STATE OF MICHIGAN
System Maintenance Guidebook (SMG)

A Companion to the
Systems Engineering Methodology (SEM) of the
State Unified Information Technology Environment (SUITE)

Michigan Department of Technology, Management & Budget

www.michigan.gov/SUITE

October 2014

Version 1.3

PREFACE

The initial version of the *System Maintenance Guidebook (SMG)* was published in August 2007, and was developed as part of a continuing effort to improve the quality, performance, and productivity of State of Michigan information systems. Development of the SMG was governed by the Michigan *State Unified Information Technology Environment* (SUITE) initiative. This update incorporates the new System Maintenance Document (SEM-0931) and its related processes.

The purpose of SUITE is to standardize methodologies, procedures, training, and tools for project management and systems development lifecycle management throughout the Department of Technology, Management & Budget (DTMB) in order to implement repeatable processes and conduct development activities according to Capability Maturity Model Integrated (CMMI) Level 3 requirements. Any questions regarding the Systems Maintenance Guidebook should be sent to the SUITE Software Engineering Process Group (SEPG) at SUITE@michigan.gov.

REVISION HISTORY

Revision Date	Section(s)	Summary
April 2011	n/a	Initial document release.
October 2014	All	Updates for consistent formatting, references to correct PMM and SEM forms and department name.

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The SMG Development Team owes a large debt to Brenda Coblentz of the U.S. Department of Energy (DOE) for both her encouragement in our efforts and for permitting us the free use of the DOE's own CMMI Level 3 compliant SEM – Chapter 10 as a basis for this document. In particular, much of this document draws directly from the DOE's Systems Engineering Methodology, which as of this writing can be found at (http://energy.gov/sites/prod/files/cioprod/documents/SEM3_1231.pdf).

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EXHIBITS

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CHAPTER 1.0 - INTRODUCTION

Description

The *System Maintenance Guidebook* (SMG) is a set of iterative processes for conducting system maintenance activities. Maintenance practice areas and their subordinate processes prescribe a minimal set of criteria that are necessary for project management and quality assurance processes, control, and management of the planning, execution, and documentation of system maintenance activities.

The use of automated tools to facilitate requirements definition, design, coding, and system documentation is encouraged. The correct selection and implementation of tools varies among the various State of Department of Technology, Management & Budget (DTMB) sites and component organizations, and should be coordinated through the DTMB Enterprise Architecture Solution Assessment process.

The State of Michigan has a consistent Project Management Methodology (PMM) in place which can be used for all types of projects. The State has also implemented a consistent Systems Engineering Methodology (SEM) for all system development efforts.

The SMG is a companion to both the PMM and SUITE. Using these methodologies, staff can move comfortably from applications development, to infrastructure roll out, to software selection to even relocating to new buildings using the same approach throughout the organization.

Significant input for the SMG was obtained from information management programs throughout the country. The SMG integrates State of Michigan and industry best practices and focuses on the quality of system maintenance processes and the work products generated from the processes.

The SMG is derived from the principles and standards advocated by information management industry leaders, such as the Institute of Electrical and Electronics Engineers (IEEE), the Carnegie Mellon University Software Engineering Institute (SEI), the Software Engineering Book of Knowledge (SWEBOK), and the Department of Energy (DOE). ***This methodology is designed to enable State of Michigan project teams to institute and maintain Level 3 maturity on the SEI Capability Maturity Model Integrated (CMMI) process improvement approach.***

The SMG promotes the belief that the result of maintenance is system reliability and the preservation and/or prolonging the life of system assets. The SMG process model does not presume the use of any particular information systems development strategy (e.g., waterfall, spiral). This process is valid regardless of size, complexity, and criticality of the application being maintained.

Project Management

To the extent possible, all maintenance and operations activities should be managed as a project to gain the benefits inherent in project management and to enable tracking of activities and costs. The extent of project management activity will vary, and should be tailored according to the size, complexity, and impact of the change or enhancement.

The State of Michigan has added a System Maintenance process and template to the SUITE methodology in

addition to the existing Systems Engineering Methodology (SEM) and SEM Express Methodology. Most system maintenance projects are typically smaller in size and will follow the system maintenance methodology. Projects with a larger effort would follow the full SEM or SEM Express. The following guidelines are meant to help DTMB staff determine which process to use and therefore which amount of project documentation and management is required:

Project Size (Effort)	Methodology to Use
0 – 200 hours	System Maintenance Document
201 – 1000 hours	SEM Express
1001 hours or larger	Full SEM

The above guidelines align with the methodology usage guidelines that are defined in the Project Management Methodology (PMM) document, Chapter 1, pages 1-31 through 1-33.

The following sections provide additional information about the SMG:

1.1 Background
1.2 System Maintenance Definition and Categories
1.3 System Maintenance Effort
1.4 Call for Projects

Bibliography

The following materials and web sites were referenced in the original preparation of this guide.

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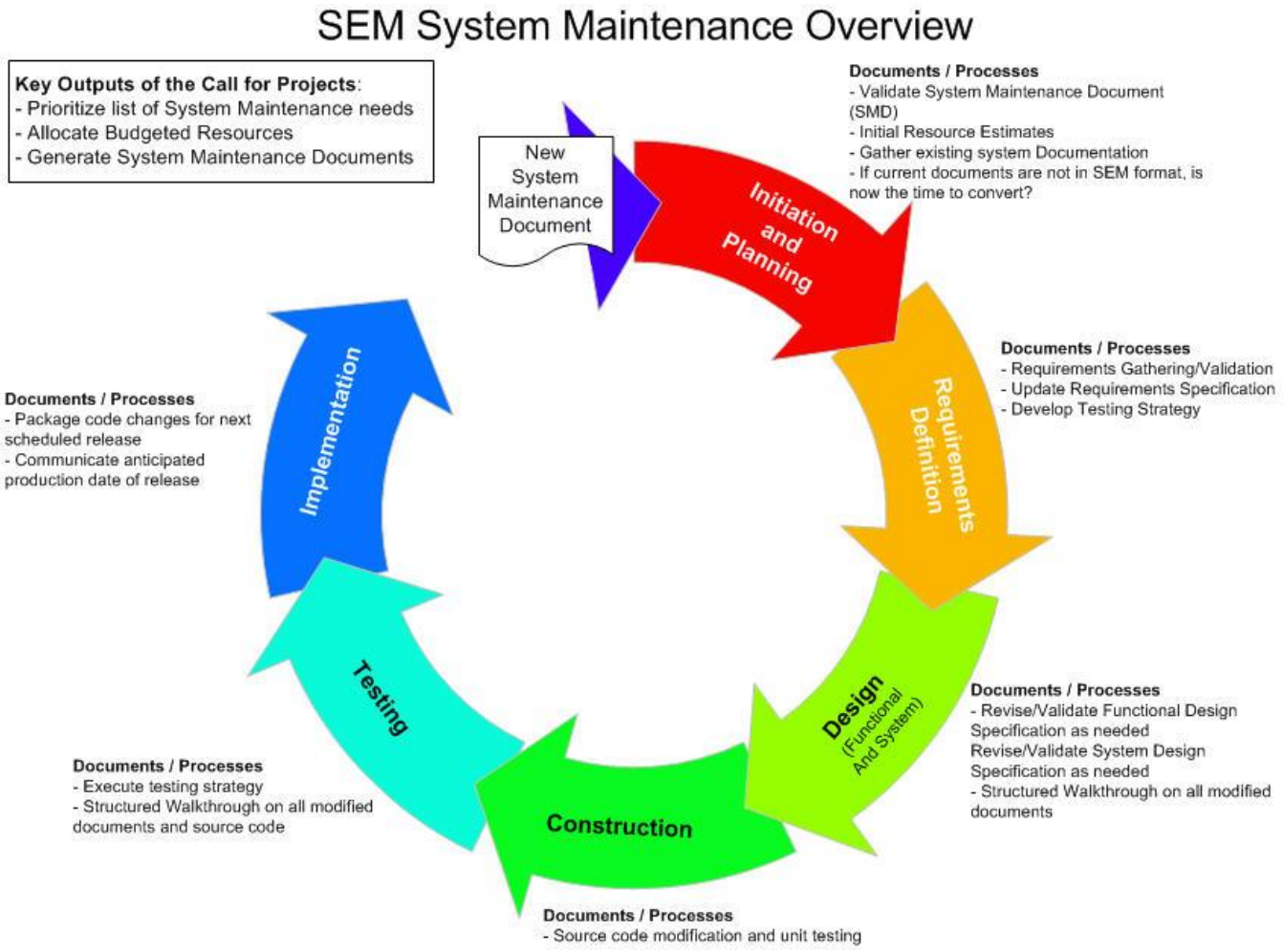
Exhibit 1.0-1 SEM System Maintenance Overview



1.1 Background

Description

Software maintenance is an integral part of any systems engineering lifecycle. In the past, however, it has not received the same degree of attention as the other lifecycle stages. Historically, systems development has had a much higher profile than systems maintenance in most organizations. This is now changing, as organizations strive to squeeze the most out of their systems development investments by keeping software systems operating as long as possible. Concerns about the Year 2000 rollover focused significant attention on the maintenance phase, and the Open Source paradigm has brought further attention to the issue of maintaining software artifacts developed by others.

Broadly speaking, systems maintenance is the totality of activities required to provide cost-effective support to systems. Activities that lay the ground work for system maintenance are performed during all stages of the DTMB Systems Engineering Methodology (SEM).

Maintenance is needed to ensure that the system continues to satisfy user requirements. Maintenance is applicable to systems developed using any systems engineering methodology (e.g., waterfall). Maintenance must be performed in order to:

- Correct faults
- Improve the design
- Adapt systems so that different hardware, software, system features, and telecommunications facilities can be used
- Improve performance
- Maintain operational status

1.2 System Maintenance Definition and Categories

Maintenance Definition

The Institute of Electrical and Electronics Engineers (IEEE) definition of software maintenance states that:

"Software maintenance is the process of supporting a software product or system after implementation to maintain operational status, correct faults, improve performance or other attributes, or adapt to a changed environment."

This definition reflects the historic common view that software maintenance is a post-implementation activity: it starts when a system is released to the client or user and encompasses all activities that keep the system operational and meet the user's needs. This view is well summarized by the classic waterfall models of the systems engineering methodology, which generally comprise a final phase of maintenance and operations.

It is essential, however, to adopt a lifecycle approach to managing and changing software systems, one which looks at all aspects of the development process with an eye toward maintenance. Thomas M. Pigoski, founder and CEO of TechSoft and member of the IEEE panel for development of a single software maintenance standard, captures the need to begin maintenance when development begins in a new, more inclusive definition:

"Software maintenance is the totality of activities required to provide cost-effective support to a software system. Activities are performed during the pre-delivery stage as well as the post-delivery stage. Pre-delivery activities include planning for post-delivery operations, supportability, and logistics determination. Post-delivery activities include software modification, training, and operating a help desk."

This definition is consistent with the approach to systems taken by the International Organization for Standardization (ISO) in its standard on software life cycle processes. It definitively dispels the image that systems maintenance is all about fixing defects or mistakes. It is also consistent with the DTMB *System Engineering Methodology* (SEM) which introduces maintenance in the Initiation and Planning Stage (Chapter 3, Activity 3.2).

The maintenance of software systems is motivated by a number of factors:

- To provide continuity of service: This entails fixing defects, recovering from failures, and accommodating changes in the operating system and hardware.
- To support mandatory upgrades: These are usually caused by changes in government regulations, and also by attempts of vendors to maintain a competitive edge of rival products. These are not to be mistaken for enhancements.
- To support user requests for certain improvements: An example would be performance tuning.
- To facilitate maintenance work: This usually involves code and database restructuring and updating documentation.

Maintenance Categories

Maintenance involves activities or costs associated with the ongoing upkeep of the application. Maintenance

includes all break/fix requests, optimizing the application, operational support and change management for all requirements identified by DTMB personnel. **Major adaptive changes (e.g. addition of costly new user requirements or porting the system to a new platform) should be carried out as separate new development projects using the SEM.**

Types of maintenance are:

- **Emergency Maintenance (break/fix)**: Unscheduled corrective maintenance. While not specifically addressed in the SMG, emergency maintenance is classified into two categories:
    - Production Issues: Issues that stop business operations and must be corrected ASAP. They are performed outside the SMG Release Management process (see Chapter 2 of this guidebook) and involve greater risk due to reduced levels of quality assurance and testing.
    - Urgent Issues: Issues that do not stop business operations, but have a significant impact on them. These issues are corrected on an accelerated basis, using standard SMG processes but outside the Release Management process.
- **Corrective Maintenance**: Identify and remove non-break/fix defects; correct actual errors. These issues are identified and processed according to the SMG and specific system governance in place. They are grouped into planned, scheduled maintenance releases by priority status. Inclusion in the release is determined first by the priority set by the business and secondly by DTMB analysis of resource requirements and dependencies. These are prioritized into two (2) categories:
    - Important: Issues that are identified within the standard governance process, but which are deemed important. Generally speaking, these issues will be resolved in the earliest scheduled maintenance release possible
    - Routine: Issues that are routinely identified and prioritized by the client. These issues then flow into the Release Management process.
- **Perfective Maintenance**: Improves the system without changing its functionality; improves performance, dependability, and maintainability, safety, reliability, efficiency or cost-effectiveness of operation.
- **Adaptive Maintenance**: Modifies the system to keep it up to date with its environment; adapt to a new/upgraded environment by providing new functionality to address requirements that crop up due to changes in the environment (hardware, interfaces, operating system, middleware) or new regulations that impact client operations.
- **Preventive Maintenance**: Identifies and detects latent faults. Changes to the existing system so as to reduce the risk of failure while operating. Preventive maintenance is not specifically addressed in this guide.

1.3 System Maintenance Effort

Costs

Understanding the ***categories*** of system maintenance helps to understand the structure of systems maintenance effort. Also, understanding the ***factors*** that influence the maintainability of a system can help to manage available system maintenance resources.

The current industry standard distribution of maintenance effort across the four system maintenance categories is as follows:

Corrective (approx. 21%)

- 12% emergency
- 9% routine

Adaptive (approx. 25%)

- 18% data environment adaptation
- 7% changes to hardware or operating system

Perfective (approx. 50%)

- 41% enhancements for users
- 6% improve documentation
- 3% other

Preventive (approx. 4%)

- 4% improve code efficiency

System maintenance consumes a major share of system lifecycle financial resources. A common perception of system maintenance is that it merely fixes faults. However, studies and surveys over the years have indicated that almost 80% of the system maintenance effort is used for non-corrective actions. One researcher describes the way in which system maintenance managers often group enhancements and corrections together in their management reports. This inclusion of enhancement requests with problem reports contributes to some of the misconceptions regarding the high cost of corrections.

Factors

Some of the technical and non-technical factors affecting system maintenance efforts are:

- Application type

- System novelty
- System maintenance staff availability
- System life span
- Hardware characteristics
- Quality of system design, construction, documentation and testing

As already noted, many system maintenance activities are similar to those of systems engineering. System maintenance staff performs analysis, design, coding, testing and documentation. They must track requirements in their activities just as is done in development, and update documentation as baselines change.

System maintenance staff may also perform supporting activities, such as system maintenance planning, system configuration management, verification and validation, system quality assurance reviews, audits and user training.

1.4 Call for Projects

Process

Call for Projects (quarterly, semi-annually or annually, including maintenance)

Responsibility

Client Services Director or equivalent, System Maintenance Team

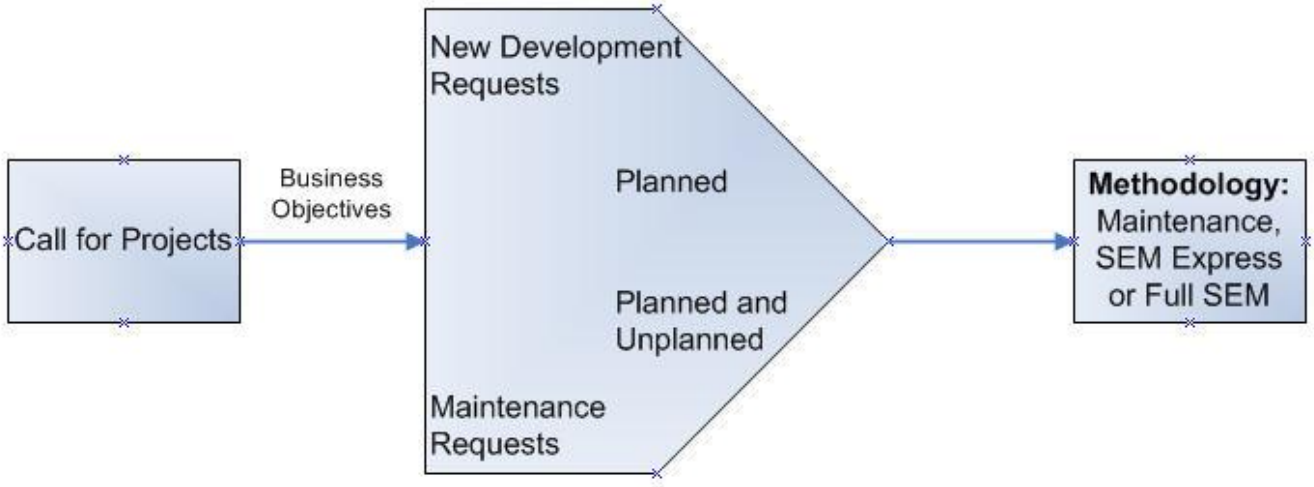
Description

The Client Services Director (CSD) along with the appropriate system managers and client representatives update strategic plans and identify system engineering business objectives to be addressed in the next fiscal year or portion thereof.

During the Call for Projects, business objectives are identified, categorized, and assigned an initial priority ranking. Each objective is evaluated to determine its classification and handling priority. Maintenance objectives should be identified according to the maintenance types identified in Section 1.2 – *System Maintenance Definition and Categories*. The factors discussed in Section 1.2 should be considered when assigning a priority to system maintenance requests.

The CSD will develop the Maintenance and Operations Strategy (MOS), the Resource Plan and Budget Estimate. These documents will be delivered to the client for review and approval.

Exhibit 1.4-1 Call for Projects Process Flow



Input

Input to the Call for Projects is one or more business objectives.

Process

If a modification to a system is required, the following activities must occur within the call for projects process:

- Assign an identification number
- Categorize the type of maintenance
- Analyze the modification to determine whether to accept, reject, or further evaluate
- Prioritize the modification according to the following categories:
    - Mandatory (e.g., legal, safety, payroll)
    - Standard: Issues identified that can be placed into the standard Release Schedule. These have 2 priorities:
- Important: Has associated benefits; e.g., productivity gains, new business drivers
- Routine: Nice to have (lower priority)

Control

Business Objectives and process determinations are uniquely identified.

Outputs

The outputs of the Call for Projects are listed below:

- Business Objectives Document (quarterly, semi-annually or annually)
- Initial requirements list
- Initial prioritization and categorization
- Verification data (for corrective modifications)
- Maintenance and Operations Strategy (quarterly, semi-annually or annually)
- Resource Plan (quarterly, semi-annually or annually)
- Budget Estimate (quarterly, semi-annually or annually)

CHAPTER 2.0 - SYSTEM MAINTENANCE

Description

The basic maintenance process model includes input, process, output, and control. It is based on the same information systems engineering principles and preferred practices that lower risk and improve quality, as described in the SEM. The Systems Maintenance Guidebook (SMG) process model is founded on the concept that planned changes should be grouped and packaged into scheduled releases that can be managed as individual projects. This proven approach allows the maintenance team to better plan, optimize the use of resources, take advantage of economies of scale, and better control outcome in terms of both schedule and product quality.

Each organization performing system maintenance activities should have a local documented procedure for handling emergency changes that cannot be implemented as part of a scheduled release. Generally, these changes include fixes to correct defects and updates to meet unscheduled business or legal requirements. **For purposes of software configuration management, emergency changes should also be integrated into the next release for full regression testing and documentation updates.**

System Maintenance Document (SEM-0931)

The System Maintenance Document (SEM-0931) is a standard SUITE template for documenting and processing application change requests and break fixes. Please refer to section 2.7 for more details.

Stages

The activities performed during maintenance are grouped into logically related segments of work called "stages." The maintenance stages follow the same model as a common Software Development Life Cycle, and are consistent with the SEM Express and full SEM stages. The remainder of this guidebook tailors system maintenance activities as depicted in the SEM-0931. The stages are presented in the sections listed below.

- 2.1 Initiation and Planning
- 2.2 Requirements Definition
- 2.3 Design
- 2.4 Construction
- 2.5 Testing
- 2.6 Implementation

A matrix depicting the maintenance process model is provided in *Exhibit 2.0-1, Process Model for Maintenance.*

Project Management

To the extent possible, all maintenance activity should be managed as a project to gain the benefits inherent in project management and to enable tracking of activities and costs.

Touch Points

In the event any of the following areas within DTMB need to be involved in system maintenance efforts, it may be necessary to follow portions of the SEM Express or SEM methodology:

- Enterprise Architecture (EA)
- Office of Enterprise Security (OES)
- DTMB Contracts and Procurement
- Infrastructure Services
- E-Michigan

Refer to the respective stages in the full SEM for additional guidance for interaction with these other entities.

Structured Walkthrough (SWT) Review Process

For small maintenance projects, the SWT processes built into the SEM-0931 are sufficient. For those projects in the medium to large categories, the SWT processes established by the SEM should be used.

In each stage (see *Exhibit 2.0-1, Process Model for Maintenance*), one or more structured walkthroughs are conducted to validate work products. The Structured Walkthrough (SWT) is a more formal review and is prescribed by the System Maintenance Document (SEM-0931) for specific project deliverables. SWTs are used to find and remove errors from work products early and efficiently, and to develop a better understanding of defects that might be prevented. They are very effective in identifying design flaws, errors in analysis or requirements definition, and validating the accuracy and completeness of deliverable work products.

SWT's typically require some advance planning activities, a formal procedure for collecting comments, specific roles and responsibilities for participants, and have prescribed follow-up action and reporting procedures. Frequently reviewers include people outside of the developer's immediate peer group.

Responsibility:
Project Manager

Work Products:
The SWT Meeting Record form (SEM-0187) is available to record the walkthrough session and to capture the findings and defect counts. Upon completion, a copy of the SEM-0187 should be placed in the Project file.

The State of Michigan guidance document titled *Structured Walkthrough Process Guide* provides a procedure and forms that can be used for SWTs. This document is available on the DTMB SUITE website. (http://www.michigan.gov/suite)

Stage Exit Review Process

Formal Stage Exit Review meetings are not required, but formal business approval is required and handled using

the authorization touch points in the SEM-0931.

Metrics

Metrics/measures and associated factors should be collected and reviewed at appropriate intervals. Refer to the "Measurement and Analysis Process Manual" for further details regarding metrics.

Exhibit 2.0-1 Process Model for Maintenance

	Initiation and Planning	Requirements Definition	Design	Construction	Testing	Implementation
Input	• System Maintenance Document (SEM-0931)	• Project/system document • Project file information • Validated SEM-0931	• Project/system document • Existing source code • Database(s) • Analysis stage output	• Current source code • Product/system document • Results of design stage	• Update documentation • Test Readiness Review Report • Integrated system • Acceptance test: Plans, Cases, Procedures • Updated system • Project / Maintenance Plan	• Tested/accepted baselined system
Process	• Assign change number • Assign change number • Categorize • Accept or reject change • Preliminary effort estimate	• Detailed analysis • Re-document, if needed	• Revise: Requirements System doc. Module doc Project plan • Create test cases	• Code • Unit test • Test Readiness Review • Revisit project risk	• Functional test • Interface testing • Interoperability test • Regression testing • Test Readiness Review • User Acceptance Test (UAT) • Functional Configuration Audit (FCA)	• Physical Configuration Audit (PCA) • Install • Training • User notification • Archival system for backup
Output	• Validated SEM-0931 process determinations	• Detailed analysis report • Updated: Requirements Modification list Test strategy Project plan	• Revised: Modification list Detailed analysis • Updated: Design baseline Test plans Project plan Constraints/risks	• Updated: Design documents Test documents User documents Training materials Project plan Statement of risk Test readiness review report	• Tested system • Test reports • New system baseline • Updated project plan • Test Readiness review report • FCA report	• PCA report • Version Description Document (VDD)
Review Assurance Approve	• Structured Walkthrough(s)	• Structured Walkthrough(s)	• Structured Walkthrough(s)	• Structured Walkthrough(s)	• Structured Walkthrough(s)	• Structured Walkthrough(s)
Metrics	*See Measurement and Analysis Guidebook for Maintenance metrics*					

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2.1 Initiation and Planning Stage

Responsibility

System Maintenance Team

Description

In this stage, product changes are identified, categorized, and assigned an initial priority ranking by the client. Each request for a modification (i.e., SEM-0931) is evaluated by DTMB to determine its classification and evaluated by the client to determine its handling priority. The classification should be identified from the following types of maintenance.

- Emergency - Unscheduled corrective maintenance required to keep a system operational.
- Corrective - Change to a product after implementation to correct defects.
- Adaptive - Change to a product after implementation to keep it functioning properly in a changed or changing environment.
- Perfective - Change to a product after implementation to improve performance or maintainability.

The need for modifications can be driven by any number of factors, including:

- Report of system malfunction.
- Operational system upgrades and new versions of resident software (e.g., COBOL, Oracle, .Net).

These factors should be considered when assigning a priority to the SEM-0931. *Exhibit 2.1-1 Initiation and Planning Stage* summarizes the input, process, control, and output for the Initiation and Planning Stage of maintenance.

Input

Input to the Initiation and Planning Stage of maintenance is one or more SEM-0931s.

Process

If a modification to the product is required, the following activities must occur within the maintenance process.

- Assign an identification number
- Categorize the type of maintenance
- Analyze the modification to determine whether to accept, reject, or further evaluate
- Prioritize the modification according to the following categories:
    - Emergency (follow emergency change procedure and integrate into the next scheduled release

or block of modifications)

- Mandatory (e.g., legal, safety, payroll)
- Required (has associated benefits; e.g., productivity gains, new business drivers)
- Nice to have (lower priority)

Outputs

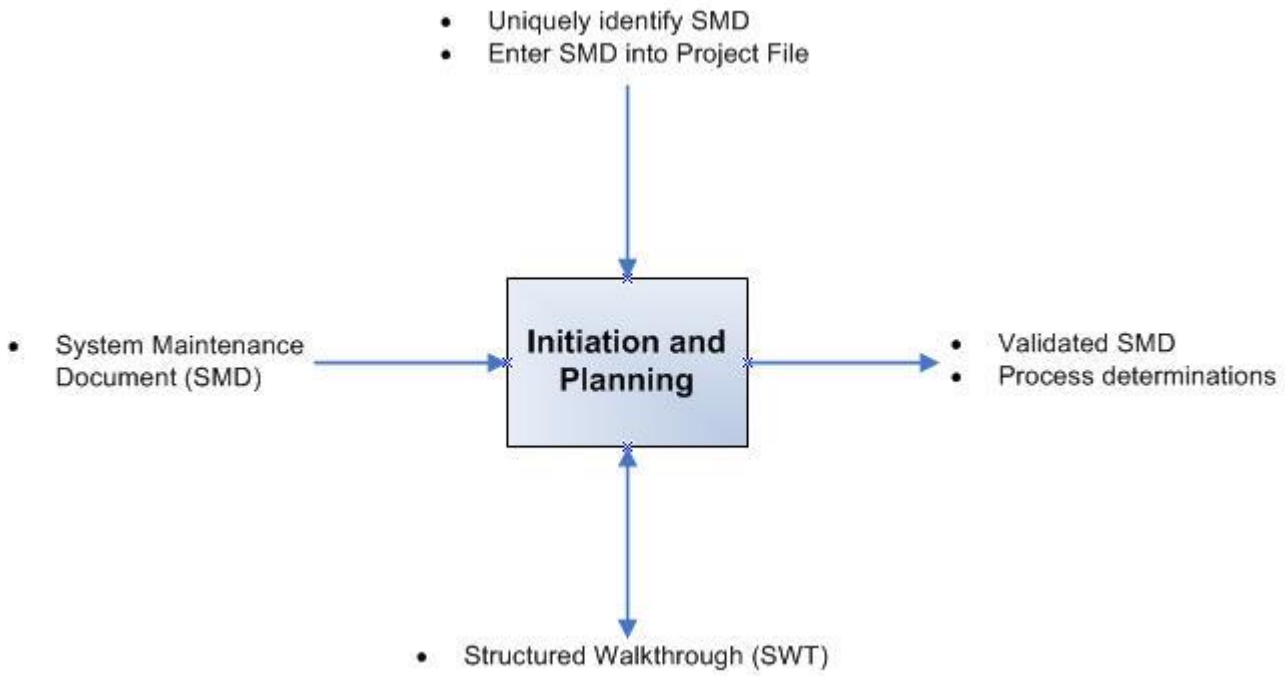
An additional output of this stage is the validated SEM-0931 and the following process determinations. Place a copy of all work products in the Project File.

- Statement of the problem or new requirement.
- Problem or requirement evaluation.
- Categorization of the type of maintenance required.
- Initial priority.
- Verification data (for corrective modifications).
- Initial high-level estimate of resources required.
- Assignment to scheduled release.
- Completed “General Information” and “Problem/Enhancement Overview” section of SEM-0931.

Review Processes

Structured Walkthrough (SWT)
For small maintenance projects, the SWT processes built into the SEM-0931 are sufficient. For those projects in the medium to large categories, the SWT processes established by the SEM should be used.

Exhibit 2.1-1 Initiation and Planning Stage



2.2 Requirements Definition Stage

Responsibility

Project Team and System Owner

Description

During the Requirements Definition Stage, the Project File information, the System Maintenance Document(s) (SEM-0931) validated in the Initiation and Planning Stage, and the system and project documentation are used to study the feasibility and scope of the modification, and to develop a preliminary Project Plan for design, test, and delivery.

If the documentation is not available or is insufficient and the source code is the only reliable representation of the system, reverse engineering is recommended to ensure the overall integrity of the system. In those cases where long-lived systems have overgrown the initial base system and have poorly updated documentation**,** ***reverse engineering*** may be required. The IEEE Standard for Software Maintenance suggests that the process of reverse engineering evolves though the following six steps:

For a smaller scope, or for local analysis on a unit level:

- Dissection of source code into formal units
- Semantic description of formal units and declaration of functional units
- Creation of input/output schematics of units

For a larger scope, or for global analysis on a system level:

- Declaration and semantic description of linear flows
- Declaration and semantic description of system applications (functions grouped)
- Creation of anatomy of the system (system architecture)

Modifications of a similar nature (i.e., affecting the same program(s)) should be grouped together whenever possible, and packaged into releases that are managed as projects. A release cycle should be established and published.

Exhibit 2.2-1 Requirements Definition Stage summarizes the input, process, control, and output for the Requirements Definition Stage.

Input

Input to the Requirements Definition Stage of maintenance includes the following.

- Validated SEM-0931(s)

- Initial resource estimate and associated information
- Project and system documentation, if available

Process

Preliminary analysis activities include the following.

- Make a preliminary estimate of the modification size/magnitude
- Assess the impact of the modification
- Assign the SEM-0931 to a block of modifications scheduled for implementation
- Coordinate the modifications with other ongoing maintenance tasks

Once modifications are agreed to, grouped if appropriate, and packaged, analysis progresses and includes the following:

- Define firm requirements for the modification
- Identify elements of the modification
- Identify safety and security issues
- Devise a test and implementation strategy
- Detailed time estimate, fit analysis in release cycle and confirmation of project schedule

In identifying the elements of the modification (creating the preliminary modification list), examine all work products (e.g., system specifications, databases, and documentation) that are affected. Each work product is identified, and generated, if necessary, specifying the portion of the product to be modified, the interfaces affected, the user-noticeable changes expected, the relative degree and kind of experience required to make changes, and the estimated time to complete the modification.

The test strategy is based on input from the previous activity identifying the elements of modification. Requirements for at least three levels of testing, including individual unit tests, integration tests, and user-oriented functional tests are defined. Regression test requirements associated with each of these levels of testing are identified as well. The test cases to be used for testing to establish the test baseline are revalidated.

Control

Control of the Requirements Definition Stage activities includes the following:

- Retrieval of the relevant version of project and system documentation from the configuration control function of the organization
- Review of the proposed changes and engineering analysis to assess technical and economic feasibility, and correctness

- Identification of safety and security issues
- Consideration of the integration of the proposed change within the existing product
- Verification that all appropriate analysis and project documentation is updated and properly controlled
- Verification that the test function of the organization is providing a strategy for testing the change(s), and that the change schedule can support the proposed test strategy
- Review of resource estimates and schedules; verification of accuracy
- Technical review to select the problem reports and proposed enhancements to be implemented in the new release

Outputs

Outputs of the Requirements Definition Stage include the following new or revised artifacts:

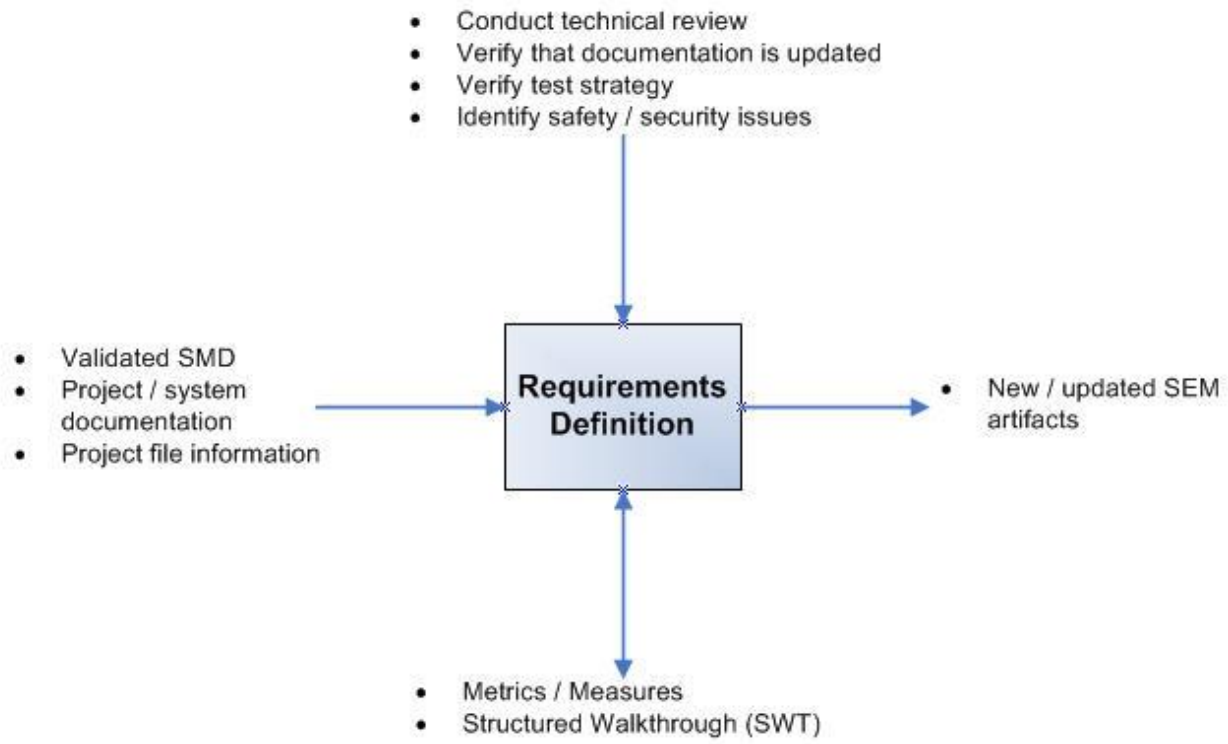
- Updated requirements (including traceability list)
- Test strategy
- Complete the requirements area of the “Problem/Enhancement Overview” section of the SEM-0931

Review Processes

At the end of the Requirements Definition Stage, a risk analysis is performed. Using the output of the Requirements Definition Stage, the preliminary resource estimate is revised, and a decision is made on whether to proceed to the Design Stage.

Structured Walkthrough (SWT)
For small maintenance projects, the SWT processes built into the SEM-0931 are sufficient. For those projects in the medium to large categories, the SWT processes established by the SEM should be used.

Exhibit 2.2-1 Requirements Definition Stage



2.3 Design Stage

Responsibility

Project Team

Description

In the Design Stage, all current system and project documentation, existing software and databases, and the output of the Requirements Definition Stage are used to design the modification to the system. *Exhibit 2.3-1* summarizes the input, process, and output for the Design Stage of maintenance.

Input

Input to the Design Stage of maintenance includes the following:

- Requirements Definition Stage output, including:
    - Detailed analysis
    - Updated statement of requirements
    - Preliminary modification list (identification of affected elements)
    - Test strategy
- System and project documentation.
- Existing source code, comments, and databases.

Process

The process steps for the Design Stage include the following:

- Identify selected modules
- Modify module documentation (e.g., data and control flow diagrams, schematics)
- Create test cases for the new design, including safety and security issues
- Identify/create regression tests
- Identify documentation (system/user) update requirements
- Update modification list
- Document any known constraints that influence the design, and any risks that have been identified. Where possible, actions, taken or recommended, that mitigate risk should also be documented.

Control

The following control activities are performed during the Design Stage:

- Verify that the new design is documented as an authorized change
- Verify the inclusion of new design material, including safety and security issues
- Verify that the appropriate test documentation has been updated
- Complete the traceability of the requirements to the design

Outputs

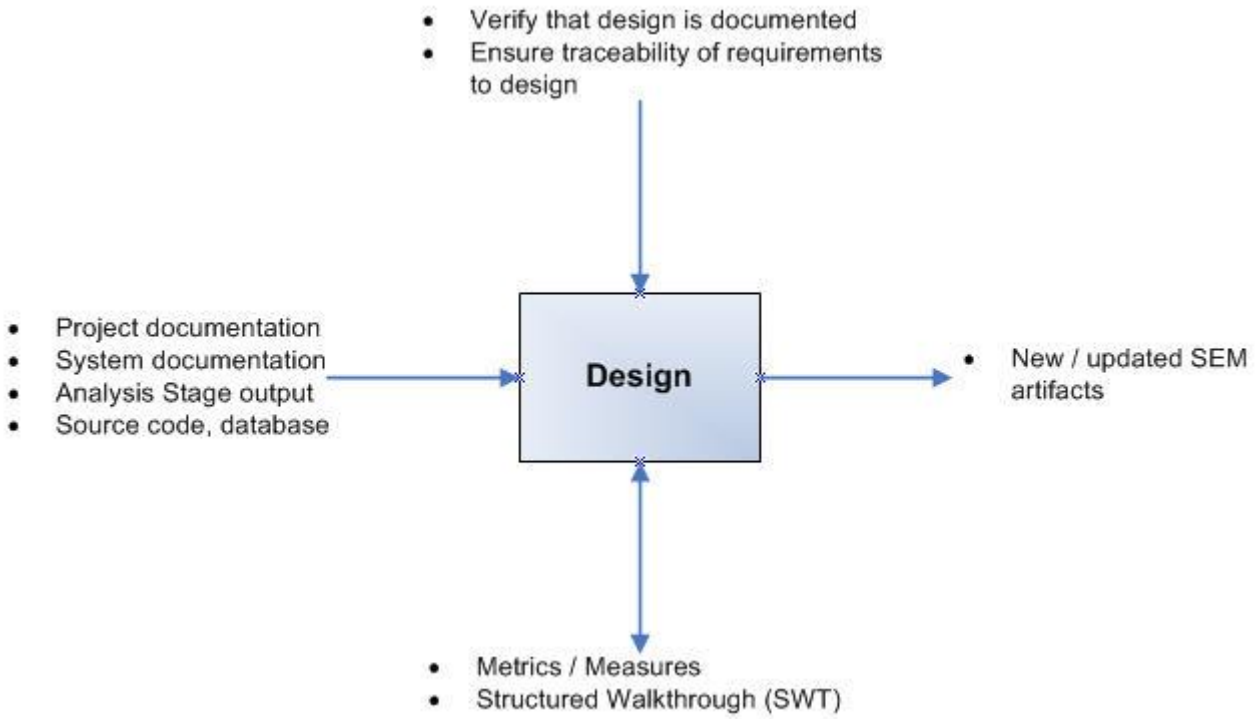
Outputs of the Design Stage include the following new or revised artifacts:

- Revised modification list
- Updated design baseline
- Updated test plans
- Revised detailed analysis
- Verified requirements
- Documented constraints and risks
- Completed “Solution and Estimates”, “Design” and “Testing” sections of the SEM-0931

Review Processes

Structured Walkthrough (SWT)
For small maintenance projects, the SWT processes built into the SEM-0931 are sufficient. For those projects in the medium to large categories, the SWT processes established by the SEM should be used.

Exhibit 2.3-1 Design Stage



2.4 Construction Stage

Responsibility

Project Team

Description

In the Construction Stage, the results of the Design Stage, the current source code, the project and system documentation, (i.e., the entire system as updated by the prior stages) is used to drive the construction effort. *Exhibit 2.4-1* summarizes the input, control, and output for the Construction stage.

Input

Input to the Construction Stage of maintenance includes the following:

- Results of the Design Stage
- Current source code, comments, and databases
- Project and system documentation

Process

The Construction Stage includes the following tasks, which may be conducted in an incremental, iterative approach:

- Coding and unit testing
- Integration
- Revisit project risk
- Test readiness review

Refer to the SEM for details on coding, unit testing, integration testing and regression testing. The SEM also provides guidance on risk analysis and review, as well as reviewing for test readiness.

Control

Control of the Construction Stage includes the following activities:

- Ensure that unit and integration testing are performed and documented in the Project File
- Ensure that test documentation (e.g., test plans, test cases, and test procedures) are either updated or created
- Identify, document, and resolve any risks exposed during software and test readiness reviews

- Verify that the new product is placed under configuration management control
- Verify that the training and technical documentation have been updated
- Verify the traceability of the design to the code

Outputs

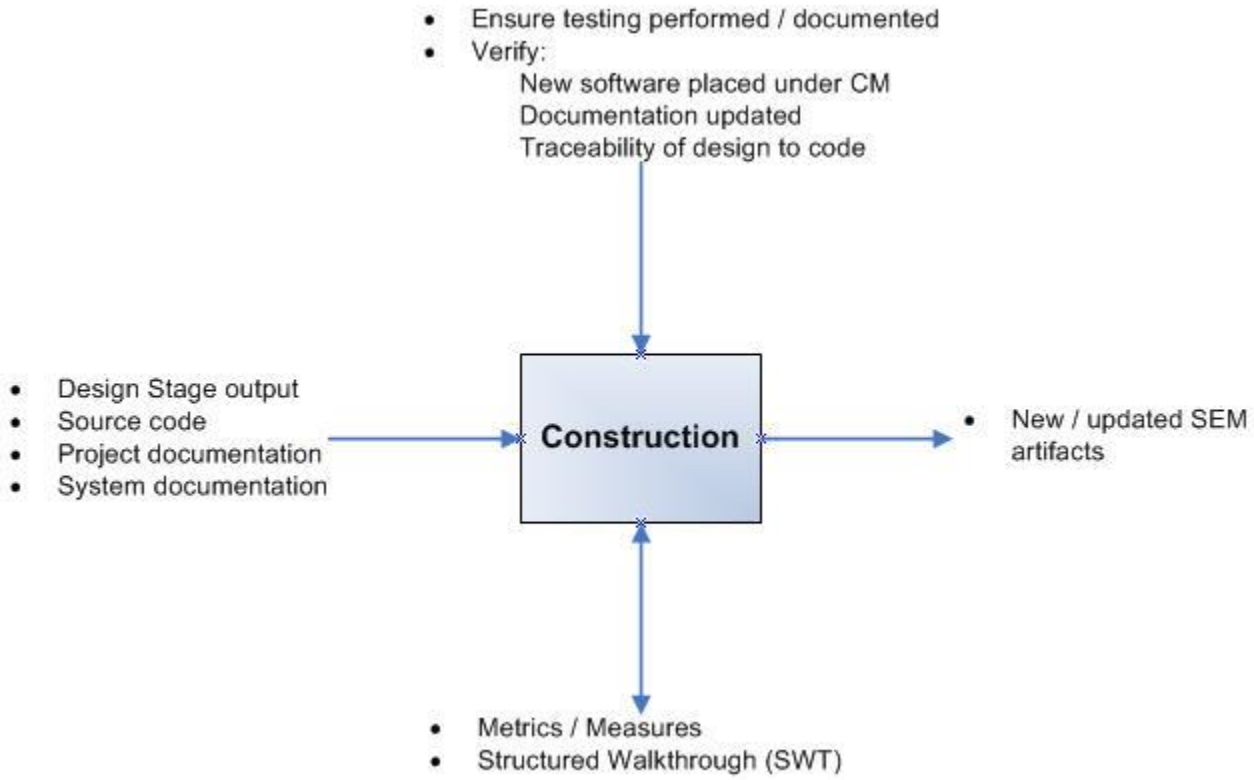
Outputs of the Construction Stage includes the following new or revised artifacts:

- Updated system
- Updated design documentation
- Updated test documentation
- Updated user documentation
- Updated training material
- Statement of risk and impact to users
- Test Readiness Review report
- Completed “Unit Test” and “Code Review” sections of the SEM-0931

Review Processes

Structured Walkthrough (SWT)
For small maintenance projects, the SWT processes built into the SEM-0931 are sufficient. For those projects in the medium to large categories, the SWT processes established by the SEM should be used.

Exhibit 2.4-1 Construction Stage



2.5 Testing Stage

Description

Testing is the process used to help identify the correctness, completeness, security, and quality of developed application software. Testing is intended to reveal quality-related information about the product with respect to the context in which it is intended to operate. Testing can never completely establish the correctness of arbitrary computer software; testing furnishes a 'criticism' or comparison that compares the state and behavior of the product against a specification.

An important point is that software testing should be distinguished from the separate discipline of Software Quality Assurance (SQA), which encompasses all business process areas, not just testing.

Good testing involves much more than just running the program a few times to see whether it works. Testing is the process of executing software in a controlled manner; in order to answer the question “Does this code behave as specified?”

Testing is used in association with verification and validation. ***Verification*** is the checking of or testing of items, including software, for conformance and consistency with an associated specification. Software testing is just one kind of verification, which also uses techniques such as reviews, inspections, and walk-throughs. ***Validation*** is the process of checking what has been specified is what the user actually wanted.

- Validation: Are we doing the right job?
- Verification: Are we doing the job right?

Activities

- **Integration testing:** in which the proper interaction between system components is verified
- **System testing:** in which the software is integrated to the overall product and tested to show that all requirements are met (*Exhibit 2.5-1*)
- **User acceptance testing (UAT):** upon which the acceptance of the complete software is based. The clients do this testing. (*Exhibit 2.5-2*)

Outputs

Outputs of the Construction Stage includes the following new or revised artifacts:

- Complete “Integration Test”, “System Test”, and “User Acceptance Test” sections of the SEM-0931

Review Processes

Structured Walkthrough (SWT)
For small maintenance projects, the SWT processes built into the SEM-0931 are sufficient. For those projects in

the medium to large categories, the SWT processes established by the SEM should be used.

Exhibit 2.5-1 System Testing

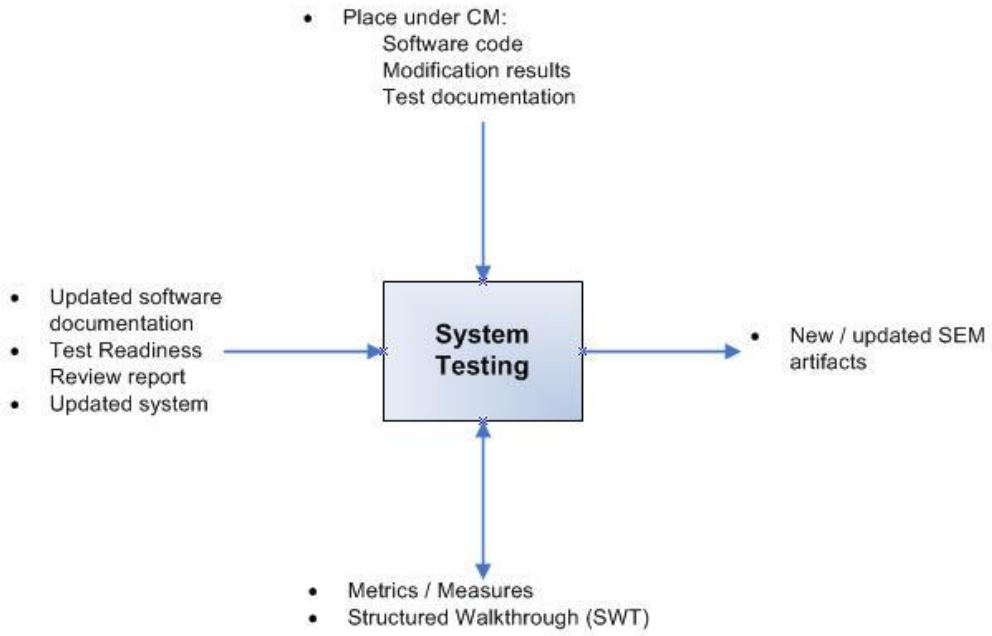
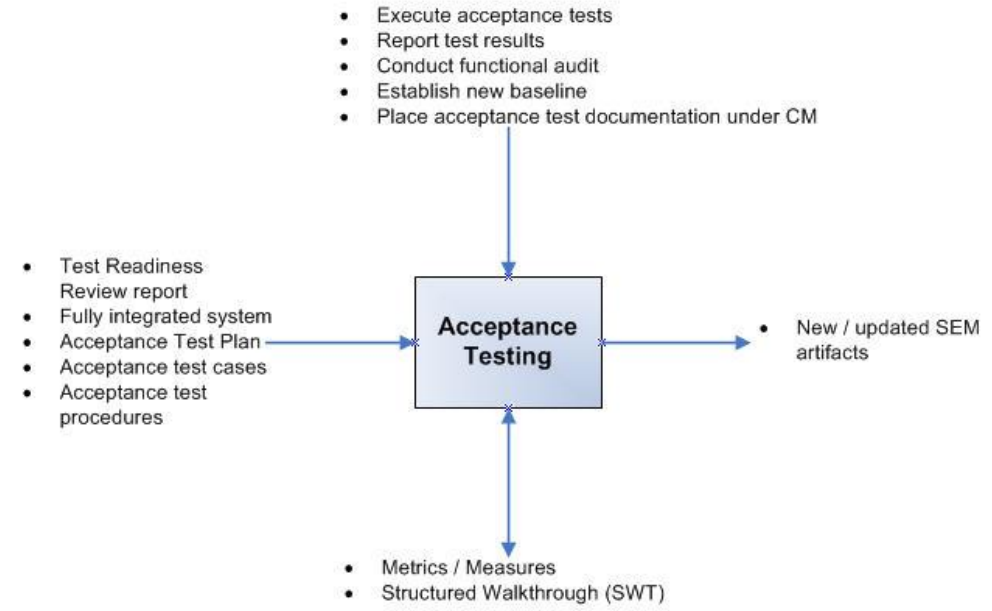


Exhibit 2.5-2 Acceptance Testing



2.6 Implementation Stage

Responsibility

Project Team

Description

This stage describes the requirements for the delivery of a modified system. *Exhibit 2.6-1* summarizes the input, process, control, and output for the Implementation Stage.

Input

Input to the Implementation Stage of maintenance is the fully tested version of the system as represented in the new baseline.

Process

The tasks for implementation of a modified system include the following:

- Conduct a Physical Configuration Audit (PCA)
- Notify the user community
- Develop an archival version of the system for backup
- Perform installation and training at the user facility

Control

Control for the Implementation Stage includes the following:

- Arrange and document a Physical Configuration Audit
- Provide access to system materials for users, including replication and distribution
- Complete the version description document
- Place under configuration management control

Outputs

Output of the Implementation Stage includes the following new or revised artifacts:

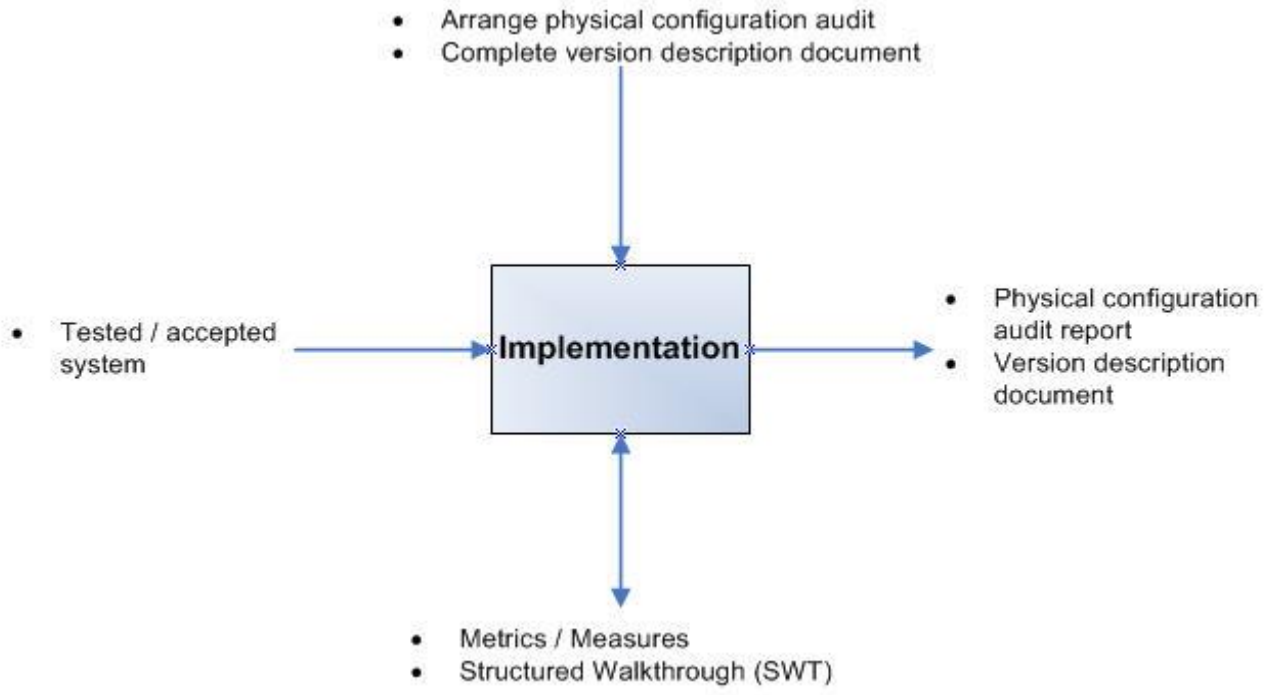
- Physical Configuration Audit report
- Version Control Documentation
- Completed “Authorization to Move to Production” and “Installation” sections of the SEM-0931

The Version control documentation contains information pertinent to the version or release of the system that is being implemented. Information provided includes system name, date delivered, version number, release number, brief description of functionality delivered in the modification, and prerequisite hardware and software with its associated version and release number. This information should be stored in a central location.

Review Processes

Structured Walkthrough (SWT)
For small maintenance projects, the SWT processes built into the SEM-0931 are sufficient. For those projects in the medium to large categories, the SWT processes established by the SEM should be used.

Exhibit 2.6-1 Implementation Stage



2.7 Systems Maintenance Document (SEM-0931)

Description

The System Maintenance Document (SEM-0931) is a standard SEM template for recording and processing minor application changes and break fixes. All application changes implemented outside of a formal project should be documented using the SEM-0931. Please see *Exhibit 2.7-1* for a sample of the SEM-0931 template.

Organizations may have an existing form and procedure for requesting application changes. The SEM-0931 may be used in place of the existing form or as a supplement to it. One or more SEM-0931's for the same application may be handled as a formal project using the full SEM or SEM Express. Or an SEM-0931 may be processed individually, using the System Maintenance methodology embedded in the SEM-0931.

SEM-0931 Sections

I. General Information
I. Problem / Enhancement Overview
III. Information Sources
IV. Solution and Estimates
V. Design
VI. Testing
VII. Unit Test
VIII. Code Review
IX. Integration Test
X. System Test
XI. User Acceptance Test
XII. Authorization to Move to Production
XIII. Installation

The SEM-0931 and Minor Application Changes

For minor application changes, use the SEM-0931 to identify and process the programming changes instead of creating a formal project. Use each section of the SEM-0931 to guide you through the system maintenance methodology and record the processing that is done. Be sure to update all existing SEM documents that may be impacted as a result of the change. Otherwise, use the SEM-0931 to record estimates, structured walkthroughs, defects and approvals. If applicable, use the SEM-0931 to ensure all changes are included in the next planned application release.

The SEM-0931and Break Fixes

For emergency break fixes, use the SEM-0931 to record the work that was done. Then afterward, use the SEM-0931 as a guide to ensure that all impacted SEM documents are updated accordingly. If applicable, use the SEM-0931 to ensure all changes are included in the next planned application release.

The SEM-0931 and Maintenance Projects

When the total effort to complete one or more SEM-0931's for an application exceeds 200 hours, it may be advantageous to create a formal project using the full SEM or SEM Express. In those cases, use the SEM-0931 to document the requested changes and as input to the Requirements Specification document (SEM-0402). Then follow the PMM and SEM as you would for any other project.

Exhibit 2.7-1 System Maintenance Document (SEM-0931)

State of Michigan
(Insert System or Project Name Here)
System Maintenance Document

I. GENERAL INFORMATION			
1. Internal Request Number	2. Application and Release Version		3. Priority
4. Date Required	Explain		
5. Submitted by Name (Client)	6. Date Submitted	7. Approved by Name (Client)	8. Date Approved
9. Author (DTMB)	10. Date Written	11. Authorized by Name (DTMB)	12. Date Authorized

II. PROBLEM / ENHANCEMENT OVERVIEW	
1. Request Type ☐ Problem ☐ Enhancement	2. Functional Area
3. Sub-Functional Area	4. Tab / Report / Screen
5. Description *(Provide a detailed description.)* "Click HERE and Type"	
6. Requirements *(Includes Functional, Cross Functional, Input/Output, Performance, User Interface, System Interface, Security and Access, Backup and Recovery.)*	

Req #	Detailed Requirement	Priority	Requestor
"Type HERE"			"Tab to add rows"

7. Base Requirements Specifications Affected

☐ YES *(If checked, update Requirements Specification, SEM-0402.)* ☐ SEM-0402 Updated

☐ NO *(Proceed to Item 8.)*

8. Problem/Enhancement Requirement – Structured Walkthrough

Date	Participants	Changes / Defects
"Type HERE"		"Tab to add rows"

III. INFORMATION SOURCES (Existing documentation used to derive solution.)

☐ Existing System Documentation ☐ Existing Infrastructure Services Request

☐ Existing System Security Plan ☐ Existing System Maintenance Plan

☐ Other *(If checked, describe.)*

"Click HERE and Type"

IV. SOLUTION AND ESTIMATES

1. Briefly describe the solution task list *(Basis for estimates. Components Impacted e.g., programs, screens, tabs, reports, scripts, files, databases.)*

"Click HERE and Type"

2. Estimating Detail *(in Hours)*

	Analysis & Design	Code Fixes	Data Fixes	Unit Testing	Other Testing	Implementation	Business Authorization	DTMB Authorization
Estimated								
Actual								

Client Agency Authorization Name	Signature	Date

V. DESIGN

1. Design Structured Walkthrough

Date	Participants	Changes / Defects
"Type HERE"		"Tab to add rows"

2. Functional Design Affected

☐ YES *(If checked, update Functional Design Document, SEM-0501.)* ☐ SEM-0501 Updated

☐ NO *(Proceed to Item 3.)*

3. System Design Affected

☐ YES *(If checked, update System Design Document, SEM-0604.)* ☐ SEM-0604 Updated

☐ NO *(Proceed to Section VI.)*

VI. TESTING

Collaboration will occur between the developer and end user to establish the test scenarios and expected test results.

1. Test Scenarios

"Click HERE and Type"

2. Expected Test Results

"Click HERE and Type"

VII. UNIT TEST *(Confirm that the program logic within an application module produces the expected output when given a known input.)*

1. Test Environment

"Click HERE and Type"

2. Date Tested	Name of Tester	Changes / Defects
"Type HERE"		"Tab to add rows"

VIII. CODE REVIEW

1. Code Structured Walkthrough

Date	Participants	Changes / Defects
"Type HERE"		"Tab to add rows"

IX. INTEGRATION TEST *(Verify the system components are integrated and working as an application.)*			
1. Test Environment "Click HERE and Type"			
2. Build/Revision No.	**Date Tested**	**Name of Tester**	**Changes / Defects**
"Type HERE"			"Tab to add rows"

X. SYSTEM TEST *(Verify that functional business requirements, business processes, data flows, and other system criteria are met.)*			
1. Test Environment "Click HERE and Type"			
2. Build/Revision No.	**Date Tested**	**Name of Tester**	**Changes / Defects**
"Type HERE"			"Tab to add rows"
3. Performance Test Complete ☐ YES ☐ NO			

XI. USER ACCEPTANCE TEST *(By the client agency.)*			
1. Test Environment "Click HERE and Type"			
2. Build/Revision No.	**Date Tested**	**Name of Tester**	**Changes / Defects**
"Type HERE"			"Tab to add rows"

XII. AUTHORIZATION TO MOVE TO PRODUCTION		
Client Agency Authorization Name	Signature	Date
DTMB Authorization Name	Signature	Date
Other Authorization Name (DBA, CM, QA)	Signature	Date

XIII. INSTALLATION		
1. Application Build	2. Implementation Date	3. Code Version
4. RFC Number Used to Deploy to Production	5. Installation Validation Complete ☐ YES ☐ NO	
6. Comments / Notes "Click HERE and Type"		

CHAPTER 3.0 - RELEASE MANAGEMENT

Description

Release Management is the discipline of managing software releases. Releases themselves are a uniquely identified set of files (or perhaps just a single file) that constitute the software release. Binding system maintenance and its related release management activities to existing project management and system engineering processes – as does this guidebook – increases the success rate of release management efforts. This is a best practice for larger applications with multiple concurrent active maintenance activities and may not be needed for smaller applications with less maintenance activity.

The goals of Release Management are:

- Deployment of high-quality release products
- Usage of repeatable, cost-effective process for deploying Releases
- Timely and accurate “building” of Releases

Some of the challenges faced in the Release Management process are:

- Undetected Software Defects
- Outstanding Issues
- Outstanding Risks
- Software Change Requests
- New Development Requests (additional features and functions)
- Packaging and Deployment
- New Development Tasks yet to be completed

Active management of the release process and products provides the project manager (or software release manager) with the following information for use in meeting the above listed challenges:

- What went into the release?
- When was the release deployed?
- Where was the release deployed?
- Why was it deployed?
- How were defects handled when they were reported?

As software systems, software development processes, and related resources become more distributed, they invariably become more specialized and complex. Software products, especially web applications, are typically in

an ongoing cycle of development, testing, and release. Add to this the evolution and growing complexity of the platforms on which systems run, it becomes clear there are many moving pieces that must seamlessly fit together to guarantee the success and long-term value of a product or project.

Discussion

A release is defined according to the needs of the users. This means that:

- Solutions to urgent problems are released as soon as possible only to people experiencing the problem, or who are likely to experience the problem;
- Other changes are released when the users are ready to accommodate them.

Once one or more changes are developed, tested, and packaged into releases for deployment, release management is responsible for introducing these changes into the production IT environment and managing their release. Release management also contributes to the efficient introduction of changes by bundling them into one release and deploying them together.

Refer to the Software Configuration Management template (SEM-0302) for more information.

Glossary

Baseline – (1) An agreed-to description of the attributes of a product, at a point in time, which serves as a basis for defining change. (2) An approved and released document, or a set of documents, each of a specific revision; the purpose of which is to provide a defined basis for managing change. (3) The currently approved and released configuration documentation. (4) A released set of files comprising a software version and associated configuration documentation.

Configuration Audit – Configuration Audits determine to what extent the as-designed/as-tested/as-built product reflects the required physical and functional characteristics specified in the requirements. Functional Configuration Audit (FCA) and Physical Configuration Audit (PCA) are done once, to establish the Product Baseline.

Development Baseline – The baseline comprising the software and associated technical documentation that define the evolving configuration of the system during development. This baseline includes the software design, and implemented code, database schema, and COTS products, and evolves into the product baseline.

Fix number – An indicator of small updates that are to be built into a regular modification or release at a later time. The version, release, modification, and fix levels together comprise the program level (or version) of a program.

Functional Baseline – The baseline comprising documentation and possibly models that specify system functional, data, and technical requirements.

Functional Configuration Audit (FCA) – An inspection to determine whether the (software) configuration item satisfies the functions defined in specifications. Consists of someone acknowledging having inspected or listed each item to determine it satisfies the functions defined in specifications.

Iteration – A distinct sequence of activities with a baselined plan and valuation criteria resulting in a release.

Modification number – The modification level of a program, which is an indicator of changes that do not affect the external interface of the program. The version, release, modification, and fix levels together comprise the program level (version) of a program.

Physical Configuration Audit (PCA) – The formal examination of the "as-built" configuration of a configuration item against its technical documentation to establish or verify the configuration item's product baseline.

Program level – The version, release, modification, and fix levels of a program.

Regression Testing – The process of running a composite of comprehensive test cases that are always run after system modifications to detect faults introduced by modification.

Release number – An indicator of changes to the external programming interface of the program. The version, release, modification, and fix levels together comprise the program level (version) of a program.

Specification – A document that explicitly states essential technical attributes/requirements for a product and procedures to determine that the product's performance meets its requirements/attributes.

Version – (1) One of several sequentially created configurations of a data/document product. (2) A supplementary identifier used to distinguish a changed body or set of computer-based data (software) from the previous configuration with the same primary identifier. Version identifiers are usually associated with data (such as files, databases and software) used by, or maintained in, computers.

Version Description Document (VDD) – A document associated with a product release that describes the version released and describes the versions of the items included in the product.

Version Number – An indicator of the hardware and basic operating system upon which the program operates. The version, release, modification, and fix levels together comprise the program level (version) of a program.