to entering the ORR. NPR 7123.1A,<sup>20</sup> establishes entrance criteria for the ORR which specifies that "Test failures and anomalies from validation testing have been resolved and the results incorporated into all supporting and enabling operational products." The IEM Program Director stated that, while the Competency Center Director understands the intent of this statement, particularly with respect to space flight systems, it does not seem feasible or cost effective to force resolution of every individual defect related to an administrative software application prior to conducting the ORR. The IEM Program Director pointed out that the Competency Center utilizes a set of rigorous entrance and exit criteria for each SIT pass and will continue to use this criteria going forward.

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<sup>20</sup> NPR 7123.1A is an update of NPR 7123.1 and was issued on March 26, 2007, after SUV testing was completed. There were no significant changes concerning entry criteria for the ORR.



**Evaluation of Management's Response.** Management's comments are not responsive because they did not agree to comply with the current policy when conducting future IEMP projects. NPR 7123.1A requires that test failures and anomalies be resolved prior to the ORR. However, at a minimum, all high<sup>21</sup> and very high<sup>22</sup> severity defects should be resolved or have documented workarounds that have been successfully tested. We request that the IEM Program Director reconsider his position and provide additional comments in response to this final report.

**Recommendation 7.** The IEM Program Director should require the project manager to ensure that all IA analysis is performed and all IA reports are complete.

**Management's Response.** The IEM Program Director concurred, stating they agree that the IA contractor missed several opportunities to formally document how schedule pressures were impacting SVU requirements stability and increasing risk, although those concerns were verbally communicated to the project team. The IEM Program Director said recent MOA adjustments have shifted the IA analysis more toward the Agile Scrum approach. The IEM Program Director also said that the IA contractor is now formally documenting findings in the IEMP Issues Tracking Database and in the NASA IV&V Issues Tracking System.

**Evaluation of Management's Response.** Management's comments meet the intent of the recommendation. We will validate implementation of this recommendation when we perform future audits of IEMP projects. We consider this recommendation closed.

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<sup>21</sup> A high severity defect is a problem that would materially affect testing, causing an immediate and substantial impact; it requires that a change be made by a specific date.

<sup>22</sup> A very high severity defect is a problem that cannot be circumvented, i.e., there is no workaround available, and that impacts the operation of the affected application; it requires that a change be made on an immediate-response basis.



## Scope and Methodology

We performed the fieldwork at NASA Headquarters, Goddard Space Flight Center, Ames Research Center, and Marshall Space Flight Center. We performed this audit from May 2006 through September 2007 in accordance with generally accepted Government auditing standards. To gain an understanding of NASA's test planning for the SVU, we obtained and reviewed applicable documents including, but not limited to

- NPR 7120.5C, "NASA Program and Project Management Processes and Requirements," March 22, 2005;
- NPR 7123.1, "NASA Systems Engineering Processes and Requirements," March 13, 2006;
- NPR 7150.2, "NASA Software Engineering Requirements," September 27, 2004;
- NASA IV&V Facility IVV 09-1, "Independent Verification and Validation," March 16, 2006;
- Industry standards such as the Institute of Electronic and Electrical Engineers (IEEE) Standard 1012, "IEEE Standard for Software Verification and Validation," June 8, 2005;
- IEMP Release 7.1 System Integration Test Plan, May 18, 2006;
- National Institute of Standards and Technology Special Publication 500-234, "Reference Information for the Software Verification and Validation Process," March 29, 1996; and
- Memorandum of Agreement Between Goddard Space Flight Center IV&V Facility and the IEM Program Management, January 4, 2006.

To determine whether the SVU Project Office prepared adequate test plans, we reviewed the test plans, the performance measures developed by the Project Test Team that establishes criteria used when determining pass or fail of specific tests, requirements documentation, and design documentation. In addition, we met with program and project management personnel.

To determine whether appropriate testing was performed, we reviewed system and software requirements, test procedures, and test results.

To determine whether procedures to address and resolve test failures were established and to ensure all failures were addressed and corrected, we reviewed test procedures and policies for resolution of test failures, reviewed test results, and met with program and project management personnel.

**Use of Computer-Processed Data.** We used data from Quality Center to view the SVU Project's requirements, test plans, and test procedures during the audit. Quality Center basically organizes and stores the testing data. The only time Quality Center manipulates data is when summaries of the testing information are generated. During the audit, we did not use summary information generated by Quality Center. Also, we did not rely solely on the information within Quality Center to draw conclusions.

## **Review of Internal Controls**

We reviewed NASA management controls for determining whether testing for the SVU Project was adequately planned and performed. We identified weaknesses in the testing process as described in the results section of this report.

## **Prior Coverage**

The Government Accountability Office (GAO) and the NASA Office of Inspector General (OIG) have issued reports of particular relevance to the subject of this report. Unrestricted reports can be accessed over the Internet at <http://www.gao.gov> (GAO) and <http://www.hq.nasa.gov/office/oig/hq/audits/reports/FY07/index.html> (NASA). In addition, a private firm has produced a report relevant to this topic.

### Government Accountability Office

“Business Modernization: Some Progress Made Toward Implementing GAO Recommendations Related to NASA’s Integrated Financial Management Program” (GAO-05-799R, September 9, 2005)

“Information Technology Management: Government wide Strategic Planning, Performance Measurement, and Investment Management Can Be Further Improved” (GAO-04-49, January 12, 2004)

“Business Modernization: NASA’s Challenges in Managing Its Integrated Financial Management Program” (GAO-04-255, November 21, 2003)

“Business Modernization: NASA’s Integrated Financial Management Program Does Not Fully Address Agency’s External Reporting Issues” (GAO-04-151, November 21, 2003)

“Business Modernization: Disciplined Processes Needed to Better Manage NASA’s Integrated Financial Management Program” (GAO-04-118, November 21, 2003)

“Information Technology: Architecture Needed to Guide NASA’s Financial Management Modernization” (GAO-04-43, November 21, 2003)

“Business Modernization: Improvements Needed in Management of NASA’s Integrated Financial Management Program” (GAO-03-507, April 30, 2003)

National Aeronautics and Space Administration

“Synopsis of Management Issues Associated with NASA’s Integrated Financial Management Program” (IG-05-020, June 3, 2005)

“Audit of the Implementation of Integrated Financial Management Program (IFMP) Audit Recommendations” (IG-05-008, February 11, 2005)

“NASA’s Travel Module Lacks Management Control Structure and Compliance With Federal Requirements” (IG-04-027, September 24, 2004)

“Integrated Financial Management Program Budget Formulation Module” (IG-04-017, March 30, 2004)

“Integrated Financial Management Program Core Financial Project Information Technology Security Planning and Implementation” (IG-04-016, March 31, 2004)

“Summary Report on Audit of Integrated Financial Management Program Core Financial Module” (IG-03-028, September 29, 2003)

“Integrated Financial Management Program Core Financial Module Conversion to Full Cost Accounting” (IG-03-015, May 30, 2003)

Gartner Research and Consulting

Gartner Research and Consulting, “Core Financial Module Implementation Assessment” (June 15, 2005)

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## ISSUES COMMUNICATED DURING THE AUDIT

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During the audit, we attended key SVU Project meetings including TRRs, the ORR, Authority to Proceed decision meetings, and defect management meetings. For the TRRs and the ORR, the SVU Project Office established testing entry and exit criteria in the Test Plan. Test entry criteria are used to ensure that all necessary components, from detailed planning aspects to environment and technical architecture, are available to support productive, effective test execution. Test exit criteria are used to ensure successful completion of each pass of testing. Throughout the course of the audit, we informed the IEM Program Director, the SVU Project Manager, and the Competency Center Director of 14 issues discussed in this report. Of the 14 issues identified, they agreed or partially agreed with 12 issues and took action on 1 issue and partially took action on 2 issues. The 14 issues and management's actions are provided in the table.

	<b>Date of E-mail</b>	<b>Issue</b>	<b>NASA Response</b>	<b>Action Taken on SVU</b>
1	June 5, 2006	Backout plan not prepared	Agreed	Took Action - The SVU Project Office added backout plan to the existing Competency Center Release 7.1 Cutover Plan.
2	June 5, 2006	Test contingency plans not prepared	Partially agreed	No Action Needed - The SVU Project Office stated they had already defined contingency test plans for areas of highest risk from an integration perspective, outlined a process in the Test Plan that dealt with issues as they occurred during testing, and defined very specific exit criteria for each SIT Pass.
3	June 9, 2006	Test procedures were not adequate and did not trace to project requirements	Agreed	No Action Taken - Although management agreed with our assessment, test procedures were never adequately documented in any of the SIT Passes.
4	June 9, 2006	Test procedures not being reviewed and analyzed prior to TRR	Agreed	No Action Taken - For future projects, they agreed to adjust their standard test plan approach to ensure that test procedures were developed and reviewed before the TRR and planned to consider implementing a process that enabled baselining test procedures and tracking changes that occur after the baseline date.

	<b>Date of E-mail</b>	<b>Issue</b>	<b>NASA Response</b>	<b>Action Taken on SVU</b>
5	June 21, 2006	Entry and exit criteria were not met before conducting Delta TRR for SIT Pass One	Agreed	No Action Taken - Although management stated they executed follow-on actions that addressed our concerns, test procedures were not adequately documented prior to testing and a review of test procedures was not completed.
6	July 26, 2006	Entry and exit criteria were not met before conducting Delta TRR for SIT Pass Two	Agreed	No Action Taken - They relied on the Agency's subject matter experts to document appropriate test procedures, ensure traceability of test procedures to SVU requirements, and provide expert consultation on an ongoing basis to members of their governing bodies so that they may make informed decisions at key decision points, primarily the TRRs.
7	August 7, 2006	Migration of Sales Order Data	Agreed	No Action Taken - Although they established a parallel test environment to test migration of sales order data, the data migration process for migrating sale orders to the new version of SAP was not completely validated.
8	September 7, 2006	IA analysis was incomplete	Partially agreed	No Action Taken - In the future, the IA contractor will use an IEMP issues-tracking system to officially log IA issues and track their progress through closure.
9	October 6, 2006	Follow Up on IA Analysis	Did not agree	No Action Taken - The current MOA specifies that reviews of requirements coverage and test plans be delivered before the start of testing. In addition, they plan to perform structured testing throughout the project life cycle, not just toward the end of the project.
10	September 18, 2006	Entry and exit criteria were not met before conducting TRR for SIT Pass Three	Partially agreed	Partial Action Taken - Although they stated that they would provide explicit risk management documentation for any high severity defect that did not have a workaround, the risk assessment concerning travel manager was not correct. In addition, the Competency Center Director did not agree to test workarounds in SIT Pass Three.

	<b>Date of E-mail</b>	<b>Issue</b>	<b>NASA Response</b>	<b>Action Taken on SVU</b>
11	September 29, 2006	Adequate testing and defect management policies and procedures not developed or implemented	Partially agreed	Partial Action Taken - Although not stated in the response to the issue, the SVU Project Office took partial action on this issue. The response stated, in the future, they are piloting a form of Agile Scrum software development project management called Scrum and creating a Software Development Operations Procedures document.
12	October 18, 2006	ORR was held prematurely	Agreed	No Action Taken - Although the SVU Project Office held two Authority to Proceed decision meetings, a presentation of the entire view of all actual system characteristics to be implemented was not accomplished.
13	October 31, 2006	Regression testing not completed	Did not agree	No Action Taken - Although SVU Project Office's continued testing through November 10, 2006, to close remaining defects, a successful regression test was not accomplished.
14	October 31, 2006	Testing and data migration not complete and effects still unresolved	Agreed	No Action Taken - Although the SVU Project Office held two Authority to Proceed decision meetings, a presentation of the entire view of all actual system characteristics to be implemented was not accomplished.

**1. Backout Plan.** On June 5, 2006, we informed the IEM Program Director that the SVU Project Office had not prepared a backout plan. We recommended that the SVU Project Manager develop a Business Continuity Plan outlining specific procedures to resume operations should the SVU project encounter a major setback. On June 15, 2006, the Competency Center Director concurred with our recommendation and stated that management added a backout plan to the existing Competency Center Release 7.1 Cutover Plan that addressed steps to be taken in the event something occurred during the upgrade that prevented go-live. In addition, the Competency Center Director had created a new 7.1 Cutover Plan that outlined steps to be taken to perform year-end close activities on the current version of the Core Financial system should the contingency option be invoked.

**2. Preparation of Test Contingency Plans.** On June 5, 2006, we informed the IEM Program Director that the SVU Project Office had not prepared test contingency plans. We recommended that the SVU Project Office develop test contingency plans to ensure that risks are identified for each phase of testing and establish procedures to address each risk. The contingency plans should establish the criteria to be used to determine whether the risks identified can be mitigated or sufficiently corrected to allow testing to continue. On June 15, 2006, the Competency Center Director partially agreed, stating that management believed they had already established a sound process that met the intent of



our recommendation. The SVU Project Manager stated management had already defined contingency test plans for areas of highest risk from an integration perspective, outlined a process in the Test Plan that dealt with issues as they occurred during testing, and defined very specific exit criteria for each SIT Pass. However, as noted in the body of this report, the SVU Project Office did not always follow its own exit criteria for each SIT Pass.

**3. Adequacy of Test Procedures.** On June 9, 2006, we informed the IEM Program Director that the SVU test procedures were not adequate and did not trace to project requirements. We recommended that the IEM Program Director require the SVU Project Manager to

- solidify all project requirements and test procedures prior to proceeding into testing,
- adequately develop test procedures and trace them to project requirements prior to entering a test readiness review and prior to actual testing, and
- provide the IA contractor the necessary inputs to conduct a requirements traceability analysis test.

On June 19, 2006, the IEM Program Director agreed, stating that the actions management was taking met the intent of our recommendations. Specifically, they were working to have all low-level design requirements (Level Vs) solidified and test plans created prior to the start of testing on June 26. However, there were still a few remaining items to be worked out in the detailed design of some custom developed objects, as well as in some process areas (e.g., reimbursable); therefore, it may not be realistic to expect zero volatility in the detailed design requirements as SVU moves into SIT Pass One. The IEM Program Director stated that he felt that it was reasonable to proceed into testing because they had clearly defined exit criteria that will help reduce risk as SVU moves from one testing pass to the next. In addition, the IEM Program Director concurred that it was a sound process to have all test plans developed and traced to project requirements prior to entering the TRR. While this may no longer be possible for SVU due to the schedule that has already been established, the IEMP Program will take the action to adjust its standard Test Plan Approach to ensure that it requires test plan development and tracing to requirements to be completed prior to a project's TRR. The IEM Program Director also stated that management was working with the IA contractor to provide all the information needed to conduct the traceability analysis and to verify where SVU was in terms of the test plan coverage for project requirements. Although management agreed with our assessment, test procedures were never adequately documented in any of the SIT Passes. In addition, the Requirements Traceability Report was issued on May 12, 2006, without including the Level V requirements.

**4. Review of Test Steps.** On June 9, 2006, we informed the IEM Program Director that a documented review and analysis of the test procedures was not being performed prior to the TRR. We recommended that functional teams document and submit all test procedures for independent verification and review at least 3 to 5 working days prior to

the TRR. All issues and modifications to the test baseline should be tracked. On June 19, 2006, the IEM Program Director agreed, stating that it is a sound process to have test plans available for review prior to the TRR. Though SVU has been diligent in ensuring that test plans are reviewed, this process was not fully completed prior to TRR. The IEM Program Director agreed that completing the test plans earlier would provide more time to locate testing gaps and correct them prior to the start of a SIT. He stated that they were taking action to adjust their standard test plan approach to ensure that test procedures were developed and reviewed before the TRR for future projects. In addition, they planned to consider implementing a process that enables baselining test procedures for future projects and then tracking changes that occur after the baseline date.

**5. Delta TRR for SIT Pass One.** On June 21, 2006, we informed the IEM Program Director that the SVU Project Office, with input from other key decision makers, decided to proceed with SIT Pass One based on an inadequate Delta TRR, held June 12-13, 2006. Several entrance and exit criteria were not met before and after conducting the TRR. We recommended that the IEM Program Director require the SVU Project Manager to conduct another Delta TRR after meeting the following conditions:

- solidify and conduct a documented review of test procedures to include tracing requirements,
- resolve technical issues surrounding data migration, and
- provide TRR participants with briefing charts, whitepaper status, and access to test procedures, allowing them adequate review time prior to conducting the Delta TRR.

We received a preliminary response from the IEM Program Director on June 21, 2006, requesting that we revise the issue statement to note that the IEM Program Director also received input from a Marshall Space Flight Center-led independent review team. We received another response to the issue statement from the Competency Center Director on June 30, 2006, stating that, although they agreed with the issues identified, action had already been taken to address our concerns; consequently, they did not agree with the recommendation to conduct a follow-up TRR. The Competency Center Director also stated that they had executed follow-on actions that addressed the specific conditions as prerequisites to a Delta TRR. Although management stated they executed follow-on actions that addressed our concerns, test procedures were not adequately documented prior to testing and a review of test procedures never occurred. In addition, some technical issues concerning data migration were not resolved before SVU was implemented.

**6. Delta TRR for SIT Pass Two.** On July 26, 2006, we informed the IEM Program Director that the SVU Project Office, with input from other key decision makers, decided to proceed with SIT Pass Two for the SVU based on an inadequate Pass Two Delta TRR, held on July 19, 2006. Several entrance and exit criteria were not met before or after conducting the TRR. We recommended that the IEM Program Director require the SVU

Project Manager to conduct another Pass Two Delta TRR after meeting the following conditions:

- solidify and conduct a documented review of test procedures to include tracing requirements,
- resolve significant technical issues surrounding data migration, and
- provide TRR participants with briefing charts and access to test procedures, allowing them adequate review time prior to conducting the Delta TRR.

We received management's response on August 9, 2006. The Competency Center Director agreed, stating that Competency Center staff relied on the Agency's subject matter experts to document appropriate test procedures, ensure traceability of test procedures to SVU requirements, and provide expert consultation on an ongoing basis to members of their governing bodies so that they may make informed decisions at key decision points, primarily the TRRs. In addition, the SVU Project Manager stated that Project Office staff would continue to work with SAP to resolve technical issues associated with data migration as they surfaced during testing.

**7. Migration of Sales Order Data.** On August 7, 2006, we informed the IEM Program Director that the SVU Project Manager, with input from other key decision makers, decided to proceed with testing even though established entry and exit criteria concerning data migration were not met. According to the Test Plan, the entry criteria concerning data migration is "Data migration programs scheduled for execution have been unit tested in a test environment," and the exit criteria is "Data migration has successfully executed and been validated according to previously documented validation and reconciliation procedures."

Prior to the Delta TRR on June 12, 2006 the SVU Project Office contracted with a SAP programming expert to assess and correct issues with the special ledger and sales orders accounts. During the SIT Pass One Delta TRR on June 12, 2006, the SVU Project Office reported the special ledger and sales orders accounts did not migrate successfully during unit testing. During the SIT Pass Two Delta TRR on July 18, 2006, the SVU Project Office reported that significant issues surrounding the special ledger accounts were corrected. However, issues with migrating sales orders were not addressed and a new method for migrating the sales orders needed to be developed. The custom developed program to migrate sales orders was expected to be ready on or about September 20, 2006. The program will not be ready for testing until the end of SIT Pass Three. We recommended that the IEM Program Director direct the SVU Project Manager to resolve significant technical issues surrounding migration of sales order data before continuing with testing.

We received management's response on August 22, 2006. The Competency Center Director did not clearly specify whether he agreed with our recommendations. The Competency Center Director stated that Competency Center staff did not fully understand

the issues surrounding the migration of sales order data until just prior to the SIT Pass Two Delta TRR held on July 19, 2006. At that review, SVU Project Office management presented several possible solutions and a recommendation to the Financial Steering Group, and later to the Financial Executive Round Table, for consideration. These key decision makers agreed that SIT Pass Two should proceed as planned but that a parallel test environment was needed to validate the solution endorsed by the governing bodies and then implement the solution into the testing environment for SIT Pass Three. While the decision was made on July 19, 2006, to continue with testing, SVU Project Office management stated that the parallel approach to resolving open issues involving migration of sales order data and the progress made addressed our recommendation without taking a serial approach that would cause critical delays in overall testing.

**8. IA Analysis.** On September 7, 2006, we informed the IEM Program Director that the IA contractor was not planning to perform all agreed-to analysis. In addition, issues that the IA contractor identified did not receive high visibility from the SVU Project Office. We recommended that the NASA IV&V Facility Project Manager for IEMP require the IA contractor for the SVU to conduct a statistical sample of requirements to ensure that the requirements were objectively testable (and include testing results in a formal report) and adequately tested (and include testing results in a formal report) and also develop, in coordination with the SVU Project Manager, a method to formally report and resolve IV&V issues.

We received management's response on September 18, 2006. The Competency Center Director partially agreed with our recommendations, stating that

- the IA contractor was including the review of traceability between Levels IV and V requirements in the Test Analysis Report due on September 22, 2006;
- the IA contractor's test plan review was sufficient to ensure that they adequately covered requirements;
- there was "little value for further review to determine objective testability of requirements, since at the current time the project has now entered the final test cycle"; and
- a close, proactive working relationship with the IV&V representative provided the greatest value to their efforts.

The Competency Center Director also stated that, in the future, the IV&V contractor will use an IEMP issues-tracking system to officially log IA issues and track their progress through closure. After reviewing management's response, we reiterated our concerns in an e-mail on October 6, 2006, and suggested that the IEM Program Director verify how much money was paid for work that the IA contractor did not perform and determine whether any of those funds could be recouped.

**9. Follow-Up on IA Analysis.** On October 6, 2006, we informed the IEM Program Director that the IA contractor did not complete or report on agreed-to tasks in support of key deliverables and did not identify SVU Project Office test planning weaknesses. We recommended that the IEM Program Director verify how much money was paid for work that the IA contractor did not perform and determine whether any of those funds could be recouped. We also recommended that the NASA IV&V Facility Director conduct a review of all IEMP projects to determine whether policies and procedures were being implemented and followed to ensure the independence of the work being performed by IV&V personnel.

We discussed those issues with the IV&V Facility Program Director and IV&V Project Manager during a teleconference on October 19, 2006. On October 23, 2006, the IV&V Facility Project Manager responded directly to the OIG, stating that we should contact the IEM Program Director and confirm whether he believed work was not performed by the IA contractor. The IV&V Facility Project Manager stated that if the IEM Program Director believed that the IA contractor did not perform the required work, then IV&V Facility would pursue recouping the cost. The IEM Program Director did not comment on this issue and has made no effort to recoup costs associated with the IA.

We received management's response on October 23, 2006. The Competency Center Director disagreed with our conclusions and recommendation, stating that the IA contractor noted that on several IEMP projects, the project teams struggle to have all requirements covered prior to the start of SIT and that test plans tend to be less than stable as testing approaches. Based on the IA Team's observations and the Competency Center's own efforts to improve processes, several steps were being taken to address these inherent project challenges. Specifically, the latest MOA between the IEM Program and the NASA IV&V Facility specifies that reviews of requirements coverage and test plans be delivered earlier, prior to the start of testing. With earlier delivery, project teams would have better and more timely insight into whether they are following procedures. In addition, the Competency Center was in the process of attempting to shift toward agile methodologies that will reduce risk by using proven requirements solicitation techniques and by performing structured testing throughout the project life cycle, not just toward the end of the project.

**10. TRR for SIT Pass Three.** On September 18, 2006, we informed the IEM Program Director that SVU Project Office management, with input from key decision makers, decided to proceed with SIT Pass Three for SVU even though the SVU Project Office did not meet established testing entry and exit criteria concerning data migration and open defects. We recommended that the IEM Program Director require the SVU Project Manager to test and document workarounds for unresolved high severity software defects as part of SIT Pass Three, where possible. We also recommended that the IEM Program Director require the SVU Project Manager to provide explicit risk management documentation for any high severity defect that did not have a workaround and include the likelihood and possible impact of the defect on SVU functionality.

We received management's response on October 3, 2006. The Competency Center Director partially agreed, stating that Competency Center staff would provide explicit risk management documentation for any high severity defect that did not have a workaround and include the likelihood and impact of the defect on SVU functionality. However, the Competency Center Director did not agree to test workarounds in SIT Pass Three because he believed the staff had made ongoing efforts to obtain closure for all high severity defects. In addition, the SVU Project Office would be providing a status report for all SVU issues, including explicit risk management documentation for each unresolved defect, during the ORR. The Competency Center Director stated that ORR participants would provide input to SVU Project Office management, IEM Program management, and leaders of the governing bodies to confirm or recommend changes to the original assessment. At the conclusion of the ORR, a decision would be made to either exercise the contingency plan and continue using the current version of SAP or proceed as planned. If the decision was made to proceed, the SVU Project Office would continue its efforts to finalize remaining workaround processes and accompanying procedures in preparation for go-live.

**11. Testing and Defect Management.** On September 29, 2006, we informed the IEM Program Director that the SVU Project Office did not develop or implement adequate testing and defect management policies and procedures. We recommended that the IEM Program Director require the SVU Project Manager to

- develop and document policies and procedures to control the modifications of test procedures;
- document and implement policies and procedures establishing the management, assignment, and change controls of defect severity levels;
- develop procedures to establish specific automatic escalation date of high defects to very high; and
- conduct a review and report those high defects that should have been escalated to very high for visibility purposes.

We received management's response on October 19, 2006. The Competency Center Director did not clearly specify whether he agreed with our recommendations but provided the following information:

In an effort to improve our software implementation processes, the Competency Center is piloting a form of Agile software development project management called Scrum. The Scrum approach advocates short cycles of iterative development, called sprints, during which an integrated team of functional and technical resources works on a pre-determined set of system features. The aim of each sprint, which typically last thirty days, is to deliver a fully tested and working solution. Both unit and full functional tests are executed as part of each sprint.

The major benefit that we see in the Scrum model versus the traditional waterfall approach is that it no longer relies on static requirements that are clearly and

completely defined early in the project lifecycle. In our IEMP projects, we are unlikely to get all the requirements during blueprint, which means that we are always playing catch-up as the project progresses. As a result, once the project plan indicates that it is time to begin the detailed software configuration and/or custom development effort, there is often a realization that detailed requirements had not yet been finalized for all process areas. Work begins on the areas where requirements are more solidified, but is postponed for areas of greater uncertainty. By the time SIT 1 begins, it is not possible to have all test plans completed, because lower level requirements, and/or functionality of the COTS [commercial off the shelf] solution, are still being discovered. The project team makes its best effort to finalize test plans to ensure testing of known functionality during SIT 1 and during subsequent SIT passes. However, as seen with SVU, the team is typically not able to fully complete this task before heading into the testing cycle.

Our intent is to use the Scrum approach to improve our ability to deliver fully tested software that better meets the needs of the user. As part of our pilot effort, we are creating a Software Development Operations Procedures document. This document describes the overall design and development process, the team structure, testing procedures, and periodic reviews.

During the development of our Software Development Operations Procedures document, we will review the policy and procedure recommendations provided by the IG in Recommendations 1 – 3 to determine if they should be included in that document.

In response to recommendation No. 4, the project team has reviewed the high and very high defects that remain open for the SVU project and reported all such defects in detail during the project Operational Readiness Review and will continue to do so at follow-on Authority to Proceed (ATP) checkpoints leading up to go-live.

**12. ORR.** On October 18, 2006, we informed the IEM Program Director that the SVU Project Office held the ORR on October 11, 2006, even though review materials were not supplied in a timely fashion, testing for the SVU was not completed, and test defects were not resolved. We recommended the following:

- The IEM Program Director should require the SVU Project Office to continue testing until all test procedures have been completed and defects have been resolved. The defect resolution should include documented fixes, related system limitations, needed operational controls, and related user workarounds.
- The IEM Program Director should require that the SVU Project Manager conduct, after completing all testing and resolution of all defects, a Delta ORR with the complete set of ORR documentation materials provided to participants sufficiently in advance of that review to allow participants adequate time for preparation.

We received management's response on November 7, 2006. The Competency Center Director agreed, stating that the SVU Project Office continued efforts to resolve and test remaining defects beyond the completion of SIT Pass Three. At the ORR, the team presented a complete status of open defects including severity level, functionality impact, business impact, and workarounds in the event the defect remained open at go-live. The

team continued to provide current status on a weekly basis leading up and subsequent to the first Authority to Proceed checkpoint on October 25, 2006. The Competency Center Director stated that the Authority to Proceed checkpoint met the intent of a Delta ORR. The next and final Authority to Proceed checkpoint prior to go-live would be conducted on November 10, 2006.

**13. Regression Testing.** On October 31, 2006, we informed the IEM Program Director that the SVU Project Office had not completed a successful regression test. Specifically, as of October 30, 2006, the SVU Project Office had identified 58 high or very high severity level new defects during SIT Pass Three, some of which required code changes to correct. According to the Test Plan, SIT Pass Three was to be a regression test for previously identified defects. The significant number of new defects identified and fixed during that Pass indicated that SIT Pass Three was not a successful regression test. We recommended that the IEM Program Director require the SVU Project Manager to conduct a regression test.

We received management's response on November 16, 2006. The Competency Center Director did not concur with our recommendation if our recommendation would require them to conduct, in essence, additional formal passes of testing. The Competency Center Director stated that given the SVU Project Office's follow-on testing activities through the Authority to Proceed review on November 10, 2006, to close remaining defects, management believed appropriate action and diligence had been demonstrated to ensure the delivered system was ready for implementation and all known risks and issues had been clearly documented and accepted.

**14. Testing, Unresolved Defects, and Data Migration.** On October 31, 2006, we informed the IEM Program Director that the SVU Project Office had not completed testing, had defects that had not been resolved, and that data migration was not complete. The SVU Project Office was to provide satisfactory resolution of risks and issues voiced by the Centers, including end-to-end testing of data migration, before it could complete a valid ORR. On October 25, 2006, the SVU Project Office held an Authority to Proceed review. According to the SVU Project Office, the purpose of the Authority to Proceed review was to provide an intermediate project milestone to assess project and environment readiness to proceed, provide an update on open issues from the ORR, review new issues found since the ORR, and assess overall release 7.1 risk. We recommended that the IEM Program Director require the SVU Project Manager to conduct an ORR after completion of all testing and resolution of all defects.

We received management's response on November 15, 2006. The Competency Center Director stated that they concurred with our recommendation, based on the alignment of their efforts with our expectations. The Competency Center Director stated that SVU project management continued to resolve and test remaining defects beyond the completion of SIT Pass Three and that they presented a complete status of open defects including severity, functionality impact, business impact, and workaround at the ORR. In addition, the Competency Center Director stated that the team continued to provide current status on a weekly basis leading up to the first Authority to Proceed review on



October 25, 2006, and the second Authority to Proceed review on November 10, 2006. The Competency Center Director stated that he determined that the Authority to Proceed reviews met the intent of our recommendation to conduct a valid ORR.

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## GLOSSARY

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**Data Conversion.** The Competency Center Director defines data conversion as the initial SAP/Core Financial (4.6C) project activity of converting data from Center legacy financial systems to SAP. This process included the development of load programs to export and transform legacy data to an intermediate format that could be imported into SAP data structures. As part of the data conversion process, the Agency financial community had to make decisions about how much history to convert, appropriate levels of data summarization (as opposed to converting lowest levels of transaction details), etc.

**Data Integrity.** The Competency Center Director stated data integrity refers to the quality of correctness, completeness, wholeness, soundness, and compliance with the intention of the creators of the data. It is achieved by preventing accidental or deliberate but unauthorized insertion, modification, or destruction of data in a database by an end user or the transaction processing software logic. With regard to the SVU project, this term is specifically used in relation to the migration of data from 4.6C to mySAP ERP 2005/ECC 6.0 at go-live as verified by experts within the Chief Financial Officer community and then during stabilization as performance of the new software was monitored to ensure that transactional processing produced the expected data integrity results.

**Data Migration.** The Competency Center Director defines data migration as the process required to move data from SAP 4.6C database table structures to mySAP ERP 2005/ECC 6.0 database table structures. This activity was necessary due to significant structural changes SAP made to its initial Joint Financial Management Improvement Program (now Financial Systems Integration Office) certified version (4.6C) in an effort to improve/expand the capabilities in subsequent versions (4.7 and mySAP ERP 2005/ECC 6.0). In some cases, new data elements were added that did not exist in 4.6C; in other cases the relational table structure was changed to support various improvements in functionality and performance.

**Data Transition.** The Competency Center Director stated that the term data transition was used specifically to describe the activity to close out open sales orders (reimbursables) in 4.6C and re-open them in mySAP ERP 2005/ECC 6.0. It was not a conversion or a migration.

**Defect.** Software defects take different names in different organizations, e.g., errors, issues, bugs, defects, or incidents. Whatever they are called and whatever form they take, defects can have a serious detrimental impact on the development phase and can continue to affect the product through its maintenance phase. Discussions within the software development community consistently recognize that most failures in software products are due to errors in the specifications or requirements.

**Defect Severity Level.** The level of importance assigned to a defect during testing.

**Low Severity Level Defect.** A problem which may require that a change be made. It is not critical to the operation of the application and a date for correction will be negotiated.

**Medium Severity Level Defect.** A problem which requires that a change be made by a requested date. If the change is not implemented by the requested date, the problems caused would not be materially damaging but would cause a serious impact.

**High Severity Level Defect.** A problem which requires that a change be made by a specific date. If the change is not implemented by the specific date, the problem would materially affect testing causing an immediate and substantial impact. Failure to implement the change on the specific date would cause the defect to automatically escalate to very high severity.

**Very High Severity Level Defect.** A problem that cannot be circumvented, i.e., there is no workaround available, and that impacts the operation of the affected application. The problem requires that a change be made on an immediate-response basis.

**Entry Criteria.** Criteria that ensure that all necessary components—from detailed planning aspects to environment and technical architecture—are available to support productive, effective test execution.

**Exit Criteria.** Criteria that ensure successful completion of each Pass of testing and establish the foundation for the next Pass of testing.

**Independent Assessment (IA).** A type of IV&V service provided by the IV&V Facility that includes an analysis of the software development life cycle and/or products, performed to identify critical software risks that could jeopardize mission safety and/or success. IA can range from an analysis of a specific subsystem performed at a specific time during the life cycle to performing assessments of several segments of the system over the entire life cycle of the development activity.

**Independent Verification and Validation (IV&V).** An engagement performed to provide assurances on the verification and validation of a project that is financially, managerially, and technically independent of the project.

**Operational Readiness Review (ORR).** A review intended to provide management with the actual system characteristics and the procedures used in the system or product's operation and ensures that all system and support hardware, software, personnel, procedures, and user documentation accurately reflect the deployed state of the system.

**Quality Center.** An automated tool the SVU Project Office uses to document test procedures including test steps, the expected test results, and actual test results. Quality Center is also used to link system requirements to test procedures.

**Regression Test.** A type of testing used to reevaluate software requirements and software design issues whenever any significant code change is made. Regression testing involves retesting to verify that the modified software still meets its specified requirements. Regression testing is performed when any changes to the product are made during installation to verify that the basic software requirements and software design assumptions affecting other areas of the program have not been violated.

**Requirements Traceability Analysis.** Identifying relationships of system requirements to software requirements for correctness, consistency, completeness, and accuracy.

**Software Requirement.** Specifications that system developers and program managers use to acquire, implement, and test a system.

**System Integration Testing (SIT).** A type of testing that validates that the software correctly implements the software requirements and design as each software component is incrementally integrated with each other.

**System Integration Testing (SIT) Pass.** For the SVU Project, iterations of testing, with each pass conducted independent from the other and within its own system environment.

**System Requirement.** What the system, process, or product/service must do in order to fulfill the business needs and how well it must do it, in terms of performance measurements such as speed, security, or usability.

**Test Plan.** A document that describes the plans for software component level testing, software integration testing, software qualification testing, and system qualification testing of software systems. The plan describes the software test environment to be used for testing, identifies the tests to be performed, and provides schedules for environment, development, and test activities. The plan provides an overview of software testing, test schedules, and test management procedures.

**Test Procedure.** The detailed steps used for testing software during each SIT.

**Test Readiness Review (TRR).** A review that is intended to ensure that the test article (hardware/software), test facility, support personnel, and test procedures are ready for testing and data acquisition, reduction, and control.

**Test Set.** A set of related business events. For SVU, a test set consists of the name of the general area that would be tested during each SIT.

**Test Traceability Analysis.** Identifying relationships in the test plans, requirements, and test procedures for correctness and completeness.

**Unit Test.** Procedure used to validate that individual modules or units of source code are working properly. A unit test is a test for a specific unit. Unit testing will not catch integration errors, performance problems, or any other systemwide issues. In addition, it may not be easy to anticipate all special cases of input the program unit under study may receive in reality. Unit testing is only effective if it is used in conjunction with other software testing activities.

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## MANAGEMENT COMMENTS

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National Aeronautics and  
Space Administration  
**Headquarters**  
Washington, DC 20546-0001



September 14, 2007

Reply to Attn of

Integrated Enterprise Management Program

TO: Assistant Inspector General for Auditing

FROM: Director, Integrated Enterprise Management Program

SUBJECT: Management Response to Office of Inspector General Draft Audit Report entitled "System Integration Testing of the Systems, Applications and Products Version Update Project Needed Improvement". (Assignment No. A-06-017-00)

Thank you for the opportunity to respond to the Draft Audit Report, Assignment A-06-017-00, provided on August 16, 2007. Below is NASA management's response to each of the recommendations set forth in the draft report. This is a consolidated response which includes inputs compiled from various members of the Integrated Enterprise Management Program (IEMP) staff, including the SAP Version Upgrade (SVU) Project Manager, the Director of the IEMP Competency Center (CC) and the IEMP Program Director. In addition, MSFC inputs were coordinated with and reviewed by the MSFC Associate Center Director.

**Recommendations:**

1. **The IEM Program Director should require the project manager to stabilize software requirements prior to beginning testing.**

**MSFC Response:** Concur. Current project efforts are utilizing a process (Agile Scrum) that is designed to help drive out requirements during recurring iterations of design, development, and testing. The IEMP Competency Center is using this process on new projects and is tracking the volatility of requirements through the iterations to verify that the approach leads to stable requirements prior to the start of SIT. The approach also consists of full-scale functional testing of the components delivered during each iteration, further helping to validate and lock down requirements.

2. **The IEM Program Director should require the project manager to establish a baseline of test procedures to be completed during each SIT before beginning testing.**

**MSFC Response:** Concur. The IEMP Competency Center has always made a concerted effort to establish a baseline of test procedures prior to the start of each SIT pass.

However, we agree that schedule pressures have sometimes negatively impacted a team's ability to completely finalize all test procedures in a timely manner. The Competency Center will examine its Release Planning procedures and, in conjunction with the benefits of testing early-and-often afforded by Agile Scrum, work on improving its ability to complete all test procedures and lock down the testing baseline prior to the start of each SIT pass.

**3. The IEM Program Director should require the project manager to implement policies and procedures establishing the management, assignment, and change controls of defect severity levels.**

**MSFC Response:** Concur. The IEMP Competency Center has already taken steps to improve the controls surrounding the management of defect severity levels. A new security role was established in Quality Center (IEMP's testing tool) that permits only specified management to change defect severities. The Competency Center is in the process of establishing a set of standard policies to be used for defect severity management.

**4. The IEM Program Director should require the project manager to report all deviations from test procedures.**

**MSFC Response:** Concur. The IEMP Competency Center agrees to include any test procedures marked as not applicable in the test metrics and report on deviations from the test baseline.

**5. The IEM Program Director should require the project manager to successfully complete a regression test.**

**MSFC Response:** Concur. The IEMP Competency Center will establish a baseline of test procedures prior to each SIT pass and will ensure that all procedures have been successfully tested, or ensure that a documented workaround exists for any failed tests, prior to system deployment.

**6. The IEM Program Director should require the project manager to not hold the ORR until testing is completed and defects are resolved.**

**MSFC Response:** Partially concur. The IEMP Competency Center agrees that an ORR should not be held until testing is completed. We do not agree that all defects must be resolved prior to entering the ORR. NASA Procedural Requirement 7123.1A, "NASA Systems Engineering Processes and Requirements" entrance criteria for the ORR specifies that "Test failures and anomalies from validation testing have been resolved and the results incorporated into all supporting and enabling operational products." While the IEMP Competency Center understands the intent of this statement, particularly with respect to space flight systems, it does not seem feasible or cost effective to force resolution of every individual defect related to an administrative software application prior to conducting the ORR. The IEMP Competency Center utilizes a set of rigorous

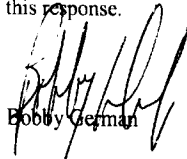
entrance and exit criteria for each SIT pass and will continue to use this criteria going forward.

**7. The IEM Program Director should require the project manager to ensure that all IA analysis is performed and all IA reports are complete.**

**MSFC Response:** Concur. We agree that the IA contractor missed several opportunities to formally document how schedule pressures were impacting SVU requirements stability and increasing risk, though these concerns were verbally communicated to the project team. Recent MOA adjustments have shifted the IA analysis more toward the Agile Scrum approach. Due to its iterative nature, the Scrum process is making the Level V requirements and their traceability available for inspection much earlier in the process. As a result, the IA resource has more of an opportunity to review the requirements, provide comments, and alert the project to schedule or scope risks. This change in process should address the intent of the recommendation, even though the IA work will continue to focus primarily on ensuring adherence to the process and not on subject matter level verification and validation. In addition, the IA contractor is now formally documenting findings in the IEMP Issues Tracking Database and in the NASA IV&V Issues Tracking System.

The enclosure to this response includes additional comments and recommendations regarding the draft audit report.

Please contact me if you have any questions or require additional information regarding this response.



Bobby German

Enclosure

cc:  
Director, Marshall Space Flight Center  
Deputy Director, Integrated Enterprise Management  
Program/Competency Center Manager  
SVU Project Manager  
ALR Representative, Marshall Space Flight Center



Enclosure

Additional NASA comments and recommendations on the OIG Draft Audit Report entitled "System Integration Testing of the Systems, Applications and Products Version Update Project Needed Improvement" (Assignment No. A-06-017-00):

**(1) Page iii, "The Issue" section, last paragraph:**

*"As a result, SVU system implementation was delayed until November 20, 2006, ..."* and

**Page 4, "Introduction/Objectives" section, last paragraph:**

*"As a result, system implementation was delayed until November 20, 2006, ..."*

The conclusion that issues with testing caused the change to the Release 7.1 cutover baseline timeline is inaccurate. We discussed the explanations for changes from the baseline Release 7.1 cutover timeline with project governance as part of the Delta Test Readiness Review September 7-8, 2006, and provided the explanations to the OIG previously on this matter.

**(2) Page iii, "The Issue" section, last paragraph:**

*"As a result, SVU system was delayed until November 20, 2006..."* and

**Page iii "The Issue" section, footnote number 3:**

*"The Core Financial System was available to a limited number of users for limited processing on November 15, 2006, ..."*

SVU implementation occurred on November 15, 2006, for existing funds; November 20, 2006 was the implementation date for new fiscal year funding transactions. The footnote is irrelevant because these dates were part of the planned implementation approach and occurred in accordance with the established plan.

**(3) Page 1, "Introduction/Background" section, third paragraph:**

*"SAP Version Update Project. The IEMP initiated the SAP Version Update in September 2005 to update from ..."*

The benefits listed in the report are not consistent with the benefits in the SVU Scope Document, Revision A, dated April 5, 2006, and should be noted as follows. The SVU Project key benefits include

- improved data integrity based on SAP Funds Management (FM) redesign;
- additional automation of adjustment accounting;
- improved support for the Budget Distribution process;

See page 21, last bullet.

See page 21, last bullet.

See page 21, last bullet.

See page 21, last bullet.

Text was revised in response to this comment (see page 1)

- improved program/project management information for decision making; and
- streamlined Year End processing (starting with FY2007 year end processing).

**(4) Page 2, "Introduction/Background", footnote number 6:**

*"An error, flaw, mistake, failure, or fault in a computer program that prevents..."*

This definition of test defect does not adequately depict the defect categories from an Integrated Enterprise Management Program (IEMP) perspective. The definition described in the report implies we only track computer program errors, while the IEMP tracks many other types of defects/root causes (i.e., user procedures, user errors, requirement changes, security, and environment issues, etc.). The definition, along with the number of defects reflected in the report presents a false assumption that all issues were catastrophic and coding/software in nature.

A definition of "defect" was added (see footnote 9 and page 42).

**(5) Page 9, "The Results" section, third paragraph:**

*"During an August 23, 2006 meeting held with the Competency Center Director and the SVU Manager, the SVU Project Manager stated it was their practice..."*

It is IEMP's standard practice to establish a baseline of test plans and sets prior to System Integration Testing (SIT), as well as steps associated with each test plan. The SVU Project Manager's (PM) statement was intended to communicate that testers are encouraged to execute tests beyond the baseline if time permits.

See page 22, first bullet.

**(6) Page 16, "The Results" section, third paragraph:**

*"ORR Held Prematurely. The SVU Project had the ORR on October 11, 2006, even though testing was not complete and some defects were still unresolved..."*

The report states that "not all of the workarounds needed for go-live had been provided. Those workarounds were not provided until November 16, 2006." The OIG's assertion is not correct, because the project team provided the referenced workarounds prior to November 16, 2006, as they were developed in the various reviews and certainly at the Authority to Proceed checkpoints. The team performed extensive analysis on the impacts of the open items against specific criteria. Perhaps the OIG is referring to the "job aid" or "one pager" that we provided to the Centers that listed all the workarounds. This was an action item intended to assist Change Management with their communications and was not a pre-November 16, 2006, requirement.

See page 22, second bullet.

**(7) Page 17, "The Results" section, fourth paragraph:**

*"What the contractor reported in the Requirements Traceability Report was that the traceability of the Level V requirements would be postponed..." and*

**Page 19, "The Results" section, first full paragraph:**

*"We agree that little value would have been gained by the IA contractor determining whether requirements were objectively testable in September 2006. ..."*

The report states on page 17 that "However, the IA contractor only traced each system requirement to one software requirement and each software requirement to one system requirement. Without considering all possible links, the independent assessment (IA) contractor could not show that system requirements were completely addressed by the software requirements." Additionally, on page 19, the report states "That the IA contractor did not determine objective testability of the requirements before the project entered the final test cycle is an example of an IA benefit that was not realized.)"

The report indicates a wide gap between how the OIG interprets the IA memorandum of agreement (MOA) and how that document is interpreted by the NASA Independent Verification and Validation (IV&V) PM for IEMP, the IEM Program Office, and the IEMP Competency Center Director. We understand the importance and value of the IA and agree that all IA analysis should be performed and all reports should be complete. However, the OIG appears to interpret the IA SVU MOA to require a detailed review of the contents of all test procedures and all Level V requirements; that an in-depth NASA business process and IEMP software application subject matter expertise be applied to verify that every test adequately addresses the requirements to which it is linked; and that every Level V is objectively testable. The amount of funds available for IA associated with IEMP projects is not sufficient to allow for a full IV&V of this type. In a full IV&V process, it might be possible to leverage several NASA business processes and IEMP applications experts to review all test procedures for subject and system accuracy; however, the costs of such a review may outweigh the benefits. The intent of the MOA established for the SVU project was to leverage IA resources to ensure that the SVU project adhered to IEMP quality assurance processes. This includes, but is not limited to, recording requirements traceability for all requirements within the appropriate tool, creating test plans in the appropriate tool sufficient to cover all testable requirements, and following test execution and defect management procedures. We never expected that the subject matter content of all tests and all requirements be cross-validated.

See page 22,  
third bullet.

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SEPTEMBER 28, 2007

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