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CONDUCTING SOFTWARE CAPABILITY EVALUATIONS

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Prepared for
Ballistic Missile Defense Organization

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PREFACE

This document was prepared by the Institute for Defense Analyses (IDA) under the task order, Ballistic Missile Defense Organization (BMDO) Software Technology, and fulfills an objective of the task, to prepare "a final guide for BMD Software Capability Evaluation (SCE) teams based on available BMD experience."

This document was reviewed by the IDA research staff members: Dr. David J. Carney, Ms. Audrey A. Hook, Dr. Richard J. Ivanetich, Dr. Reginald N. Meeson, Mr. Michael S. Nash, Dr. Charles P. Pfleeger, Mr. Clyde G. Roby, and Dr. Richard L. Wexelblat. Their contributions are gratefully acknowledged.

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SUMMARY

Software in Department of Defense (DoD) programs has become a critical element over the past 10 years, and the DoD has increased its emphasis on the need to evaluate and monitor software contractors and subcontractors. Consequently, the Software Engineering Institute (SEI) and the MITRE Corporation were tasked by the Air Force to develop a software evaluation methodology; the results were the SEI process maturity model, identification of key process areas in its data element set, and the method of evaluating, the Software Capability Evaluation (SCE). The Ballistic Missile Defense Organization (BMDO) is using the SCE method to determine whether developers have good software practices to reduce cost and schedule overruns. This document presents the results of an ongoing study to assess and recommend procedures for improving the effectiveness of the SCEs, based on lessons learned from conducting them on BMD programs. It will be used to supplement SEI's training material and reports.

In conducting SCEs, the BMDO is encouraging continuous process improvement among software development contractors. SCEs have been scheduled throughout the BMD life cycle, and BMD program offices will use SCEs for input to the Source Selection Evaluation Board (SSEB) as well as for monitoring existing contracts.

Institute for Defense Analyses (IDA) staff members were trained at SEI in conducting SCEs and participated as technical advisors for the SCEs performed for the National Test Facility, Brilliant Pebbles, and Brilliant Eyes programs. The lessons learned were incorporated in this paper along with findings and recommended procedures and techniques. They are presented in the time frame of when activities occur in the SCE process: before, during, or after conducting the SCE. Following is a brief overview of the lessons learned.

Activities Prior To Conducting Evaluations (In Order of Occurrence)

Develop inputs to the Request for Proposal (RFP). The offerors must be made aware of the SCE requirement in the RFP. Text is given within this report that can be used

to insert the SCE requirements notice within the RFP and the associated Instructions for Preparation of Proposals.

Establish evaluation criteria. The Source Selection Authority (SSA) will use the results of an SCE during source selection as either a specific criterion or a general consideration. The SSA will request the evaluation criteria support either a color rating or a numerical rating, depending on whether procurement is for the Air Force or the Army. Examples of both rating systems are included in this report.

Identify specific program needs. Each BMD program office may have specialized software needs. Additional key process areas may be added to the standard SEI process maturity model. The standard key process areas are process improvement, defect prevention, process measurement and analysis, quality management, process focus, process definition, training, peer reviews, standards and procedures, project management, project planning, configuration management, quality assurance, and subcontractor management.

Select the evaluation team. Detailed qualifications of team members are identified. Qualifications include training and technical or managerial experience in the area of software development or acquisition support. BMD teams should not consist of members from a single Service or Government organization; representatives from the Air Force, Army, National Test Facility, and Federally Funded Research and Development Centers should be included. Other considerations include team skills, leadership, and lack of conflict of interest. All SCE team members will be required to sign a Procurement Integrity Certificate (PIC) for source selection at hand. The PIC requires disclosure of financial interest in any of the RFP offerors. Finally, additional training should be arranged for SCE teams who have little SCE experience or who have not worked together on an actual evaluation.

Conducting Evaluations

Select projects to be evaluated. The contractor will provide information on seven to nine projects. The SCE team will select three projects to perform an SCE during a three-day visit. The projects selected must adequately represent the contractor's proposed role and help to judge the risk associated with awarding the proposed project to the contractor. Guidance for selecting the appropriate projects is provided.

Establish site visit schedule. A detailed schedule identifying the activities during the three-day visit is described. It includes a list of interview candidates, a prioritized list of topics to explore during each interview, and the allotted time for document reviews and for finalizing SCE findings and results.

Submit document request to the contractor. The SCE team will submit a list of documents to be made available to the SCE team prior to the site visit and during the site visit. Prior to the site visit, the contractor will furnish the Software Development Plan, project profiles, an organization chart, and a completed SEI questionnaire form. This documentation is used by the SCE team to plan an interview schedule, identify issues and questions, and form a basis for the findings. During the site visit, additional documentation is requested to substantiate findings. A detailed list of documents is identified for each key process area.

Develop entrance briefings. The SCE team and the contractor will provide an entrance briefing to identify the scope of the SCE on the contractor's software process. Recommended topics for the presentations are listed.

Establish interview approach. Interviews are conducted with project personnel, and project documentation is reviewed to verify the adequacy of the contractor's software practices. All information gathered during the site will be documented to support SCE findings. Recommendations are included for conducting interviews, establishing SCE team member roles, and documenting interview notes.

Activities After Conducting an Evaluation

Final report. The SCE team will prepare a report of its findings for the contractor, the SSEB, the BMD program office, and the BMDO. The report will be marked CONFIDENTIAL and distribution will be controlled. Descriptions of the report format and content are included in this report.

Contractor feedback of evaluation results. The winning contractors will be briefed after the contract is awarded; at this time the contractors can provide feedback. The losing contractors will receive a very high-level overview of the SCE results. Guidance is included for providing feedback to the contractor.

Use of evaluation results in source selection. The report will contain a summary of the contractor's strengths, weaknesses, and improvement plans for each key process area. Details of the SCE report are included along with a description of the summary which will be used by the SSEB.

Use of evaluation results for contract monitoring. An SCE may be used to help monitor a contract. The program office can compare the results of the evaluation with the contractor's process improvement plans. If there are discrepancies, the program office

should notify the contractor who should produce an acceptable plan to mitigate the risks and to reduce the principal weaknesses over the length of the contract.

Registry of evaluation results. The results of an SCE should be stored by BMDO in a repository for possible reuse in later procurements. This can reduce time, effort, and expense. Using an SCE repository could also shorten the procurement cycle by reducing the number of new SCEs that must be done.

1. INTRODUCTION

1.1 Purpose

This document provides the means for improving the effectiveness of the Ballistic Missile Defense (BMD) Software Capability Evaluation (SCE) teams and the quality of their results. The originator of the SCE concept and process, the Software Engineering Institute (SEI), provides basic information for performing SCEs in the SEI training course [SEI 1991a]. In practice, additional information and procedures are necessary to help achieve the best possible results.

The SCE is a valuable tool that assists in ensuring that the Federal Government gets a timely quality product for its software investment. SCEs are being used in the BMD program as part of two distinct activities: source selection and contract monitoring. When used in source selection, SCE results will figure into the overall scores of the offerors. When SCEs are used for contract monitoring, the program office can check whether the contractor's software development process has been maintained and, if required, whether improvement has occurred.

This paper is for use within the BMD program by teams already trained at SEI to conduct SCEs. It is intended to supplement SEI's training material and reports with other information and procedures the BMD teams have learned and used through their experiences performing SCEs.

1.2 Background

In the last decade, the visibility and importance of software in Department of Defense programs have increased the need to improve the Federal Government's ability to evaluate and monitor software contractors. Responding to a request by the United States Air Force, SEI, with assistance from the MITRE Corporation, developed a software evaluation methodology.

The SEI methodology provides five levels of process maturity, each associated with key process areas (KPA). Refer to Table 1 for details [SEI 1991b].

Table 1. SEI Process Maturity Model

Level	Characteristics	KPAs
5 Optimizing	Continuous process improvement	Process Improvement Defect Prevention
4 Managed	Product quality planning and tracking of measured software processes	Process measurement and analysis Quality management
3 Defined	Development process defined and institutionalized to provide product quality control	Process focus Process definition Training Peer reviews Standards and procedures
2 Repeatable	Management oversight and tracking of project; stable planning and product baselines	Project management Project planning Configuration management Quality assurance Subcontractor management
1 Initial	Ad hoc (unpredictable and chaotic)	"People"

BMD evaluation teams attend a four-day training course at SEI to learn how to apply the basic methods for conducting an SCE. The SEI course reviews the main process maturity concepts, teamwork skills, interview practices, scoring project questionnaires, and the exit briefing containing the SCE findings. These methods are taught at a high level and are documented in a training manual [SEI 1991a].

The Institute for Defense Analyses (IDA) began this study in 1991 after participating as technical advisors for the SCEs performed at the National Test Facility (NTF) and on the two Brilliant Pebbles (BP) contractors. We applied the lessons learned from the NTF and BP SCEs in subsequent SCEs performed on offerors for Brilliant Eyes (BE). The additional lessons collected and observations made during these SCEs are used as the basis of the information presented in this document.

1.3 Approach

The following steps were taken in preparation for the analyses in this paper.

a. Trained IDA personnel at SEI.

   SEI has developed and administers a four-day training course for conducting an SCE. The course introduces the software evaluation methodology that focuses on KPAs tied to the maturity model. SEI's case studies and mock evaluations are used to provide some initial hands-on experience to the trainees. Currently, five IDA research staff members have completed training.

b. Developed supplemental training materials.

   Based on previous experiences in conducting three SCEs for BMD, IDA reexamined SEI's training course and training materials for completeness and applicability to the BMD program. IDA developed additional training materials to emphasize the information-gathering aspects of conducting an SCE and to share the lessons learned from earlier SCEs. A course was administered at IDA for the BE evaluation team which had been previously trained at SEI.

c. Participated in conducting evaluations.

   IDA participated in the SCEs performed on the competing contractors for BE. The IDA members of an evaluation team act as technical advisors, providing additional depth to the team.

d. Developed recommended procedures and techniques.

   The supplemental training materials developed by IDA, and the lessons learned by the IDA participants on the NTF, BP, and BE evaluation teams, have been collected and are the basis for this document.

1.4 Organization

Section 1 presents a brief background of the origins of the evaluation method and the approach taken in writing this paper. Section 2 describes the views of the Ballistic Missile Defense Organization (BMDO) on SCEs and how these views apply to the BMD program. In Sections 3, 4, and 5, the activities that surround SCE are presented. The appendices provide plans, worksheets, and sample findings the evaluation teams are to use in obtaining the SCE information. A list of acronyms and a list of references are provided at the end.

2. BMD OBJECTIVES IN USING SCEs

BMDO wants to ensure that BMD software developers have good software practices to reduce the risk of software cost and schedule overruns. For this reason, SEI's process maturity model and practices are being used in BMD to identify software process risks and to guide software process improvement. Since SEI's model is limited in scope, the model and practices will be extended to help evaluate and monitor other areas of importance to the BMD software program, such as trusted software.

2.1 Use the Current Process Maturity Model

The BMD program will use the current SEI process maturity model and methods for implementing the model. SEI's methods have undergone two major changes in the last five years and are still evolving. As SEI methods are updated, the BMD teams will be retrained to use the most recent version being taught by SEI.

The first SEI process maturity model was documented in 1987 by Humphrey and Sweet [1987]. This method was based on a questionnaire consisting of 101 questions. Since 1991, the method evolved into what is known as the "model-based approach" which includes goals and practices associated with KPAs. SEI is currently training people in this method and the BMDO SCE teams are using it [SEI 1991a].

In August of 1991, SEI released a preliminary draft of the new model commonly referred to as the Capability Maturity Model (CMM). The draft CMM has undergone a public review and is currently being revised. SEI plans to release the new CMM in December 1992 and update the SCE training course by March of 1993. Once the method is complete and training provided, SDI will use the CMM for performing SCEs.

2.2 Encourage Continuous Process Improvement

The underlying goal when conducting SCEs is to encourage continuous process improvement among software development contractors. It should be an on-going effort within a contractor's organization rather than something done only once. Continuous process improvement will not simply happen because a contractor or program office wishes or

requires it. Rather, a comprehensive process improvement plan must be put in place and followed.

Due to the large number of contractors involved in the BMD program, it is desirable to use both the SCE and the software process assessments (SPA) to encourage continuous process improvement. SCEs are evaluations performed by a government team on the contractor's process, whereas a SPA is performed by a contractor team on its own software process. BMDO Software Directive 3405 specifies an evaluation and assessment hierarchy, as pictured below.

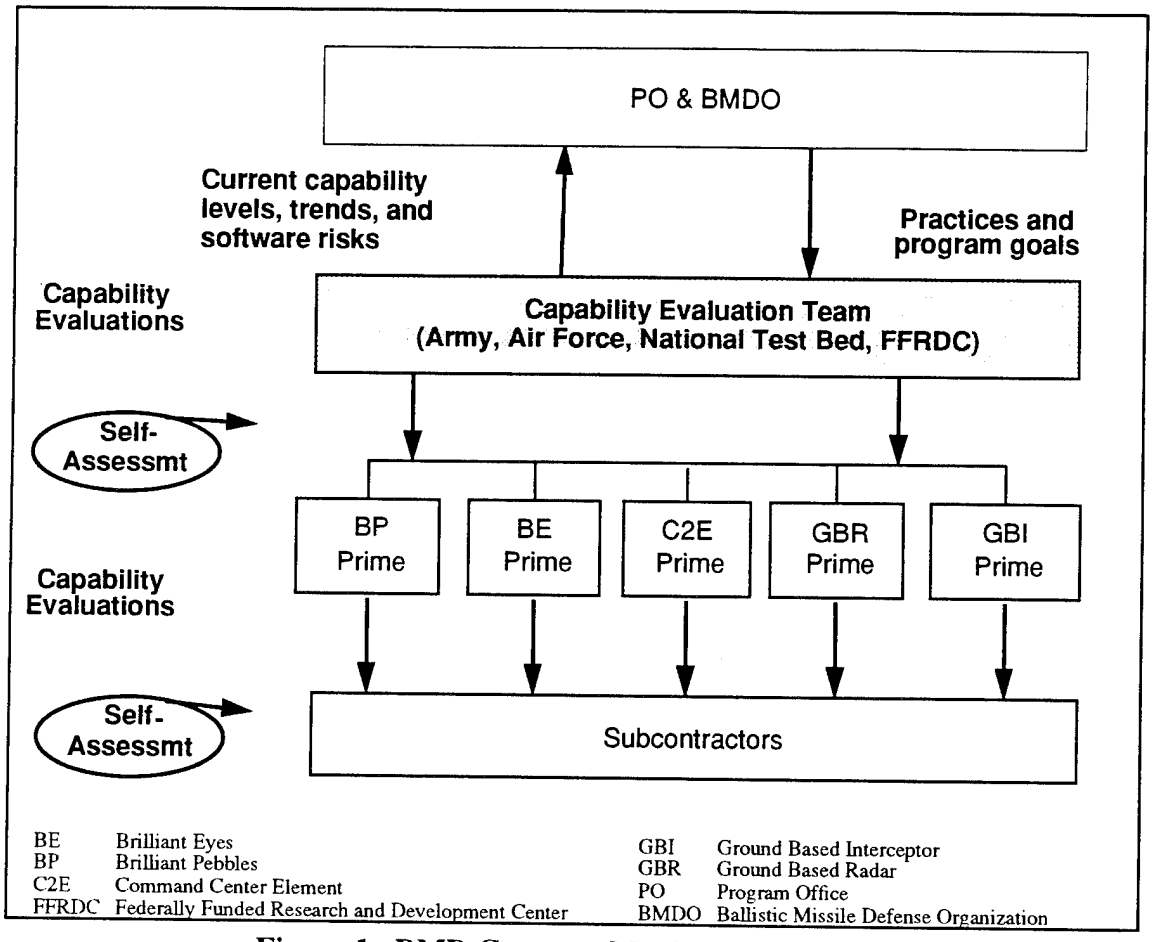

Figure 1. BMD Contract Monitoring Process

The Directive specifies that the subcontractors and the prime contractors perform annual self-assessments of their development processes and develop annual software process improvement plans. The contractors are responsible for identifying and improving their process over the life of the BMD program. In addition, prime contractors are responsible for the quality and cost of their subcontractor's software. Thus, the prime contractors

are required to perform annual SCEs on their subcontractors. The BMD evaluation team will only evaluate prime contractors and not all of the subcontractors. But the BMD teams will look closely at how well the prime contractors oversee their subcontractors and will validate the results of the self-assessments and the quality of the contractor's software process improvement plans. The results of the SCEs are provided to the contractor and the element program managers for input to their risk management process.

2.3 Scheduling SCEs Throughout BMD Life Cycle

BMD program offices will use SCEs for input to the Source Selection Evaluation Board (SSEB) and to help monitor contracts previously awarded. SCEs will be used for source selection for both Demonstration/Validation (Dem/Val) and Engineering Manufacturing and Development (EMD). Since it may take one to three years for a contractor to advance from one maturity level to another, BMD plans include the use of SCEs as a contract monitoring mechanism to encourage the contractors to continuously improve their software development process, as noted in Figure 2.

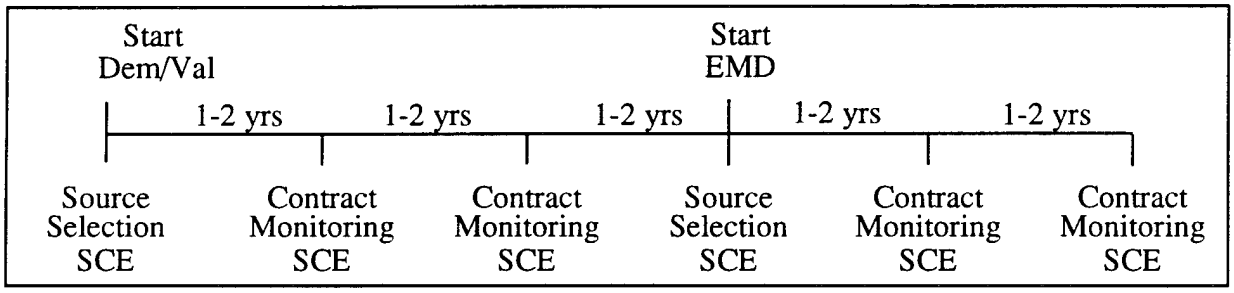

Figure 2. Schedule for SCEs

The first SCE should be performed during source selection, the next SCE one to two years later to give the contractor an opportunity to improve and to monitor his progress. Contractors typically welcome SCEs as a contract monitoring mechanism since it gives them an independent view of their process and an opportunity to prepare for the SCE that will be used at the next source selection. If, however, an SCE was not performed during source selection, an SCE should be done approximately six to nine months after the contract is awarded, as noted in Figure 3. By this time, the contractor should have the software process defined and documented in a Software Development Plan (SDP). It is important to have the SDP available prior to an SCE so that the evaluation team can verify that the pro-

cess being described in the interviews is the same process being applied to the BMD element.

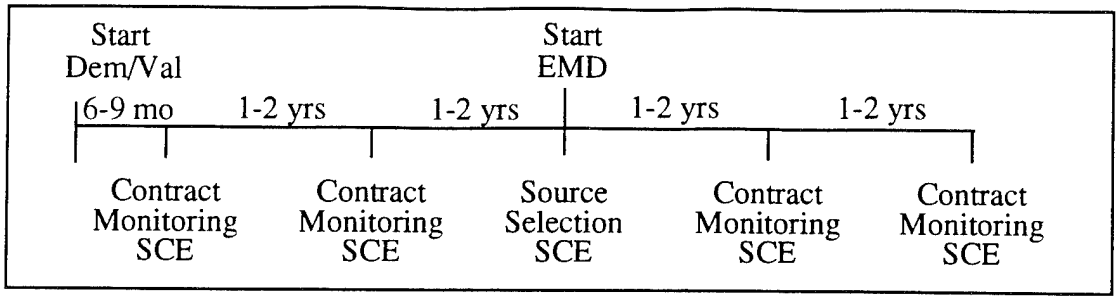

Figure 3. Alternative Schedule for SCEs

2.4 Emphasis of BMD Projects in SCEs

When performing an SCE, the evaluation team looks at several projects within the contractor's organization to gain an understanding of the contractor's software development process. The SCE team reviews information on six to nine of the contractor's projects and interviews people from three projects. Section 4.1 describes how the team selects the projects to review. The team looks at several projects in order to determine what processes are unique at the project level and what processes are standard across the organization and applied to all of the projects. When new software projects are initiated, it is desirable to have a well-defined organizational approach to software process development from which a new software project can draw. The organization's standard software process should be derived and refined, based on the experience and "lessons learned" from the projects within the organization. It is not desirable for each project to learn the lessons first hand, but rather to learn from the trial and error of previous projects. Thus, an SCE evaluates the organization's approach to software development by looking at the organizational practices and how they are used in on-going projects.

When a project is initiated, the organization's standard approach to software development has much more effect than when a project is nearing completion. Consequently, the focus of a BMD SCE will vary, depending on whether the BMD project is just being initiated or whether it is well into development. For example, at the start of Dem/Val, the offerors will not have a well-defined software process for the BMD element for which they are competing. An SCE for Dem/Val source selection should therefore evaluate the processes being applied to other projects within the contractor's organization supporting BMD. Once the Dem/Val contract is awarded, the contractor will begin to define the soft-

ware process for the BMD element. By the time Dem/Val is completed, the process being applied to the EMD contract is well defined for the BMD element. The SCE performed for EMD source selection will focus less on the organization's process and more on the process being used on the BMD element.

2.5 Extending the Process Maturity Model

The KPAs in SEI's Process Maturity Model (PMM) cover certain components that are recognized as part of good software development practice. BMDO's efforts to improve the development process, such as the BMD Trusted Software Development Methodology (TSDM), raise additional requirements that could be included in SCEs. Other assessment methods such as Software Development Capability/Capacity Review (SDC/CR) [AFSC 1991] and Software Productivity Research (SPR) [SPR 1991] also show that the PMM is not exhaustive and could be extended for BMD needs. For example, additional areas of investigation in SDC/CR but not found in the SEI KPAs are systems engineering and development tools. SPR has additional areas of coverage such as the physical environment, experience of the staff, and development methodologies.

The basic approach for extending the SCE and PMM into additional areas will be to define additional KPAs for the new requirements. For reference, these may be called program-defined KPAs, in contrast to SEI-defined KPAs included in the PMM or CMM. In adding program-defined KPAs, it is most important to preserve intact SEI's model and assessment approach for several reasons. First, this allows a program to leverage off SEI-developed training and the experience of DoD and industry in practicing SEI's approach. Second, a program can use the benefit data emerging from this experience as an aid to assessing its own improvement achievements or problems. Third, a program should find it expeditious and economical to address the added requirements with the same team and at the same site visit as the SEI evaluation.

The addition of a program-defined KPA, such as for the BMD TSDM, involves developing a set of explicit criteria for satisfaction of the KPA. The criteria may be expressed as direct requirements or as a set of candidate questions to be answered through the SCE team's interview approach. The criteria also must lead to a report for the added KPA, similar to the one prepared for SEI's KPAs; that is, it must help identify strengths and weaknesses, and support a clear resolution of whether or not the KPA is satisfied.

Any score or level scale associated with added KPAs should be separate and distinct from SEI maturity levels (to preserve SEI's approach without change). Strengths, weak-

nesses, and KPA satisfaction should be the important consideration in either case, not overall score or maturity level.

A program-defined KPA may involve requirements in which SCE team members are not well versed. This means that special training may have to be established for SCE teams, so that they can consistently judge various implementations of requirements as they will encounter in practice.

Program-defined KPAs may depend in part upon evidence and requirements established for SEI's KPAs. An SCE team should have this overlap clearly in mind during interviews in order to gather all the pertinent facts at the most convenient time, rather than doing repeat interviews to handle added KPAs separately from SEI's KPAs.

An SCE team must be able to address all added KPAs within a reasonable additional time on site, perhaps no more than one additional day. This factor especially limits the number and scope of additional requirements. Experience with added KPAs is needed to provide firm guidelines on scheduling.

3. ACTIVITIES PRIOR TO CONDUCTING EVALUATIONS

Prior to performing SCEs, several activities need to be accomplished so that the contractor and government program office can incorporate the SCEs into their schedules and budgets. In order of occurrence, they are 1) develop inputs to the Request for Proposal (RFP), 2) establish evaluation criteria, 3) identify specific program needs, and 4) select the evaluation team. This section will discuss these activities in more detail.

3.1 Develop Inputs to RFP

When using SCEs for source selection and contract monitoring, the offerors must be made aware of the requirement in the RFP. Appendix A of this document provides text that can be used to insert the SCE requirements notice within the RFP and the associated Instructions for Preparation of Proposals (IFPP). The text is expected to be tailored to accommodate the specific requirements of the acquisition.

Appendices B and C provide additional information that should be included in the RFP. Appendix B is a sample project profile that each contractor should complete. The project profile requests general information about a software development effort, such as coding language used, host development system, and applicable standards. Appendix C is a modified version of SEI's PMM questionnaire. The questionnaire requests detailed information on the software engineering practices used on a project. Each of the contractors should complete six to nine of these forms. The SCE team will then review the forms to select the set of projects to examine during the site visit.

3.2 Establish Evaluation Criteria

The Source Selection Authority (SSA) will use the results of an SCE during source selection as either a specific criterion or a general consideration. The former is preferred, since the SCE process can provide valuable information useful in selecting a contractor. In either case, the SSA will request that evaluation criteria be established for using SCE results to support either a color rating or a numerical rating, depending on whether procurement is for the Air Force or the Army. Both rating systems should identify software devel-

opers as high risk if they have a low process maturity, and low risk if the maturity rating is high. In other words, contractors with a level 1 maturity should be ranked lower than those with a level 3 maturity. The criteria for establishing a rating of the contractor's maturity is based on the findings in each of the KPAs.

For example, the following criteria might be used to map SCE results to the Air Force's blue, green, yellow, and red rating scheme:

- Blue: A blue rating is given when the SCE findings show that the offeror is acceptable in all of the following KPAs: project management, project planning, quality assurance, configuration management, training, peer reviews, software engineering process group, standards and procedures.
- Green: A green rating is given when the SCE findings show the offeror is acceptable in all of the following KPAs: project management, project planning, quality assurance, configuration management. In addition, the offeror is acceptable in at least two of the following KPAs: training, peer reviews, software engineering process group, standards and procedures.
- Yellow: A yellow rating is given when the SCE findings show the offeror is acceptable in at least three of the following KPAs: project management, project planning, quality assurance, configuration management.
- Red: The red rating is given when the SCE findings show the offeror is acceptable in fewer than three of the following KPAs: project management, project planning, quality assurance, configuration management.

As an alternative, the following numerical rating method might be used. In this example, a total of eight points can be earned as follows:

- For each of the following KPAs that are acceptable, the offeror earns a point: project management, project planning, quality assurance, configuration management.
- For the offeror to earn any additional points, the offeror must have been acceptable in at least three of the KPAs identified above. The offeror can earn an additional point for the following KPAs, provided that they were acceptable: training, peer reviews, software engineering process group, standards and procedures.

The SSEB will apply either the color rating scheme or the numerical scheme to the SCE results. The examples given previously may be tailored to meet the specific acquisition needs. If the program office is selecting between two contractors that have similar maturity levels, the criteria should be more stringent to differentiate between them. Depending on the program office's concerns, the evaluation criteria can be tailored to emphasize specific KPAs.

3.3 Identify Specific Program Needs

Each BMD element program office may have specialized software needs. It is conceivable that the specialized needs of one or more of the elements would not be appropriately addressed in an SCE performed with the standard PMM-based KPA set. The program office will need to determine if additional KPAs need to be added.

In addition to supplementing the list of KPAs, the program office may also wish to examine SEI's KPAs for ones of special interest to the program office. The SCE team would then put extra emphasis on collecting data from the contractor for that KPA.

3.4 Select the Evaluation Team

When forming an SCE team, the program office must coordinate through BMDO which is responsible for SCE team training and schedules.There are several qualification requirements that BMDO requires of the team and its members.

All team members must have attended an SCE training course, preferably together. Currently, SEI conducts a four-day course. In the future, other training sources, such as the Defense Systems Management College, may be available.

Before being selected for SCE training, potential trainees must have adequate software technical or managerial experience. SEI recommends that trainees have at least seven years of software development or acquisition experience. It is not adequate to have a SCE team consist of solely software acquisition experts nor development experts. It is desirable to have a mix of both professions on the team; at least one representative must have extensive software acquisition experience and at least three representatives must have software development experience. When deciding the team composition, it is also important that at least two of the members have a strong background in each of SEI's key process areas.

BMD teams should not consist of members from a single Service or government organization. Representatives from the Air Force, Army, NTF, and Federally Funded Research and Development Centers (FFRDCs) should be considered for the team.

Other considerations for selecting SCE team members include team skills, leadership, and lack of conflict of interest. Team skills are an important aspect during an evaluation. Those who find the consensus process difficult and those who are unable to contribute to the SCE process will not be effective SCE team members. Team members must have good communication skills in order to work with other team members and with contractors during the evaluation process. Team members must be good listeners so that they can judge what they hear during the evaluation process. Team members should also take initiative. Without such initiative, the evaluation process might become shallow and superfluous.

It is also important to have some team members who can take a leadership role during an SCE to ensure that the SCE progresses smoothly and effectively. All SCE team members will be required to sign a Procurement Integrity Certificate (PIC) for the source selection at hand. The program office should check to ensure that all potential SCE team members will be able to sign the PIC. (Among other things, the PIC requires disclosure of financial interest in any of the RFP offerors.)

If the chosen SCE team has little previous SCE experience or has not worked together on an actual evaluation, it is beneficial to arrange additional training. The purpose of such training is to sharpen skills learned during formal SCE training and to develop interpersonal team building skills. The PMM and the SCE process discussed during the SCE training course should be reviewed. In particular, each KPA should be reviewed to familiarize team members with the criteria to be used during the evaluation. If possible, a mock SCE should be arranged, consisting of interviews with "typical" people encountered during site visits. A mock evaluation helps build interpersonal team skills prior to the first actual site visit.

4. CONDUCTING EVALUATIONS

This section provides guidance to an SCE team for the period between when RFP responses are received and the team has completed the three day on-site evaluation of each contractor. In order of sequence, the SCE team will 1) select projects to be evaluated, 2) establish site visit schedule, 3) submit documentation request to the contractor, 4) develop site visit entrance briefings, and 5) establish interview approach. This section will provide additional details on each of these activities.

4.1 Select Projects To Be Evaluated

In response to the project profile request in the RFP, a contractor will provide information on six to nine projects. The SCE team will use information contained in both project profiles and the SEI questionnaire to select three projects to be evaluated in greater detail during the SCE. This selection process is critical to the success of an SCE. The projects selected must provide data that can be used to judge the risk associated with awarding the proposed project to the contractor. The following paragraphs provide guidance for selecting the projects.

Projects examined during an SCE must be from the same site, division, group, or profit center as that of the proposed project. These organizational divisions vary considerably in industry. During an evaluation, the team will be looking for an organization-level set of policies and procedures that are applied consistently across all projects. Specifically, the team will seek to examine projects with a common quality assurance (QA), configuration management (CM), and software engineering process group (SEPG). One way to determine whether the selected projects are appropriate for examination is to trace the management control from each of these functions up through the organization. These lines should converge at a point also in the management structure of the proposed project; i.e., the QA manager, CM manager, and SEPG managers should be the same for all the projects being reviewed.

Contractor responsibilities on the selected projects should be similar as those on the proposed project. If the contractor is the prime on the proposed project, it is important that

the projects selected for examination represent examples where the contractor also served as the prime. If the contractor has never been the prime before, this is a risk that must be brought to the attention of the Source Selection Authority (SSA). The same is true for any of the following conditions:

- Projects which were subcontracted to another contractor will not provide the SCE team with the information they need. In subcontract work, the development processes used by the subcontractor may have been influenced and guided by the prime contractor and do not represent those of the subcontractor.
- Similarly, the SCE team should avoid evaluating projects where most of the software was government furnished since the team is evaluating the contractor's development process rather than the contractor's ability to integrate government-furnished software.

If the proposed project involves a subcontractor, the SCE team should select at least one project for examination that has included some subcontract work. This will allow the SCE team to evaluate the contractor's ability to assess and guide the processes used by the subcontractor.

Projects selected for examination during an SCE should be technically related to the proposed project. For example, a management information system (MIS) project may not provide adequate information for judging the risk involved with building a sophisticated launch control system.

The scale of the development effort on the selected projects should be roughly equivalent to that of the proposed project. Staff resources and lines of source code are two possible indicators of the scale of the projects. Despite guidance provided to the contractor, the team may still find wide ranging projects offered for their consideration.

It is preferable that the projects selected for examination be on-going development projects. At worst the projects may be up to six months into the maintenance phase. After a project is completed or is in the advanced maintenance phases, people, documentation, and tools used in the project tend to be harder to locate. Often people cannot remember what was done on older projects or how.

4.2 Establish Site Visit Schedule

SEI provides a strawman site visit schedule in the SCE training manual. This strawman has been elaborated to illustrate the breadth and depth of interview coverage desirable during the three-day site visit.

Table 2 represents a suggested scheme for allocating time for interviews during a site visit. The job titles used in the table are generic and refer to typical areas of responsibility. The amount of time allocated to interview individuals in an area is proportional to the number of KPAs typically under the responsibility of that individual. The SCE team should use organizational charts and other documentation to identify the actual titles and names of the individuals with the responsibilities listed in Table 2.

Table 2. Allotted Time for Interviews

Position	Length of Interview (hrs)	Number Interviewed
Project Managers	0.50	2
Software Managers	1.25	2
Manager of QA	0.50	1
Project QA	0.75	1
Manager of CM	0.50	1
Project CM	0.75	1
SEPG	1.25	1
Standards	0.75	1
Training	0.50	1
Software Cost Manager	0.50	1
Subcontract Manager	0.75	1
Subcontractor	1.25	1
Developer	0.75	1

Some functions may be grouped under a single person, others may be spread across several individuals. Table 3 identifies the typical responsibilities of these key positions as they relate to the KPAs. The KPAs are numbered to help the SCE team members to priori-

tize the interview questions. If time runs out during the interview, the KPAs with the highest priority will at least be addressed

Using the allocation from Table 2, the site visit schedule may look something like Figures 4, 5, and 6. These schedules allow fifteen-minute breaks between interviews. This time can be used to discuss findings, modify an interview approach, check documentation or organization charts, modify the schedule for the day, or take a necessary break. The SCE team should avoid overscheduling. Always prioritize the list of people to interview and the topics to be covered during each interview. Allow extra time in the schedule to accommodate unanticipated interviews or document reviews.

Table 3. Topic Priorities for Interviews

Position	Priorities of KPAs[a]							
	PM	PP	CM	QA	ST	PR	TR	SEPG
Project Managers (2)	1	2		3	5		4	6
S/W Managers (2)	3	1		7	5	4	2	6
Manager of QA				1	2	3		4
Project QA				1	2	3		4
Manager of CM			1		2	3		
Project CM			1		2	3		
SEPG		4			2		3	1
Standards				3	1			2
Training							1	2
S/W Cost Manager		1					3	2
Subcontract Manager	1	2	6	3	5	4		
Subcontractor	3	1		7	5	4	2	6
Developer	6	5	3	4		1	2	

a. PM - Program Management; PP - Project Planning; CM - Configuration Management; QA - Quality Assurance; ST - Standards & Procedures; PR - Peer Reviews; TR - Training; SEPG - Software Engineering Processing Group.

Figure 4 provides the sample schedule for the first day of the site visit. The site visit begins with entrance briefings by both the evaluation team and the contractor. The remainder of the day is spent conducting interviews with the senior project personnel.

8:30 - 9:00	BMDO Introductory Brief
9:00 - 10:00	Contractor Entrance Briefing
10:00 - 11:00	Documentation Review
11:00 - 5:30	Interviews:
	1.25 hrs S/W Lead (project A)
	0.25 Break
	0.50 hr Program Manager (project A)
	0.25 Break
	0.75 hr SEPG Manager
	0.25 Break
	1.25 hrs S/W Lead (project B)
	0.25 Break
	0.75 hr S/W QA (project A)
7:30 - 9:30	Caucus

Note: Lunch around 12:00 (1hr)

Figure 4. Schedule for Day One

The second day of the site visit involves interviewing personnel responsible for specific KPAs such as standards and cost estimation. Substantial time is also allotted for documentation review. Refer to Figure 5 for additional details.

The third day of the site visit is reserved primarily for reviewing specific documents requested during the course of the interviews and for finalizing and documenting the SCE findings. Refer to Figure 6 for details.

4.3 Submit Documentation Requests

Organization and project documentation is requested at three stages for an SCE: prior to a site visit, at the start of a site visit, and during the interviews.

Prior to arrival on site, the SCE team will have requested and received a Software Development Plan (SDP), project profiles, an organization chart, and a completed SEI questionnaire. The SDP should be either generic, a corporate standard SDP, or one from the projects offered for examination. The team may request that additional documentation be

provided upon arrival. This documentation is used to plan an interview schedule, identify issues and questions, and form a basis for findings. Figure 7 lists the documents typically requested for use during the site visit.

8:30 - 10:30	Interviews:
	0.75 hr Standards & Training
	0.50 hr S/W Management & Costing
	0.75 hr S/W Configuration Management (project B)
10:30 - 3:00	Documentation Review and lunch
	0.50 hr Project Director (project C)
	1.25 hr S/W Lead (project C)
	0.25 Break
	1.25 hrs Subcontractor S/W Lead
	0.25 Break
3:00 - 5:30	Additional interviews (TBD)
7:30 - 9:30	Documentation Review (at hotel)
Note: Lunch around 12:00 (1 hr)	

Figure 5. Schedule for Day Two

8:00 - 9:00	Documentation Review
9:00 - 12:00	Interviews as needed
12:00 - 3:30	Prepare Exit briefing* (or Final Report)
3:30 Exit Briefing	(*None for source selection)

Figure 6. Schedule for Day Three

During a site visit the team may request additional documentation. These requests come as a result of information gained during the interview process. Information contained in these documents will be used to support information learned during the interview, and

may be used to corroborate findings in the final report. Sample documents to collect during the interview process are listed in Figure 8.

Project Documents:	Program Management Plan
	Software Development Plan
	Software Configuration Management Plan
	Software Quality Assurance Plan
	Software Test Procedures
	Software Standards and Procedures Manual
	Sample Software Development Folder
Division Documents:	Software Policy, Standards, and Procedures
	Generic Software Development Plan
	Quality Assurance Plan
	Configuration Management Plan

Figure 7. Documents To Request Upon Arrival

4.4 Develop Entrance Briefing

At the beginning of the site visit, both the evaluation team and the contractor provide an entrance briefing which helps to identify the scope of the SCE and the contractor's software process.

The evaluation team's entrance briefing is given to the contractors on the first morning of the site visit. The purpose of the briefing is to describe the SCE process and what the contractor can expect over the next three days. An annotated standard BMD entrance briefing is available [Springsteen 1991]. The briefing should inform the contractor that the SEI questionnaire is used by the team only to become acquainted with the contractor and its processes, and that the SCE findings will be based on information collected during the site visit.

The contractor's entrance briefing is an opportunity for the SCE team to become acquainted with the contractor's organization and begin to collect information. The direction the team provides to the contractor's point of contact will determine the quality and amount of useful information they receive during the entrance briefing. It is important that the contractor's entrance briefing not concentrate on findings from other SCEs or SPAs. A

Project Management Documents

- Progress tracking reports or software status reports
- Subcontractor status reports
- Policy and procedures for monitoring subcontractors

Project Planning Documents

- Metrics reports (size, quality, progress, computer performance)
- Estimation process (size, schedule, cost)
- Policy for committing or approving estimates
- Description of central estimation database

Quality Assurance Documents

- Audit checklists and schedules
- Subcontractor audit reports
- Summary reports to senior management (e.g., non-concurrence reports)

Configuration Management Documents

- Software configuration management plan
- Requirements traceability matrix
- Change control board membership and minutes
- Version description document

Peer Review Documents

- Checklist and schedules (design, code, and test case)
- Summary statistics (e.g., type of errors found per life cycle phase)
- Policy and procedures
- Minutes (design, code, test case)

Training Documents

- Training policy
- Training records
- Schedule

Standards Documents

- Templates (SDP, CM, QA)
- Practices for submitting revisions to standards
- Software Standards and Procedures Manual

SEPG Documents

- Process Improvement Plan
- Policy and procedures (e.g., charter)

Figure 8. Documents To Request During Interviews

contractor could use this information to try to influence the SCE team. Since time is limited, the SCE team should ensure the entrance briefing contains as much useful information as possible.

A significant amount of information can be learned from a review of the contractor's organization charts. This information can help the team plan their strategy for the interviews by identifying specific offices or individuals responsible for key management or technical functions. The team should specifically request that the briefing include a discussion of the lines and scope of authority represented by the organization charts. This information indicates the extent to which policies and procedures are institutionalized. It may also begin to indicate inhibitors to process improvement.

Organization charts also serve as a mechanism to discuss the relationships between projects within the company. Shared lines of authority, services, and resources among projects may indicate corporate-wide institutionalization of some policies or procedures.

Support services and groups are generally only visible on higher level organization charts. The organization charts may also identify other, maybe external, review or approval authorities such as a Risk Board.

Lastly, organization charts also indicate the relationship between the contractor and any subcontractors involved with the project.

During a discussion of the organization charts, the team should identify or ask where the SEPG, CM, QA, Costing, Standards and Procedures, and Training managers are in the organization hierarchy. These are critical functions. The team may want to suggest or request a short briefing by each of these managers. The team can make a formal request for specific information, possibly to include organizational charts, in these briefings. The information sought includes the roles and responsibilities of individuals, the scope and influence of their function on the projects being examined, the resources under their control, and the products, standards, and tools they provide to the rest of the organization.

4.5 Establish Interview Approach

The site visit allows the SCE team an opportunity to assess and verify the software practices being used by the contractor. During the site visit, interviews are conducted with project personnel and project documentation is reviewed to verify the adequacy of the practices being employed by the contractor. This section describes the approach taken by the SCE team to conduct and document the interviews.

4.5.1 SCE Checklist

To ensure consistency among BMD SCEs, a standard checklist has been developed (Appendix D). During the course of the interviews, the checklist offers the SCE team a quick reference to ensure that all appropriate topics are covered. The checklist identifies the KPAs and specific issues being explored by the team. Federal Acquisition Regulations require evaluations to be consistent [FAR 1992]. Hence, the checklist can not be changed between SCEs.

4.5.2 Team Member Roles

The SEI SCE training materials provide guidance on the roles of SCE team members during a site visit. This section includes additional roles created from the lessons learned in seven recent SCEs. If possible, roles should be rotated during subsequent evaluations in order to increase the experience of each team member.

a. Door Keeper.

   This person has the responsibility of ensuring that the interviews proceed uninterrupted. The door keeper should arrive at the site with signs that indicate, "SCE Interviews. Please Do Not Disturb." These signs should be posted for the duration of the visit. The door keeper will ensure that the doors to the interview room remain closed during the interview and will escort an interviewee in or out of the room.

b. Introducer.

   This person will introduce the team members to the contractor and give any introductory remarks. The introducer should reiterate to the contractor that all information will be kept in strict confidence and that all comments made during interviews will remain non-attributed.

c. Document Tracker.

   This person will keep a log of all documents requested during the interviews. The log should include the following information: name of interviewee, document name, who requested it, associated KPA, delivered (check), reviewed (check). All documents provided to the SCE team during the visit should be logged, distributed, and maintained by the document tracker.

d. Consensus Builder.

This individual ensures that each team member is afforded the opportunity to express his or her opinion on a given issue. The consensus builder will focus the team during discussions, possibly by suggesting what additional information may help the group reach consensus.

e. Time Keeper.

This individual keeps track of the time during the interviews and the consensus meetings and is responsible for keeping the SCE team on schedule.

f. Report Organizer.

This person maintains the final reports and all the supporting documentation.

4.5.3 Document Interviews

It is important that all information gathered during the site visit be documented so that it may later be used to support findings. During the site visit, interview notes serve to stimulate further questions and documentation requests and to build consensus. Since time is limited, the site visit must be conducted efficiently. Experience has shown that an interview note template may help organize the note taker's thoughts and better support the consensus building process. Figure 9 contains a template which is convenient for formatting interview notes. In addition, the following suggestions are recommended:

a. Use a new notebook for each contractor.

By doing this the team avoids the possibility of confusing one contractor's findings with another and illegally sharing information among the competitors.

b. Use a new page for each person interviewed.

Clearly identify the interviewee at the top of the page. This will eliminate any confusion regarding who may have provided what information.

c. Use the KPAs to organize the information provided during the interview.

By using the name of KPAs as labels, information will be easy to find later during team discussions.

d. List all the documents requested during the interview in a box at the bottom of the page.

The document tracker can then do a quick check before requesting information from the contractor.

e. List questions that arise during the interview in a box at the top right-hand corner of the page.

If one team member is leading the questioning, it is not appropriate for other team members to interrupt to ask their pressing questions. Rather than miss an opportunity to pursue an issue, document the questions as they come to mind so they can be asked at a more appropriate time.

	Questions
Name, title of interviewee Name of KPA - Relevant notes during interview Requested documents Name of document, who requested it, associated KPA	

Figure 9. Template for Interview Notes

4.5.4 Daily Objectives

To ensure the team allocates their time appropriately during the three-day site visit, the following objectives must be achieved each day:

a. Day One.

The SCE team should revisit the schedule following the first day of interviews. Names of people to be interviewed may need to be added or removed from the schedule for the succeeding days. Time allocations may need to be adjusted based on information learned during the first day of interviews. A list of all the documentation requested but not yet received by the team should be provided to the contractor point of contact at the end of day one.

After revisiting the schedule, the SCE team should gather in the evening to discuss the results from the first day of interviews. A rough pass through each KPA should be performed, writing down initial thoughts and impressions. These impressions should indicate where the contractor appears to be strong or weak. All

conclusions must be corroborated by information provided by either another interviewee or by documentation. The SCE team should plan how they will uncover additional information to substantiate their initial conclusions.

b. Day Two.

Following the contractor interviews on day two, the SCE team should continue to develop initial impressions and findings on the strengths and weaknesses of the contractor. The team may need to readjust the site schedule based on information gathered on day two. For this reason, the SCE team should prioritize the KPAs that still need to be addressed before the end of the site visit.

At the end of day two, each member of the SCE team should write a preliminary summary of the strengths and weaknesses for each KPA. The following morning, the team may review initial findings to ensure that sufficient information is being gathered.

c. Day Three.

At the beginning of day three, the SCE team should review each KPA individually. This should be done in a round robin fashion. The discussion should enable each team member to provide feedback on his/her understanding of the information gathered during the visit from interviews and documents. The team should identify areas of agreement and disagreement within the team, and schedule the appropriate interviews to resolve differences of opinion. The team should then make a formal request to conduct these additional interviews with the contractor point of contact.

All interviews must be concluded before noon on the third day. This will allow sufficient time for the team to prepare its findings. Before the team departs from the contractor's facility at the end of the third day, the SCE team should complete the report of its findings.

4.5.5 Other Interview Practices

Following are other good practices for performing SCEs.

a. Record information from document review.

During any document review phase, detailed information about the document must be kept. The individual reviewing a document should log the title and date

of the document in their notebook. If a process is identified in the documentation, this should be logged in too.

a. Establish privacy for SCE team.

   The SCE team requires privacy during the interview process. The SCE team coordinator should request a soundproof room with locking doors for use during the site visit. A room with non-soundproof walls will not permit free discussion among the SCE team members.

b. Use Watts Humphrey's book.

   The members of an SCE team should use the SCE tutorial information and Humphrey's book, *Managing the Software Process* [Humphrey 1989], as reference material during a site visit. This material contains valuable information, and can often clarify any confusion among team members. Each team member should bring this material to each site visit made by the SCE team.

c. Be aware of terminology differences.

   Terms may be understood by people to have different meanings. An example of this is the term "peer review." Even commonly understood terms may be used by a contractor in an entirely different way. The SCE team must be flexible in conversing with a contractor. Make sure to understand the contractor's language rather than insisting that the contractor use the terms familiar to the team.

d. Conduct interviews with the entire SCE team present.

   Although time is limited during the SCE site visit, it is critical that the team remain together and conduct every interview with all the team members present. It is tempting to break the team into subgroups to conduct interviews in parallel. When building consensus, the team will need input from every member. Thus, it is vital that all interviews occur as a group.

e. Assign KPAs.

   Several approaches can be taken in assigning KPA responsibility during the interviews. The team may decide that each member will assume primary responsibility for one KPA, and secondary responsibility for another KPA. In this way each KPA will have the explicit attention of two team members, although all team members will provide input on that KPA during the consensus building process. The team member with primary responsibility for a KPA will formu-

late interview questions and follow-ups, and research the documentation for information. This team member may also be responsible for producing the wording for the findings slides and final report. The team member with secondary responsibility will also pursue information on the KPA and provide back-up during the interview process.

Another approach is to allow team members to pursue all KPAs for which they feel qualified.

f. Take advantage of breaks between interviews.

The breaks between interviews can be effectively used by the SCE team. Breaks provide an opportunity for the team members to discuss information gathered during the last interview and information remaining to be confirmed or pursued during the next interview. Breaks can also be used by the team members to discuss the interview process, a team member's approach to seeking specific information, or to clarify or improve the effectiveness of questions being asked.

g. Establish consensus.

During the consensus-building process, the team should listen to each member. The Consensus Builder is responsible for ensuring that this occurs. Avoid trying for force consensus too early while information is still being collected. Verify all conclusions by cross-checking with other team members' interview notes and with documents provided by the contractor.

It is important to determine early if there are different opinions on whether the contractor is satisfying a KPA. If consensus is not established, this indicates that more information is needed. Identify what information is necessary to support the different view points and appropriately adjust the interview schedule and document requests list. Consensus must be established when ranking the KPAs as acceptable or unacceptable. It is less critical, however, to have consensus on the contractor's individual strengths and weaknesses for particular KPAs. In this event, the team should reach a compromise on the wording of the strength or weakness to accurately reflect the contractor's process.

5. ACTIVITIES AFTER CONDUCTING AN EVALUATION

This section of the report will review the activities that occur after the SCE site visit. Included in this section is a description of the final SCE report and the feedback to the contractor, the SSEB, the program office, and BMDO concerning the results of the SCE.

5.1 Final Report

The SCE team must prepare a report of its findings and their rationale for the contractor, SSEB, program office, and BMDO. Refer to Figure 10 for a depiction of the outline of the report.

1. Summary of Findings

- Acceptable KPAs
- Unacceptable KPAs
- Summary of contractor's software process improvement plans

2. Summary of Project Information

- List of original projects submitted (7-9 projects)
- List of projects selected (1-3 projects)
- Rationale for project selection
- Interview schedule, interviewee names and positions

3. Details of KPAs

- Exit briefing slides
- Rationale for each bullet

Appendix

- Project Profiles (7-9 projects)
- Supporting documentation

Figure 10. Report Outline

The first section of the SCE report should include a high-level summary of the findings. A list of the acceptable and unacceptable KPAs should be provided along with an overview of the contractor's software process improvement plans.

The second section should describe the focus of the site visit. It should include a summary of the SEI questionnaires and a summary of the six to nine project profiles submitted by the contractors. In addition, the site visit schedule should be provided along with the rationale for selecting the specific projects to review.

The main body of the report will contain the exit briefing, annotated to include the details of each of the KPAs. Thus, the main body of the report should include a description of each bullet that appears in the exit briefing (Figure 8) so that the SSEB and the contractors may fully understand each finding.

Each of the slides should contain a summary statement of the KPA, and a list of KPA strengths, weaknesses, and improvement activities the contractor has planned. The summary statement of the KPA should identify whether the KPA was acceptable or unacceptable and the prevailing rationale. This is the most important section of the report. Refer to the example below (Figure 11).

Peer Reviews

Summary: Peer Review process is unacceptable, the process is informal and not applied consistently across all projects.

Strengths:

- Some projects perform low-level inspections of critical modules

Weaknesses:

- Design, code, unit test cases not consistently reviewed across projects
- No formal procedures for conducting peer reviews (e.g., checklist)
- Lack of formal reporting and tracking of peer review findings
- Lack of statistics on findings, results, and effort

Planned Improvement Activities

- None

Figure 11. Sample Exit Briefing Slide

Appendix E contains a list of strengths and weaknesses for each of the KPAs used by previous BMD teams. The SCE team can use these to help formulate the wording of

their findings. It is important, however, to use only the findings that have been verified through the interview process or documentation reviews.

The appendix of the report should contain substantiating information provided by the contractors that support the findings. Included in this section are the six to nine project profiles and questionnaires submitted by the contractors. In addition, copies of information that support a finding should be collected in the event that the SSEB requires additional detail. For example, a page of the SDP that identifies details of an unsatisfied KPA may be copied and included in the appendix for future reference.

The report must be marked CONFIDENTIAL and distribution controlled. The report should be made available only to the SSEB, the element program manager, element software lead, and the Director of Computer Resources Engineering at BMDO.

5.2 Contractor Feedback of Evaluation Results

The contractor may provide feedback on the SCE. When SCEs are used for source selection, the competing contractors will not receive an exit briefing at the end of the SCE site visit. Instead, the winning contractors will be briefed soon after the contract is awarded. At that time the winning contractors have an opportunity to provide feedback of the SCE results and to clarify any questions. The losing contractors will receive a very high-level overview of the SCE results at the "loser's conference," and no detailed feedback will be provided of the SCE results at this time.

When SCEs are used to help monitor a contract, the contractors will receive a detailed Exit Briefing at the end of the SCE site visit. The Exit Briefings offers the contractor an opportunity to understand the SCE results and to question the team on its findings. Since the Exit Briefing slides are not very detailed and the audience is generally very large, contractors may request a follow-up meeting with their SEPG and the SCE team to ensure that the findings are interpreted correctly and incorporated into their software process improvement plans.

5.3 Use of Evaluation Results in Source Selection

One of the most important program management responsibilities in using an SCE for source selection is defining how the SCE results should be communicated to the SSEB. The SCE team and the SSEB must agree upon the format. One method that has been used successfully is for the SCE team to provide the SSEB a copy of the SCE report after each site visit. The report contains a summary of the contractor's strengths, weaknesses, and

improvement plans for each KPA. In addition the summary identifies each KPA as acceptable or unacceptable. Refer to Section 5.1 for additional details of the final report format.

This summary of the KPAs is used by the SSEB and is incorporated with the rest of the source selection process. Refer to Section 3.2 for details of the criteria the SSEB will use to assign a color or numerical rating. In the event that the SSEB requires additional clarification of the findings, the SCE team leader should be available to respond to any questions.

5.4 Use of Evaluation Results for Contract Monitoring

When an SCE is performed to help monitor the contract, the program office should compare the results of the evaluation with the contractor's process improvement plans. If there is a discrepancy between the weaknesses identified by the independent SCE team and those of the contractor's self-assessment, the contractor should be made aware of the differences. The program office should ensure that the contractor has an acceptable plan to mitigate the risks that could result from the weaknesses and to reduce the principal weaknesses over the length of the contract.

There are several approaches the program office can take to encourage contractors to improve their software development processes. One is to emphasize to the contractor the importance of software process improvement in the BMD program. If there are two or more contractors competing for a future contract, the program office can state its plans to use SCE results during the next source selection process. This should help to motivate the competing contractors to improve so that they can better their scores during the next source selection. In addition, the contractors can report the status of their process improvement program at the software reviews (e.g., preliminary design review or critical design review). At the program reviews, the contractors should be required to describe their improvement plans and accomplishments.

Another means of encouraging contractors to improve is to incorporate software process improvement into an award-fee program. Since process improvement focuses on the organization rather than on a specific program, not all projects are good candidates for an award fee. The best are those contractors who have an organization devoted to the BMD program and are working on several BMD projects. For example, the National Test Bed and Integration Contractor (NTBIC) would be a suitable candidate.

If an award fee is suitable, the award fee plan should contain incentives for improving the software process. Depending on the length of the contract and the initial maturity

of the contractor, the plan should include intermediate goals that emphasize the benefits of advancing from a level 1 maturity up to a level 5. Since it is estimated to take at least a year to improve from one level to another, the award fee should be staggered. Assuming that the contractor's initial maturity rating is a level 1, there should be a minimal award at the end of the first year for advancing from a level 1 to a level 2. At the end of the second or third year, there should be a larger reward for advancing from a level 2 to a level 3, and so on. Sample award fee plans can be provided by BMDO.

5.5 Registry of Evaluation Results

As described in Sections 3, 4, and 5 the preparation, conduct, and follow-up for an SCE consume considerable amounts of time, effort, and expense on the part of both the Government and the contractor. Subjecting a contractor to multiple SCEs in the context of several procurements compounds this problem. Reducing the results of an SCE to a meaningful, concise form that can be stored in some repository and reused in later procurements can greatly reduce this time, effort, and expense. Use of an SCE repository could also shorten the procurement cycle considerably by reducing the number of "fresh" SCEs that must be done in order to evaluate fairly and fully the software development process maturity of all the contractors who may respond. Therefore, SCE results should be archived by BMDO.

APPENDIX A. RFP WORDING

A.1 SCE Text For Inclusion in the RFP

The following sample text illustrates how SCEs might be inserted within Section L or M of the Request for Proposal (RFP). This example assumes that the SCE will be used as a specific criterion for source selection.

> Software Engineering Capability. The Government will evaluate the software process by reviewing the offeror's Software Process Improvement Plan and by using the Software Engineering Institute (SEI) developed technique, Software Capability Evaluation (SCE). The Government will determine the software process capability by investigating the offeror's current strengths and weaknesses in key process areas defined in the SEI report *Characterizing the Software Process: A Maturity Framework*, CMU/SEI-87-TR-11. The Government will perform an SCE of each offeror by reviewing current projects at the site proposing on this contract. The evaluation will be an organizational composite, substantiated through individual interviews and reviews of documentation, of the offeror's software process practices on selected projects. The evaluation will determine the offeror's strengths and weaknesses in key process areas relative to maturity level three, i.e., the extent to which an offeror meets or exceeds maturity level three criteria. The on-site evaluators may be separate and distinct from the proposal evaluation team and may include a Government contracting representative. The evaluators will have been trained in conducting SCEs.

A.2 SCE Text for Inclusion in the IFPP

The Instructions for Preparation of Proposals (IFPP) provides guidance to offerors as to how they should prepare their proposal. The following text requests the offeror to provide Project Profiles, organization charts, sample documentation, and a software process improvement plan. It also requests the offeror to provide the SCE team with facilities during the site visit.

> The technical proposal shall include the offeror's response to the software evaluation process. The offeror shall provide the following information to

assist the Government's preparation for the Software Capability Evaluation of each offeror:

a. The offeror shall complete the Project Profile form for six to nine major software engineering development projects.

   All projects should be drawn from the same site and organization (e.g., profit center) bidding on this solicitation. One of these projects must include the [proposed] software development effort and the others should be projects that are near completion or completed within the last three months. These projects should be as similar as possible in scope and magnitude to the [proposed] effort. The projects should be from programs where the offeror was the prime contractor, at least one project should include a development where another subcontractor developed portions of the software, and at least one project should be an Ada project, more if applicable. Project profiles from Special Access Programs are discouraged. For offerors with fewer than seven projects at the bidding site, submit information for as many projects as are available.

   Appendix B [of this report] contains an outline that should be used to generate the project profiles for each of the projects. Included in the outline is the SEI questionnaire. For convenience the SEI questions and response form are provided in Appendix C [of this report]. Respond to the SEI questions with a Yes or No answer. For each "Yes" response, please note the mechanism or document for justifying the response on a separate form.

b. The offeror shall provide project-level and higher-level organization charts.

   The organization charts should contain individual's names and job titles and indicate how the projects above are related to each other. If there are departments that the software projects rely on, these too should be positioned on the organization chart (e.g., training, Software Engineering Process Group (SEPG), quality assurance, configuration management, standards, policy and procedures).

c. The offeror shall provide a sample Software Development Plan (SDP) and a Software Standards and Procedure Manual (SSPM).

   If there are "generic" SDPs and SSPMs, those are preferred; otherwise, select a sample SDP and SSPM from the project that has the most representative SDP.

d. The offeror shall submit its site's Software Process Improvement Plan, in the format of its choosing, with its proposal.

   The document shall be no longer than 15 pages. The Software Process Improvement Plan shall be detailed enough for the offeror to communicate its current software process capability, specific planned improvements, dedicated resources, effort estimates, and a time phasing of those improvements to bring the offeror's software process maturity to the organization's desired maturity level.

e. After the proposal is received, the government will coordinate a site visit with the offeror to discuss the questionnaire responses and conduct the SCE at the offeror's location.

   The offeror shall provide a point of contact and phone number at the offeror's site for the SCE team leader to coordinate all SCE activities. So that the site visit will transpire smoothly for both parties, the government will also communicate low-level details about the site visit during the coordination process, e.g., interview schedules, documentation requests, facilities for the evaluation team. The offeror shall be notified approximately two working days prior to the site visit of the projects to be examined. The site visit dates selected by the government are not open for discussion.

f. During the site visit, the SCE team will need a closed meeting room capable of accommodating at least eight people.

   The offeror shall have a copy of the organization's software standards, procedures and/or operating instructions, and organizational charts for the projects being reviewed in the meeting room when the SCE team arrives. All interviews conducted as part of the SCE shall be done in private, one individual at a time. The SCE team may be separate and distinct from the proposal evaluation team. The SCE team has been trained in performing Software Capability Evaluations.

g. If security authorization is necessary for the evaluation team to be on the contractor's site, a FAX number and telephone number of the contractor's security office should be provided along with a list of any other pertinent information required to obtain security approval.

   It is not the intent of the evaluation to discuss classified information. It is only a matter of convenience for the evaluation team not to require an escort when walking to the cafeteria and restroom.

APPENDIX B. PROJECT PROFILE OUTLINE

The following form is a sample project profile that can be referenced in the Request for Proposal (RFP). Six to nine of these forms, for different projects, should be filled out by each contractor.

a. **Project Name:** name of project listed on the contract.

b. **Project Number:** unique identifying number on the contract.

c. **Project Type:** e.g., scientific, human-machine, business, control, support software.

d. **Customer:** the agency that procured the software and a point of contact within that organization.

e. **Subcontractors/Prime Contractors:** list any subcontractors employed on the project or list the prime contractor if the offeror was a subcontractor.

f. **Current Phase:** identify the current phase of the software development process, e.g., requirements definition, detailed design, code and unit test, integration test, maintenance.

g. **Location:** primary site of the software development effort.

h. **Start Date:** starting date of the contract.

i. **Design Completion Date:** estimated or actual.

j. **Code Completion Date:** estimated or actual.

k. **End Date:** contract completion date.

l. **Team Size:** peak staff-month period and average staff-years over the contract period.

m. **Estimated KSLOC:** estimated/actual Thousand Source Lines of Code. (KSLOC)

n. **Programming Languages:** percentage of KSLOC in languages (e.g., Ada, Fortran, Pascal, C, Assembly).

o. **Target Hardware System:** computer on which software executes.

p. **Development Hardware System:** host computer for the compiler and support environment.

q. **Applicable Standards:** e.g., DOD-STD-2167A.

r. **Cost:** actual/estimated dollars spent to date/completion.

s. **SEI Questionnaire:** The attached questionnaire and its answer sheet should be completed for each of the projects.

t. **Organization Chart:** most recent organization chart for each project with titles and individual names. This chart should identify the individual responsible for the following activities: project management, system engineering, software project management, software engineering, quality assurance, configuration management, subcontractor control, simulation, integration and testing, and other technical software activities.

APPENDIX C. SEI QUESTIONNAIRE AND RESPONSE FORM

This form is a modified version of the Software Engineering Institute (SEI) Process Maturity Model (PMM) questionnaire. It should be referenced and included in the Request for Proposal (RFP), and filled out by each contractor.

Name of Projects

Project A: _____

Project B: _____

Project C: _____

Project D: _____

Project E: _____

Project F: _____

Project G: _____

Project H: _____

Project I: _____

	A	B	C	D	E	F	G	H	I
PROJECT MANAGEMENT									
2.1.3* Is a *formal procedure* used in the management review of each software development prior to making contractual commitments?									
2.1.4 Is a *formal procedure* used to assure periodic management review of the status of each software development project?									
2.4.1* Does senior management have a *mechanism* for the regular review of the status of software development projects?									
2.4.7* Do software development first-line managers sign off on their schedules and cost estimates?									
1.1.1 For each project involving software development, is there a designated software manager?									
1.1.2 Does the project software manager report directly to the project (or project development) manager?									
2.4.4 Is a *mechanism* used for independently calling integration and test issues to the attention of the project manager?									
2.1.17 Is a *mechanism* used for ensuring that the software design teams understand each software requirement?									
2.4.3 Is a *mechanism* used for identifying and resolving system engineering issues that affect software?									
1.1.5 Is software system engineering represented on the system design team?									
2.4.10 Is there a formal management *process* for determining if the prototyping of software functions is an appropriate part of design *process*?									

	A	B	C	D	E	F	G	H	I
2.4.5 Is a *mechanism* used for regular technical interchanges with the customer?									
2.1.5 Is there a *mechanism* for assuring that software subcontractors, if any, follow a disciplined software development *process*?									
PROJECT PLANNING									
2.1.14* Is a *formal procedure* used to make estimates of software size?									
2.1.16* Are *formal procedures* applied to estimating software development cost?									
2.2.7 Are profiles maintained of actual versus planned software units designed, over time?									
2.2.8 Are profiles maintained of actual versus planned software units completing unit testing, over time?									
2.2.9 Are profiles maintained of actual versus planned software units integrated, over time?									
2.2.18 Is test progress tracked by deliverable software component and compared to the plan?									
2.2.19 Are profiles maintained of software build/release content versus time?									
2.1.15* Is a *formal procedure* used to product software development schedules?									
2.2.1* Are software staffing profiles maintained of actual staffing versus planned staffing?									
2.2.2* Are profiles of software size maintained for each software configuration item, over time?									

	A	B	C	D	E	F	G	H	I
2.2.10 Are target computer memory utilization estimates and actuals tracked?									
2.2.11 Are target computer throughput utilization estimates and actuals tracked?									
2.2.12 Is target computer I/O channel utilization tracked?									
QUALITY ASSURANCE									
1.1.3* Does the QA function have a management reporting channel separate from the software development project management?									
2.1.7 For each project, are independent audits conducted for each step of the software development *process*?									
2.4.19* Is a mechanism used for verifying that samples examined by QA are truly representative of the work performed?									
2.4.6* Is a *mechanism* used for ensuring compliance with the software engineering *standards*?									
CONFIGURATION MANAGEMENT									
1.1.6* Is there a software configuration control function for each project that involves software development?									
2.4.9* Is a *mechanism* used for controlling changes to software requirements?									
2.4.17* Is a *mechanism* used for controlling changes to the code? (Who can make changes and under what circumstances?)									
2.4.13* Is a *mechanism* used for controlling changes to the software design?									

	A	B	C	D	E	F	G	H	I
1.1.4 Is there a designated individual or team responsible for the control of software interfaces?									
2.4.8 Is a *mechanism* used for ensuring traceability between the software requirements and top-level design?									
2.4.11 Is a *mechanism* used for ensuring traceability between the software top-level and detailed designs?									
2.4.14 Is a *mechanism* used for ensuring traceability between the software detailed design and the code?									
2.4.18 Is a *mechanism* used for configuration management of the software tools used in the development *process*?									
2.4.20 Is there a *mechanism* for assuring that regression testing is routinely performed?									
2.4.21* Is there a *mechanism* for assuring the adequacy of regression testing?									
PEER REVIEWS									
2.4.12* Are internal software design reviews conducted?									
2.4.16* Are software code reviews conducted?									
2.4.22 Are formal test case reviews conducted?									
2.2.13* Are design and code *review coverages* measured and recorded?									
2.2.4* Are statistics on software code and test errors gathered?									

	A	B	C	D	E	F	G	H	I
2.2.3* Are statistics on software design errors gathered?									
2.3.2* Are the *review data* gathered during design reviews analyzed?									
2.3.8* Is *review efficiency* analyzed for each project?									
2.2.16 Are software trouble reports resulting from testing traced to closure?									
2.2.15* Are the action items resulting from design reviews tracked to closure?									
2.2.17* Are the action items resulting from code reviews tracked to closure?									
TESTING									
2.2.14* Is *test coverage* measured and recorded for each phase of functional testing?									
TRAINING									
1.2.2 Is there a required training program for all newly appointed development managers designed to familiarize them with the software project management?									
1.2.4 Is there a required software engineering training program for first-line supervisors of software development?									
1.2.5* Is a formal training program required for design and code *review leaders*?									
1.2.3* Is there a required software engineering training program for software developers?									

	A	B	C	D	E	F	G	H	I
STANDARDS AND PROCEDURES									
2.1.9 Are coding *standards* applied to each software development project?									
2.1.6 Are *standards* applied to each software development project?									
2.1.11 Are code maintainability *standards* applied?									
2.1.10 Are *standards* applied to the preparation of unit test cases?									
2.1.18 Are man-machine interface *standards* applied to each appropriate software development project?									
2.1.12 Are internal design review *standards* applied?									
2.1.13* Are code review *standards* applied?									
SOFTWARE ENGINEERING PROCESS GROUP									
1.1.7* Is there a software engineering *process group* function?									
2.1.1* Does the software organization use a standardized and documented software development *process* on each project?									
2.1.2 Does the standard software development *process* documentation describe the use of tools and techniques?									
2.4.15 Are formal records maintained of unit (module) development progress?									

	A	B	C	D	E	F	G	H	I
2.3.1* Has a managed and controlled *process database* been established for *process metrics* data across all projects?									
2.3.9 Is the software productivity analyzed for major *process* steps?									
2.2.5* Are design errors projected and compared to actuals?									
2.2.6* Are code and test errors projected and compared to actuals?									
2.3.3* Is the error data from code reviews and tests analyzed to determine the likely distribution and characteristics of the errors remaining in the product?									
KEY PROCESS AREAS									
2.4.2* Is a *mechanism* used for periodically assessing the software engineering *process* and implementing indicated improvements?									
2.3.4* Are analyses of *errors* conducted to determine their *process* related causes?									
2.3.5* Is a *mechanism* used for error cause analysis?									
2.3.6* Are the error causes reviewed to determine the *process* changes required to prevent them?									
2.3.7* Is a *mechanism* used for initiating error prevention actions?									

APPENDIX D. CHECKLIST

Project Management

- Software managers play an active roll in proposal preparation.
- Software progress is tracked. Managers frequently review the progress.
- Software schedules and cost estimates are approved by the software managers.
- There is a process for raising, tracking, and resolving issues.
- Software managers are in the reporting chain.
- Software requirements team relate to software design team.
- Managers have visibility into integration & test.
- System engineering & software engineering relationship is defined and trade-offs are made.
- Subcontractor's development process is known and monitored.
- Subcontractor's standards, procedures, process comply with prime's.
- Subcontractor's results, performance, and commitments are tracked.
- Prime's subcontract manager is knowledgeable of software & trained.
- Subcontractors products undergo periodic technical reviews & interchange with prime.
- Prime's QA & CM monitors subcontractor's QA & CM.
- Prime's senior management reviews status of subcontractors regularly.

Project Planning

- Metrics: design progress, test progress, staffing, integration progress are used.
- Metrics: software size over time, memory utilization, throughput, I/O channel utilization are used.
- Development progress is tracked and reported to program management regularly.
- Software size, cost, & schedules are estimated according to documented procedures
- Commitments are obtained and documented for size, cost, schedules, and resources.
- Policy exists for resource planning & commitments.
- Software managers are trained on software estimation procedures.
- Actual vs. planned estimates are recorded and compared.
- Central estimation manager & data base are maintained for tracking and improving accuracy.

Quality Assurance (QA)

- Independent QA reporting chain exists.
- Audits are conducted during all phases of software life cycle & on all line activities.
- Audits are representative.
- QA has adequate resources (3%).
- QA audits subcontractors.
- Deviations are handled according to documented procedures.
- Senior management reviews QA activities regularly.
- QA authority & concurrence are required.

Configuration Management (CM)

- CM controls requirements, design, code, and interface changes.
- Traceability is maintained from requirements to design to code.
- Tool is used to help control versions and builds.
- Regression testing is performed.
- Baselines are established and include tools and change log in addition to requirements, design, code, and tests.
- CM plan includes staff, schedule, responsibilities, resources, tools, & facilities.
- Library system stores work products and prevents unauthorized changes.
- Documented change request process includes check in/out, reviews, regression tests, and baseline descriptions.
- Change Control Board & change proposal process are documented.
- Change log is used to track open/closed change requests.

Peer Reviews

- Design, code, test case peer reviews are conducted.
- Attendees include no management, interface leads, peers, several people (more than one).
- Documented procedures & checklists are used.
- Peer review process is in SDP.
- Peer review schedule and list of attendees are published.
- Statistics are collected identifying type of errors, severity, location, time preparing, reviewing, and correcting.
- Errors are tracked to closure.
- QA audits peer review activities.

Training

- CM and QA leaders are trained.
- Project managers are trained on software estimation and peer reviews.
- Software supervisors are trained on QA, CM, software estimation, and peer reviews.
- Software developers are trained on peer reviews, software development process, and tools.
- Training resources include money, facilities, tools, and schedules.
- Training policy exists.
- Projects have training needs identified.
- Job functions are mapped to training.
- Training records are maintained and include people and courses attended.

Standards and Procedures

- Coding, unit development folders, and man-machine interface standards exist.
- Generic Software Development Plan, QA plan, CM plan. and standards exist.
- Standards are enforced.
- Standards are updated as needed.
- Responsibility for updating standards & policy is assigned.

Software Engineering Process Group (SEPG)

- Organization is focused on standard software process & improvement.
- Strengths & weaknesses, are assessed, plans to improve are developed.
- Activities include reuse, computer-assisted software engineering, measurement, training, process definition, and improvement.
- SEPG plan includes activities, schedules, responsibility, and resources.
- SEPG is informed of projects process: new techniques, technology & problems.
- Repository of software process information is maintained (life cycle models, lessons).
- Projects have received benefits of SEPG.
- Projects provide input to SEPG activities.
- SEPG has mechanism to transfer technology to projects.
- Full-time SEPG resources are available.

APPENDIX E. SAMPLE FINDINGS

1. PROJECT MANAGEMENT

1.1 Sample Strengths

a. Software leads have direct reporting to Project Management.

b. Project management and software leads are regularly informed of software development status and issues.

c. Compliance with project plans is monitored and enforced (e.g., Quality Assurance (QA)).

d. Management has visibility into software issues. Issues are elevated and tracking process in place.

e. Subcontract management process is well defined and enforced.

f. Software engineering is represented throughout system engineering process (e.g., concurrent engineering teams).

g. Software estimates and commitments are reviewed and approved by senior management.

h. Project responsibilities for each life cycle phase are documented.

i. Regular technical interchanges are held with the customer.

1.2 Sample Weaknesses

a. Lines of authority to support organizations are not clearly understood (by people in the organization).

b. Project management procedures remain informal and non-standard across projects (i.e., not formally or consistently documented). Examples are risk management procedures, procedure for escalation and tracking of issues to senior management, project plans, and the concurrent engineering team concept.

2. PROJECT PLANNING

2.1 Sample Strengths

a. Process for cost estimation is well defined and is based in reality (i.e., cost estimation data is maintained in a database).

b. Corporate historical databases are available for the sizing tools and updated periodically with cost, sizing, and quality metrics collected from all projects.

c. A central group is responsible for maintaining a central cost-and-size database.

d. Guidelines exist for developing software size, cost, and schedule estimates.

e. High-level software schedules and costs are monitored regularly (e.g., milestone reports).

f. Project-level software metrics data are being collected (progress, utilization, staffing, errors, earned value).

2.2 Sample Weaknesses

a. No formal process is in place for estimating software resources (lines of code, effort).

b. Software managers are not trained in software size estimation methods.

c. Software schedules are not derived from a defined and repeatable process.

d. No central software estimation personnel, data base, or feedback mechanism exists.

e. Software development progress monitoring is inconsistent for computer software configuration items, computer software components, and computer software units.

f. No standardized software measurements exist to track progress and product quality consistently across projects.

g. Metrics (e.g., size, cost, schedules) are being collected at the project level but not in a consistent or effective manner.

h. Hardware utilization decomposition and tracking (memory, throughput) is lacking.

i. No enforceable organization-wide directive exists for use of estimating tools.

3. QUALITY ASSURANCE

3.1 Sample Strengths

a. Authority and responsibilities are well defined and documented for each phase of life cycle and activities.

a. QA has separate reporting chain to senior management.

b. QA concurrence is required for major transitions in development.

c. QA has adequate resources.

d. QA has a visible audit trail through all phases of software development and all line activities (e.g., configuration management (CM)).

e. Well-documented policies and procedures are consistent across programs (e.g., audits, checklists).

3.2 Sample Weaknesses

a. Combining the test function with the QA function may negate the advantage of a separate reporting path to senior management.

b. No mechanism exists to determine if audits are representative and sufficient.

c. QA personnel are also performing some line activities (e.g., CM, testing).

d. No feedback mechanism exists for improving software quality process.

4. CONFIGURATION MANAGEMENT

4.1 Sample Strengths

a. Configuration control board responsibilities are defined and implemented.

b. Project change control processes are defined and documented.

c. Automated tools are used to enforce change control process on projects.

d. Configuration status account report is produced.

e. Strong traceability is shown between development products.

f. Formal mechanism is in place for tracking problem reports.

g. Feedback mechanism is in place to refine division-wide CM practice.

4.2 Sample Weaknesses

a. Standard software configuration control is lacking across all projects.

b. Regression testing is not performed and reported.

c. No CM training is performed at the project level.

a. Traceability between requirements, design, and code is inadequate.

b. No organization-wide policies and procedures exist for developmental CM practices.

c. No feedback mechanism exists to track and refine CM practices.

5. TRAINING

5.1 Sample Strengths

a. Comprehensive training requirements for career progression exist for management and technical personnel.

b. Senior management is committed to training.

c. Senior management is responsive to training needs.

d. Comprehensive training manuals and guidebooks are provided.

e. Course schedules are documented.

5.2 Sample Weaknesses

a. Organizational training requirements for software personnel are lacking (e.g., introductory, managers, task specific).

b. Training records are not maintained (e.g., completed course work per person).

c. Routine training schedules are not identified.

d. No training is provided in support functional areas (e.g., CM, QA).

e. No formal feedback mechanism exists to determine adequacy of training (critique forms).

f. A process for identification of project training requirements is lacking.

g. Centralized administration of a group training program is lacking.

6. STANDARDS AND PROCEDURES

6.1 Sample Strengths

a. Responsibility has been assigned for standards development and maintenance.

b. Audit criteria has been established and audits are routinely performed.

c. Management is committed as evidenced by reviews of compliance.

d. Well-defined corporate/group and division/company level standards and procedures exist.

e. A Software Development Plan (SDP) template is developed to facilitate consistency among project SDPs.

f. Review and sign-off on all project SDPs facilitates the flowing of the process guidance to the projects.

g. Deviations from group and division policies require policy control board approval.

6.2 Sample Weaknesses

a. No review process exists to ensure policy, standards, and procedures are current and effective.

b. Standards and practices for software engineering are not enforced at the project level.

c. Process for developing project standards is ad hoc.

d. No formal process exists for tailoring software standards and procedures.

7. SOFTWARE ENGINEERING PROCESS GROUP (SEPG)

7.1 Sample Strengths

a. Group-level SEPG is active with full time staff.

b. SEPG is focused on continuous process improvement.

c. Periodic self-assessments are performed by trained personnel.

d. Process improvement action plan is in place.

e. Process repository is established (e.g., tools, size, cost data).

f. SEPG facilitates flow of information between divisions.

7.2 Sample Weaknesses

a. No feedback mechanism exists for SEPG users—SEPG activities are not effectively communicated to all project software development personnel.

b. No process metrics exist to measure effectiveness of processes.

c. No technology insertion plan exists.

8. WALKTHROUGHS

8.1 Sample Strengths

a. Policy and procedures exist to support the walkthrough process at all phases of the software life cycle (requirements, design, code).

b. Guidelines define walkthrough process activities (e.g., attendance, preparation, review, checklists, reporting results).

c. Formal reporting and tracking of walkthrough findings are performed at project level.

d. QA verifies closure of problems raised during walkthroughs.

e. Walkthrough process is applied to subcontractors.

f. Announcements of walkthroughs are made and contents are distributed in advance.

8.2 Sample Weaknesses

a. Execution of walkthrough guidelines across projects is inconsistent (i.e., no code and test case walkthroughs).

b. No walkthrough summary data and analysis exist to determine effectiveness of walkthrough process (e.g., is sufficient time spent preparing) and to improve the development process (i.e., identify reoccurring problems).

c. Level and composition of participants is of concern (e.g., management attends, audience can be as large as 20).

d. No training courses are available for walkthrough participants (e.g., mediator, reviewer, developer).

REFERENCES

[AFSC 1991] Air Force Systems Command. 1992. *Pamphlet 800-5, Acquisition Management: Software Development Capability Capacity Review.* Wright-Patterson AFB, OH.

[DoD 1987] Department of Defense. 1987. *DOD-STD-2167A, Defense Software Development Standard.*

[FAR 1992] *Federal Acquisition Regulations*. February 1992. Chicago, IL: Commerce Clearing House.

[Humphrey 1987] Humphrey, W.S., and W.L. Sweet. 1987. *A Method for Assessing the Software Engineering Capability of Contractors*. SEI Technical Report SEI-87-TR-23. Pittsburgh, PA: Software Engineering Institute.

[Humphrey 1989] Humphrey, W.S. 1989. *Managing the Software Process*. Reading, MA: Addison-Wesley.

[SEI 1991a] Software Engineering Institute. 1992. *Evaluation Team Training: Participant's Handbook*. Pittsburgh, PA: SEI.

[SEI 1991b] Software Engineering Institute. 1992. *Capability Maturity Model for Software*. Pittsburgh, PA: SEI.

[SPR 1991] Software Productivity Research. February 1991. *Checkpoint Questionnaire, Version 3.0*. Burlington, MA: SPR.

[Springsteen 1991] Springsteen, B. and Dennis Fife. 1991. *Software Maturity Model Applied to SDI*. IDA Document D-1042. Alexandria, VA: Institute for Defense Analyses.

LIST OF ACRONYMS

BE	Brilliant Eyes
BMD	Ballistic Missile Defense
BMDO	Ballistic Missile Defense Organization
BP	Brilliant Pebbles
CM	Configuration Management
CMM	Capability Maturity Model
Dem/Val	Demonstration/Validation
DoD	Department of Defense
EMD	Engineering Manufacturing and Development
FAR	Federal Acquisition Regulation
FFRDC	Federally Funded Research and Development Center
GBI	Ground Based Interceptor
GBR	Ground Based Radar
IDA	Institute for Defense Analyses
IFPP	Instructions for Preparation of Proposals
KPA	Key Process Area
KSLOC	Thousand Source Lines of Code
MIS	Management Information System
MMI	Man-Machine Interface
NTBIC	National Test Bed and Integration Contractor
NTF	National Test Facility
PIC	Procurement Integrity Certificate
PMM	Process Maturity Model
PO	Program Office
QA	Quality Assurance
RFP	Request for Proposal
SCE	Software Capability Evaluation
SDC/CR	Software Development Capability/Capacity Review
SDP	Software Development Plan

SEI	Software Engineering Institute
SEPG	Software Engineering Process Group
SPA	Software Process Assessment
SPR	Software Productivity Research
SSA	Source Selection Authority
SSPM	Software Standards and Procedures Manual
SSEB	Source Selection Evaluation Board
TBD	To Be Determined
TSDM	Trusted Software Development Methodology

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13. ABSTRACT (Maximum 200 words)

This document presents the results of an ongoing study to assess and recommend procedures for conducting a Software Capability Evaluation (SCE) for Ballistic Missile Defense Organization (BMDO) programs. BMDO is using the SCE methodology of the Software Engineering Institute (SEI) to evaluate contractors during the source selection process and to monitor contractors after the award has been granted. SEI provides basic procedures in its SCE training course, but during the course of conducting more than seven SCEs, IDA found that additional procedures and information were necessary to improve the effectiveness of the BMD SCE teams. This document provides additional information in the form of lessons learned, findings, and recommended procedures and techniques for conducting SCEs on BMD contractors. This paper will be used to supplement SEI's training material and reports.

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