A close-up photograph of a hand holding a key, with the hand and key slightly out of focus against a teal background. The key is held between the thumb and index finger, with the head of the key pointing upwards and to the left. The background is a solid teal color with a vertical line on the right side.

# Earned Value Professional Certification Study Guide 3rd Edition

A Product of the Education Board of AACE® International

AACE® INTERNATIONAL

The Authority for Total Cost Management®

AACE<sup>®</sup> International

**Earned Value Professional  
(EVP)  
Certification Study Guide**

Third Edition

Editor  
Sean T. Regan, CCP CEP FAACE

2015



# Earned Value Professional (EVP) Certification Study Guide

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Printed by CreateSpace

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ISBN—13: 978-1502315960  
ISBN—10: 1502315963

A Special Publication  
of  
AACE® International—The Authority for Total Cost Management

# **Earned Value Professional (EVP) Certification Study Guide**

2015

A continuing project of the AACE International Education Board  
With collaboration from the  
AACE Certification Board and AACE Technical Board

## Acknowledgments

The 2013/2014 AACE International Education Board is grateful to the following individuals and companies who have assisted in the development of the **EVP Certification Study Guide, Third Edition**:

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AACE International and the Education Board would like to give special thanks to Jacobs Engineering, Administrative Controls Management, Inc. (ACM), PMSOFT Group of Companies, Management Technologies, and LGM International, LLC, for the time and support they provided to the writers and editors of this document. Without their support and the dedication of their writers, reviewers and editor, the timeframe in which this document was written could not have been met.

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## Preface

AACE International developed the “Earned Value Professional (EVP) Certification Study Guide” for two reasons. First it is to aid professionals studying for AACE International’s (AACE) specialty certification in earned value management (EVM). Second, to assemble and summarize various topics considered essential for earned value management professionals’ knowledge, as outlined in AACE International’s Recommended Practice 11R-88, “*Required Skills and Knowledge of Cost Engineering.*”

The “Earned Value Professional Certification Study Guide” (study guide) serves the needs of EV professionals who are preparing to take the AACE International Earned Value Professional (EVP) certification examination. It is organized in a concise and easy-to-follow format and covers the major skills and knowledge used by a EV professional.

The information contained in the study guide parallels the related topics of the “Skills and Knowledge of Cost Engineering” and the “Certified Cost Professional (CCP®) Certification Study Guide.” These publications can be combined for a course of study in both cost engineering and earned value management, which include sample problems related to the subject matter.

Most terms and phrases incorporated in the study guide are generic to the profession; where applicable, however, professionals should understand the definitions provided in AACE International’s Recommended Practice 10S-90, *Cost Engineering Terminology*, and the terms found in the glossary of this study guide. The terms and phrases used in industry and software may not conform to the readers’ understanding, so consult the EVP glossary found in Appendix A.

The goal of the AACE International Education Board is continually to improve this publication, making it a living document that will be revised as needed to support the EVP exam, while maintaining its strengths. AACE’s Education Board encourages everyone to offer comments and suggestions for improvements to future editions; please forward comments to the AACE International Education Board at: [education@acei.org](mailto:education@acei.org).

Please see **Introduction to the EVP Certification Study Guide** on page 9

# Introduction to the EVP Certification Study Guide

This is a study guide for the Earned Value Professional (EVP) certification examination sponsored by AACE International, the Authority for Total Cost Management.

The following systematic approach was used to develop this guide:

1. Review basic Earned Value Management (EVM) concepts.
2. Establish the terminology used in EVM in a way that is consistent with the ANSI/EIA 748 C, September 2013 standard and AACE Recommended Practice 10S-90, *Cost Engineering Terminology*, which has been adopted by ANSI.
3. Review the EVM process.
4. Review methods for monitoring a project by using EVM.
5. Review methods of reporting, executing, and forecasting project performance using EVM.
6. Ensure consistency with AACE International’s Total Cost Management (TCM) Framework, as shown in figure 1.

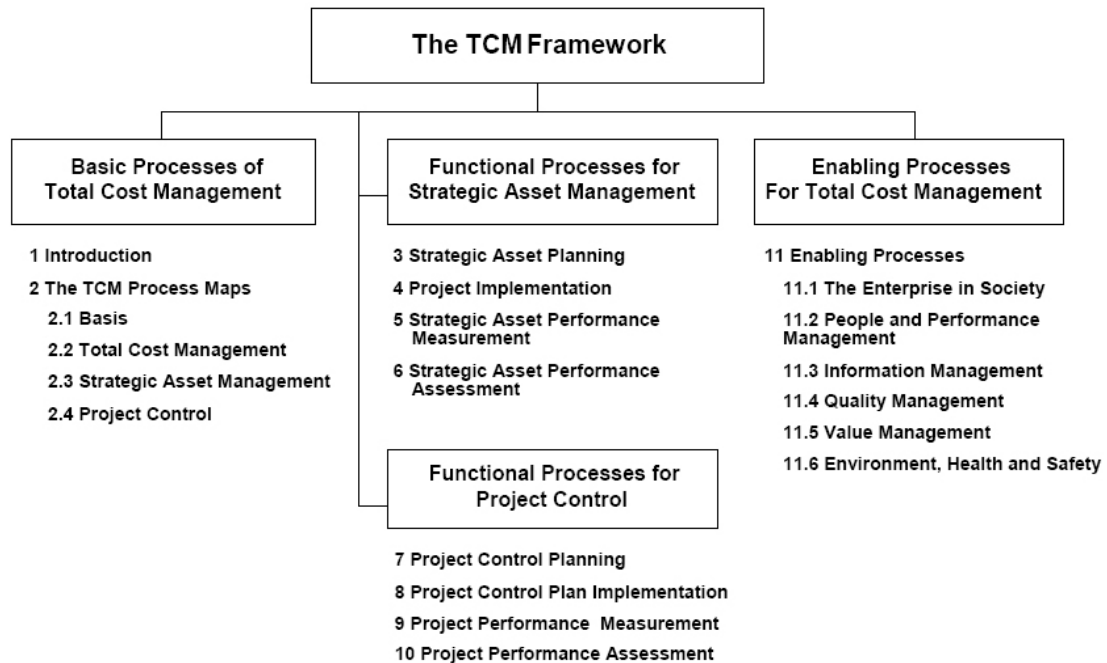


Figure 1—Outline Structure of AACE International’s TCM Framework

As shown in figure 1, EVM comprises a critical part of the functional processes for project control. EVM is a specific methodology that includes planning, performance measurement and assessment steps. EVM contains many elements of the project controls process, as described in the AACE publication, **Total Cost Management Framework, Part III. Project Control Process**. While the TCM Framework process is not limited to EVM methods, it is consistent with them. This is illustrated by the *TCM Process Map for Project Performance Measurement* (from the TCM Framework, Section 9.2, *Progress and Performance Measurement*), shown in this study guide as figure 2. It includes general measurement steps that apply to EVM, as well as the process map. A the *TCM Process Map for Project Performance Assessment* (TCM Framework, Section 10.1) shown in figure 3,, as well as a *TCM Process Map for Change Management* (TCM Framework, Section 10.3) shown in figure 4, that includes general project assessment steps applicable to EVM. It should be noted that there are a number of other areas within TCM that are applicable in EVM (for example, but not limited to: TCM Framework, Section 8.1 – *Project Control Plan Implementation*, and Section 9.1 – *Project Cost Accounting*).

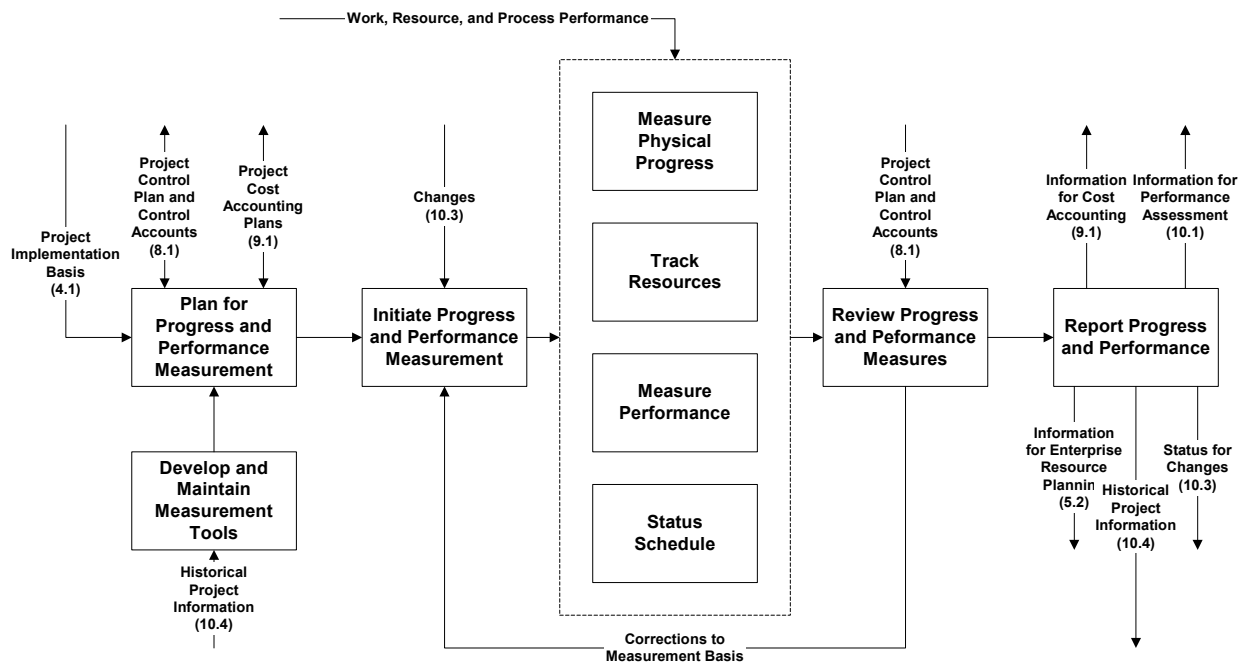


Figure 2—The TCM Process Map for Project Performance Measurement

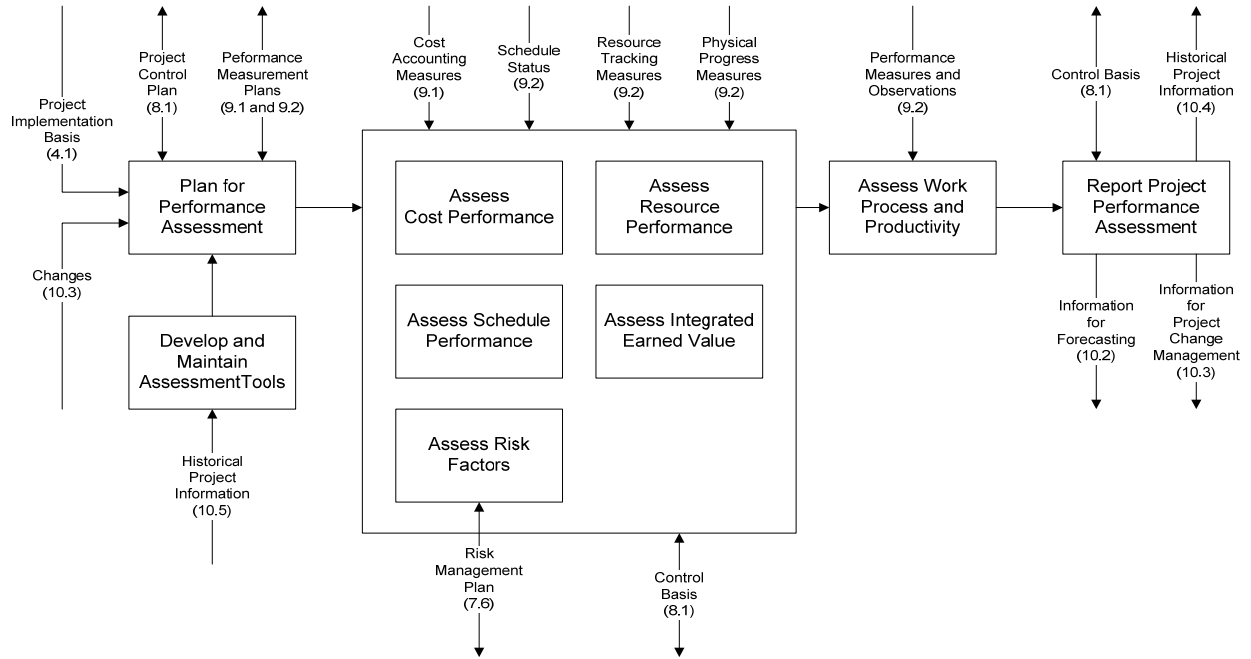


Figure 3—Process Map for Project Performance Assessment

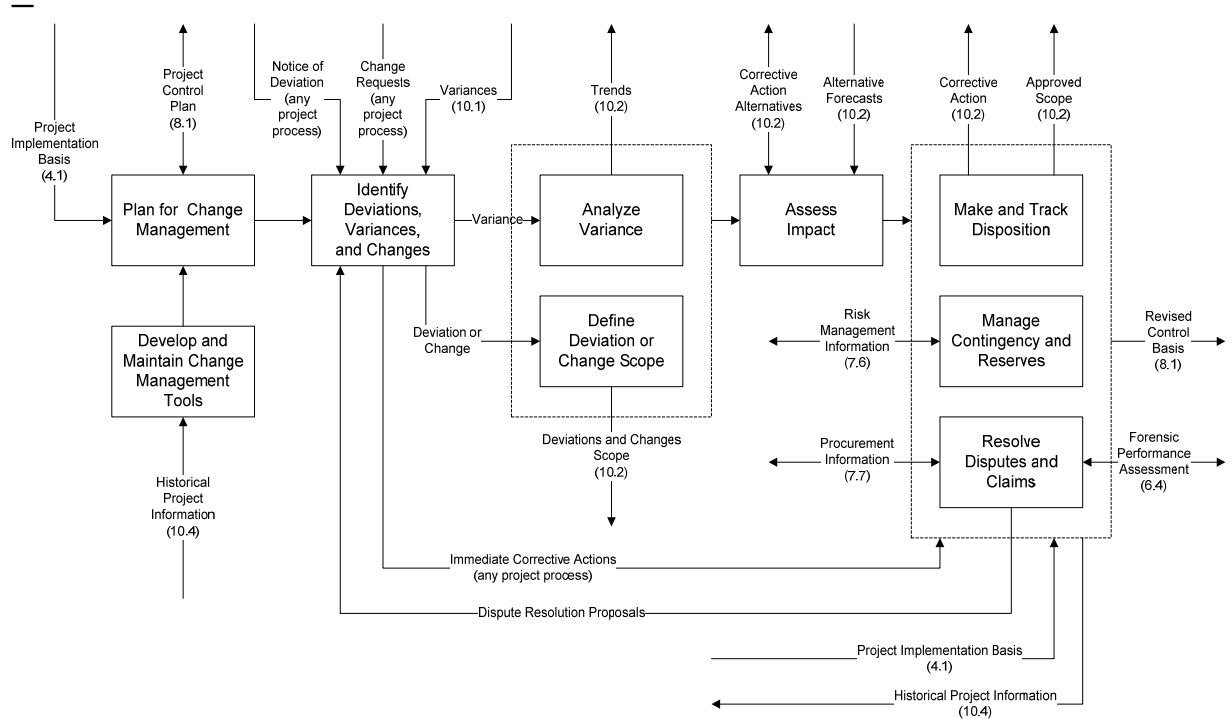


Figure 4—Process Map for Change Management

The overall learning objectives of this *Study Guide* are:

- Understand the basis of EVM within the TCM Framework process.
- Know the evolution of EVM.
- Describe what is essential to plan and implement an earned value management system (EVMS).
- Understand and be able to execute the measurement and tracking of EV as a basis of project management. And,
- Provide the basis for AACCE International's EVP Certification within the TCM Framework of figure 2.

## References

These are the references providing the basis of knowledge outlined in this guide (Please visit [www.aacei.org](http://www.aacei.org) for the most current version of the referenced AACE Recommended Practices (RP) as the RPs are periodically updated):

1. **AACE International Recommended Practice (RP) 10S-90, Cost Engineering Terminology.** (2014).
2. **AACE International Recommended Practice (RP) 11R-88, Required Skills and Knowledge of Cost Engineering.** (2013).
3. **AACE International Recommended Practice (RP) 14R-90, Responsibility and Required Skills for a Planning and Scheduling Professional.** (2006).
4. **AACE International Recommended Practice (RP) 23R-02, Planning and Scheduling Identification of Activities.** (2007).
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8. **AACE International Recommended Practice (RP) 81R-13, Required Skills and Knowledge of Earned Value Management.** (2014).
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[http://management.energy.gov/documents/NDIA\\_PMSC\\_EVMS\\_IntentGuide\\_Nov\\_2006.pdf](http://management.energy.gov/documents/NDIA_PMSC_EVMS_IntentGuide_Nov_2006.pdf)
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27. Pritchett, M. (Ed.). **CCP Certification Study Guide**, 1st Edition. (See especially Section 4, *Progress and Cost Control*.) AACE International, (2014).
28. Wickwire, J., T. Driscoll, and S. Hurlbut. **Construction Scheduling: Preparation, Liability and Claims**, 2<sup>nd</sup> Edition, (2007).

This **EVP Certification Study Guide** assumes a basic knowledge of EVM on the part of the candidate. The study guide addresses EVM knowledge and skills that are non-industry specific.

This manual guides the student to learn the basic terminology and processes for the earned value management process. However, an individual's company or industry may dictate or emphasize other methods or means as part of the EVM process of a project or program implementation.

The *study guide* is organized according to the EVP body of knowledge, and this body of knowledge is described at the beginning of each individual section. The recommended examination preparation should include review of many of the references listed above. The candidate must also draw knowledge from personal EVM experience.

## Origin of Earned Value Management

The Earned Value Management System, or EVMS, is not a new concept. In fact, according to Lt. Gen. (USAF) Hans H. (Whitey) Driessnack, it was derived from the factory floor in the late 1800's. Planned, earned, and actual standards were the terminologies used then:

*"The earned value concept came to us right off the factory floor, from the industrial engineers who were comparing their planned standards with the earned standards and the actual costs. We simply applied this same concept to our one-time only, non-recurring developmental tasks." [Driessnack, 1990].*

In the 1950s, "cost variance" was defined by industrial engineers as the difference between the actual costs expended as compared to the earned standards achieved. This is an early indication of the correct application of modern earned value analysis methods.

### **PERT/Cost, Late 1950s-Early 1960s**

The earned value concept evolved over time in major phases. Much of the material below is taken from Quentin Fleming in his book, *Earned Value Project Management*, 2<sup>nd</sup> Edition [Project Management Institute, 2000].

The scheduling methodologies that underlie today's earned value systems derived from two types of schedule logic networks:

- *Activity-on-Node (AON) Network* also referred to the *Arrow Diagramming Method (ADM)*.
- *Precedence Diagram Method (PDM) Network*.

The *Program Evaluation and Review Technique (PERT)* was developed by the US Navy in 1958, to manage the Polaris Missile Program. Its objective was to simulate the schedule risk of the missile Research & Development program work using a flow diagram technique that, in turn, lent itself readily to scheduling and network analysis. However, its complexity made it unpopular and limited its applicability as a tool for general scheduling. The scheduling methodology called *Critical Path Method (CPM)* was developed at about the same time by a DuPont engineer using the *Activity-on-Arrow (AOA)* method for network development, and it became a more readily accepted basis for scheduling. While not identical, procedures for both techniques were similar and leveraged the computational capabilities provided by electronic computers.

According to Fleming, "Most of the networks today that are called PERT are actually *Precedence Diagram Method (PDM)* networks, not true PERT networks." The importance of PERT to earned value, however, lies in the implementation of the PERT/cost models in industry. With the implementation of PERT in 1962, eleven reporting formats were required, one of those being a "cost of work report," which required the measurement and comparison of "value of work performed" versus the "actual costs." This was a beginning of the modern earned value technique as a project management tool as we know it today.

### **Cost/Schedule Control Systems Criteria (C/SCSC): 1967 to 1996**

The development of the C/SCSC was led by the US Air Force, which endeavored to determine if contractors involved in the development of systems could do so while observing certain simple management criteria. According to Driessnack, an interview of an individual who was actually

involved in the development of this system revealed that these criteria covered the following questions:

- Does the contractor break down the work into short span packages that can be budgeted, scheduled, and evaluated?
- Does the contractor have a system for accumulating costs?
- Does the contractor measure performance on these work packages? And,
- Does the contractor report status and variances to their own internal management?

When initially implemented, the US Department of Defense (DoD) imposed 35 criteria on any contractor desiring to perform work on cost reimbursable or cost incentive contracts, over a certain funding threshold. This system was adopted by many governmental agencies.

According to Fleming, although generally beneficial in its ultimate effect, the C/SCSC had mixed results. Although much valuable project data was gained, the system grew ever more bureaucratic and difficult for contractors to implement and maintain on projects. Many of the more detailed aspects of system implementation were resisted by contractors. In fact, it was not adopted by private industry for a number of reasons. Much of the rejection of the C/SCSC was based on the need to understand a new set of terminologies that were not intuitive to many project managers, such as using the term *Budgeted Cost for Work Scheduled* (BCWS) instead of the word “planned”; *Budgeted Cost for Work Performed* (BCWP) instead of “earned;” and *Actual Cost of Work Performed* (ACWP) instead of “spent.” Additional frustration was experienced by practitioners in the field through the adoption of other confusing terms within the system that, they believed, served to only cloud the simpler project issue of cost over-runs and schedule delays.

#### **EVMS (ANSI/EIA 748): 1996 to Present**

Feedback from practitioners and the refusal of private industry to adopt the C/SCSC led the US government to revise it and develop a simpler system that would be accepted by the private sector.

This demonstrated conclusively that EVM mattered to secretary-level leadership. In the 1990s, many [U.S. Government regulations](#) were eliminated or streamlined. However, EVM not only survived the acquisition reform movement, but became strongly associated with the acquisition reform movement itself. Most notably, from 1995 to 1998, ownership of EVM criteria (reduced to 32) was transferred to industry by adoption of ANSI EIA 748-A standard [7].

The National Defense Industrial Association (NDIA) led this effort, reducing the number of system performance criteria from 35 to 32. The result of NDIA’s work was called the “*Earned Value Management System*” (EVMS), which was adopted by the Department of Defense in December 1996, and incorporated into *DoD Instruction 5000.2R*. Wider application of this system outside the realm of the DoD was the goal of its 32 guidelines being reflected in American National Standard Institute/Electronic Industry Association (ANSI/EIA) 748 Guide that was issued in 1998. The ANSI/EIA 748 B Guide was published in July 2007 and C issued September 2013.

With a return to a simpler, more intuitive approach as represented by EVMS, private industry adoption of EVM techniques grew in recognition of it being a “best-practice methodology.” The passage of the Sarbanes-Oxley (SOX) Act in 2002, which intended to more effectively detect fraud in corporate operations, has further strengthened the standing of the EVM method as a robust means to ensure that project execution proceeds in a transparent.

## EVP Certification Examination Structure

### **Introduction**

Certification as an Earned Value Professional (EVP) requires passage of a written examination in addition to other experience criteria as set forth by AACE International. This study guide provides information for preparing to take the EVP examination, however it is recommended that the latest version of ANSI-748 be studied as it is the basis for the examination.

### **Examination Basis**

The purpose of any professional certification or licensing program is to provide a mechanism to formally and objectively evaluate and publicly recognize the capabilities of an individual in a defined skill area. Certification as an Earned Value Professional (EVP) recognizes certificate holders who have demonstrated their expertise in Earned Value Management (EVM). Specifically, EVM includes the following:

- organizing;
- planning, scheduling and budgeting;
- accounting considerations;
- analysis and management reports; and,
- revisions and data maintenance.

These EVM components provide the basis for the AACE International certification examination. The examination tests for proficiency across these areas.

To define EVM more specifically in terms of expected skills and knowledge, AACE International has published several Earned Value Recommended Practices (RP). Please refer to the RPs for additional technical background which will be useful during the examination. In addition, other references include the ANSI-748, the National Defense Industrial Association (NDIA) Intent Guide dated 2014, and the Recommended Practices for the basis for the EVP examination. Other helpful documents include the GAO Cost Estimating and Assessment Guide dated March 2009 and the GAO Scheduling Guide dated 2013; the DOD EVM Guide; the PASEG Planning and Scheduling Excellence Guide. In recognition of this, the examination addresses the following.

- minimum knowledge covered by the basic skills documents; and
- advanced knowledge based upon EVM experience.

A professional project controls engineer specializing in EVM is expected to keep abreast of these advances and demonstrate this awareness in the examination.

### **Computer-Based Examination Schedule**

Computer-based examinations are offered year-round in over 500 locations around the world. When you're ready to take the examination, submit your application to AACE Headquarter along with payment. Once you're approved for the examination, contact the Kryterion office to schedule the location and date that you want to take the examination. The exam must be taken within a specified period of time after approval.

**Examination Format**

The examination consists of four parts

- **MULTIPLE CHOICE EXAMS:** The exam is delivered through computer based testing (CBT)\* and is comprised of multiple-choice and compound, scenario questions.
- **MEMO ASSIGNMENT:** The memo assignment will allow the candidate to choose from an onscreen list of suggested scenarios and will require the candidate to demonstrate professional writing skills and a general knowledge around an estimating competency. The memo will be written in the text box provided onscreen and should demonstrate a candidate's ability to organize thought and communicate effectively. The memo will need to be addressed properly, include a purpose statement, describe the potential impact of any described problem or issue, propose a clear actionable solution with supporting rationale and include a closing statement. In addition to demonstrating technical knowledge, successful candidates will be recognized for applying appropriate Enabling Knowledge. See also Appendix C for additional and more comprehensive guidance notes

The exam is closed book. Candidates are permitted to bring any style of calculator, including programmable calculators, to use during the exam.

The examination is not based upon use or knowledge of specific software, but rather embodies the knowledge and experience of a DRM practitioner using such tools. All materials provided during the examination, including work paper, must be turned in upon completion of the examination.

Recognizing that there are many industries and fields within the profession—engineering, construction, manufacturing, process facilities, mining, utilities, transportation, aerospace, environment and government—candidates can expect questions from any of these practices. The exam takes into account the fact that no one can be expected to be conversant in all practice areas through its multiple-option format and extensive use of questions of general applicability.

EVP candidates are expected to have fairly broad skills, knowledge, and experiences in cost engineering in addition to specific EVM skills and knowledge. While it is not required, candidates will benefit from first passing the CCP examination because of the exams' shared skills and knowledge of total cost management (TCM) and cost engineering in general and economic analysis in particular. However, passing the EVPP is not a substitute for nor does it indicate achievement of the CCP. EVM professionals cannot provide effective support to decision makers and project leaders without understanding the context of the relevant asset and project management process.

Earned Value Management goes beyond the CCP with respect to skills and knowledge of EVM process steps (as shown in figures 3 and 4) and incorporated methods such as decision analysis, risk analysis, and contingency analysis. These methods require strong quantitative skills and knowledge, particularly in the areas of probability, statistics, and modeling. Finally, communication skills are vital to making sure earned value skills are identified and understood, particularly among stakeholders, decision makers, and managers who have strong expectations and biases. Before investing in the effort and expense required for taking the exam, candidates should review objectively their understanding, skill, and experience of this diverse body of knowledge.

# Chapter 1.0—Organization

## Introduction

Organizing the work is the initial task for planning any project or task. Organization entails defining the project or task scope of work and the groups or individuals that will be responsible for the various execution phases of any task or project. The organizational elements of a *Program* or *Project Management Office* (PMO) consist of, at a minimum, the *Work Breakdown Structure* (WBS), *Organizational Breakdown Structure* (OBS), *Work Authorization* (WA) process and documents, and a *Responsibility Assignment Matrix* (RAM).

The OBS reflects the company’s organization as integrated with a particular PMO to support a specific project. Many organizations operate as a matrix organization and others may use an *Integrated Product Team* (IPT) approach. A PMO is usually established to be responsible for the business and technical management of the project.

## Terms to Know

- *Program or Project Management Office* (PMO);
- *Work Breakdown Structure* (WBS);
- *Organization Breakdown Structure* (OBS);
- *Work Authorization* (WA);
- *Work Authorization Document* (WAD);
- *Responsibility Assignment Matrix* (RAM);
- *Integrated Product Team* (IPT);
- *Budgeted Cost for Work Scheduled* (BCWS); also referred to as *Planned Value* (PV);
- *Budgeted Cost for Work Performed* (BCWP); also referred to as *Earned Value* (EV);
- *Actual Cost of Work Performed* (ACWP); also referred to as *Actual Cost* (AC);
- *Budget at Completion* (BAC); and,
- *Estimate at Completion* (EAC).

## Key Points for Review

Organization is the key in developing a system for execution and management of a project supported by an EVMS.

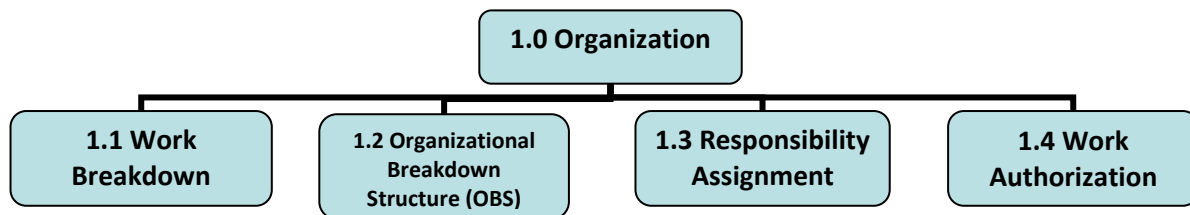


Figure 1.0 —EVP Body of Knowledge Diagram for Organization

## Section 1.1 Work Breakdown Structure (WBS)

### Introduction

The *Work Breakdown Structure* is the fundamental building block of an earned value management system. It is the “What” of the EVM system. The WBS provides the framework by which all project effort is organized so it can be scheduled, budgeted, authorized, measured, and reported. The WBS is an organized, hierarchical decomposition of project scope that serves as the backbone for the planning and management of the project. The WBS contains all of the work scope required by the contract, called the *Statement of Work (SOW)*. It may also be referred to as *the Statement of Objectives (SOO)* or other government document.

The WBS is developed by decomposing the program into its various deliverables and services. It should be based on deliverables rather than on functions. Each deliverable is continually decomposed until all tasks necessary to complete the project are identified *and assigned to a specific party or team, and all resources essential to accomplish the tasks are assigned* in detail to the tasks. The deliverable-orientation of the structure allows for effort to be estimated for the identified tasks, the effort to be translated into an estimated cost, and the estimated costs to be rolled-up to sub-deliverables of the program. This, in turn, allows for the balancing of scope to budget that is crucial for a successful earned value management program.

The *WBS Dictionary*, a separate document from the WBS, provides definitions of each WBS element and is a cross reference between WBS elements and the corresponding project statement of work, mission statement, or other customer documents that define the scope of work. It is essential that the cross reference be checked for completeness against the SOW and that no work included in the *WBS Dictionary* is in excess of the SOW scope. The latter is necessary to ensure that no work is being performed that is outside of the contractual requirements. It also is used to validate the opposite that all of the SOW has been planned within the WBS structure. The WBS Dictionary that defines the WBS elements must be unique to the project or program. Typically, the WBS Dictionary should include the number, title, definition of the scope, any deliverables under that WBS element, and the organization responsible for performing the work. See example shown in figure 1.1 for a sample WBS.

Each WBS element should be identified in a numeric (or alpha or alphanumeric combination) hierarchy such that each element is associated with a unique identifier that also identifies the level at which the element exists. Often numeric indenture levels are separated by periods. Normally, the customer defines the top two or three levels of the contract WBS (CWBS) and the contractor further defines the WBS to the lowest managerially significant level depending on the complexity of the project. The WBS must go down to at least the level required for management control, however it may be extended below this to the work package or even to activities/milestones/or charge numbers.

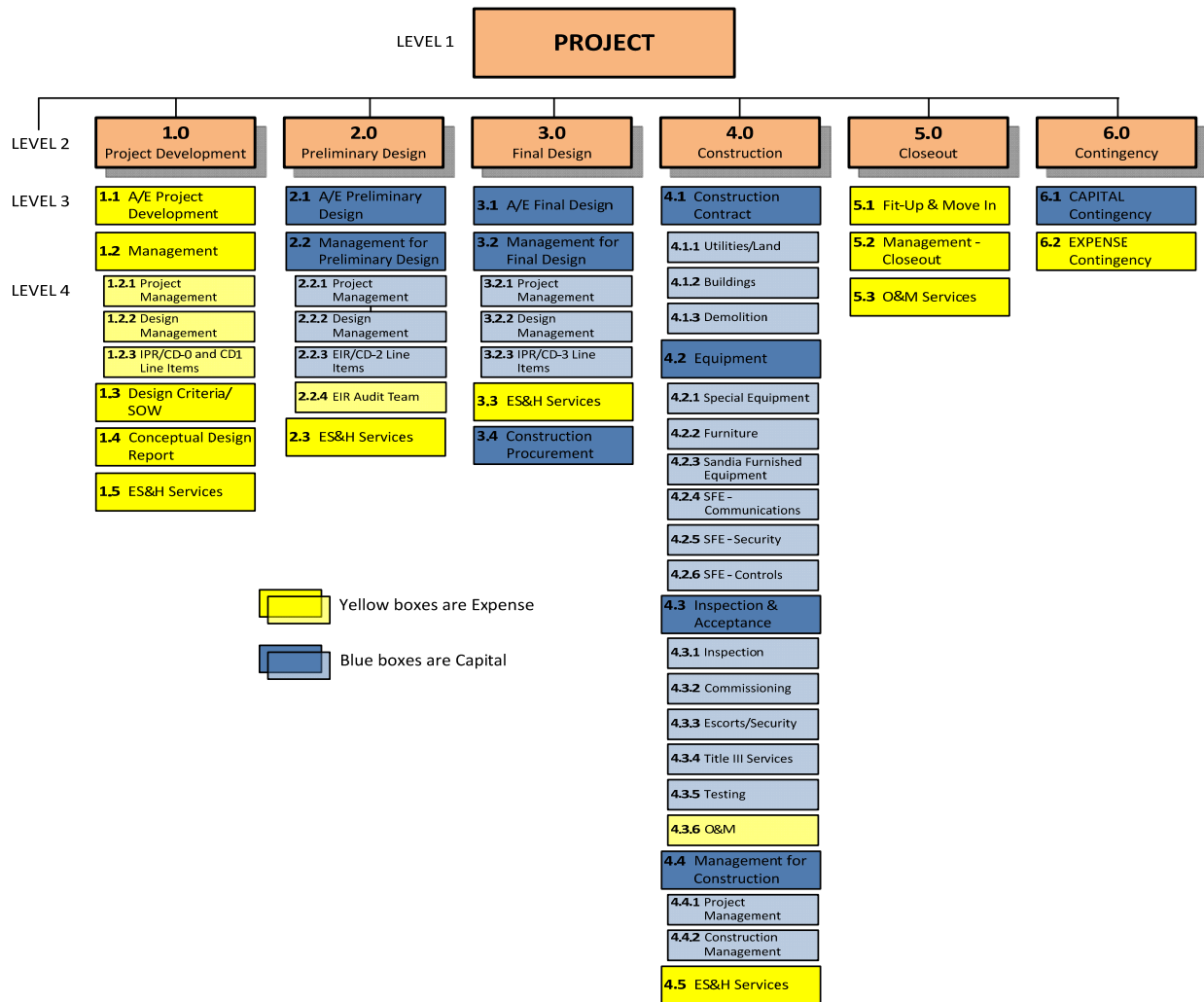


Figure 1.1—Sample WBS

**Terms to Know**

- *Work Breakdown Structure (WBS);*
- *Statement of Work (SOW);*
- *WBS Dictionary;*
- *WBS number; and,*
- *WBS level.*

**Key Points for Review**

1. Know why the WBS should never over or under-represent the full project scope.
2. Know how the WBS graphically displays products and services.
3. Know the relationship between the WBS and SOW. And,
4. Know how to develop the *WBS Dictionary*.

Please see **Sample Questions for Section 1.1** on page 23

**Sample Questions for Section 1.1:**

1. Which of the following is not a component of the *Work Breakdown Structure*?
  - A. Scope
  - B. Deliverables
  - C. Numeric designator
  - D. WBS Dictionary
  
2. The WBS numeric designator 01.02.023.01.502.06 typically represents what level of the WBS hierarchy?
  - A. 4
  - B. 5
  - C. 6
  - D. 7
  
3. Which of the following statements about the WBS is not true?
  - A. A project consists of the sum of all the WBS elements.
  - B. Any element that is not contained in the WBS is not part of the project.
  - C. Any work that cannot be identified in the WBS requires an approved change order.
  - D. The WBS contains functional elements such as engineering and manufacturing.
  
4. A WBS:
  - A. Is derived from the project schedule network logic diagram.
  - B. Is derived from the conceptual cost estimate for the project.
  - C. Always has five hierarchical levels.
  - D. Is the structure by which the project scope is decomposed into manageable components.

**Solutions to Sample Questions for Section 1.1:**

1. D The WBS Dictionary is not part of the WBS, but is a separate document.
2. C Six levels, as identified by the break, which is normally a period.
3. D A WBS is the “What.” The WBS should be based on deliverables, not on functions. Functions are the “Who” and belong in the *Organizational Breakdown Structure* (OBS).
4. D The WBS divides the project into manageable scopes of work, which are assigned to responsible parties with necessary management authority.

## Section 1.2 Organizational Breakdown Structure (OBS)

### Introduction

The *Organizational Breakdown Structure* (OBS), or the project organization structure as it is called by some organizations, reflects the company's responsible organization in a hierarchical breakdown of the project team. The OBS is the responsibility breakdown of the project, contrasted to the WBS which is a product-oriented breakdown of the project. For further information, refer to EVM Guideline #2. The OBS is usually a graphical or tabular listing of responsibility from the Project Manager to the *Control Account Managers* (CAMs), structured in a hierarchical manner. The OBS defines the work authorization and flow of responsibility for scope and budget management within the project.

The OBS is a direct representation of the hierarchy of the organization responsible for the successful execution of the work scope, schedule, and budget of assigned WBS elements or portions thereof. It is established to ensure that the necessary resources to plan and perform the required work are available. The OBS helps management establish the most efficient organization by taking into account the availability and capability of management and technical staff including subcontractors to achieve the project objectives. The project manager works with functional managers to determine organizational responsibility for the project's scope of work and ultimately determines who has responsibility for the Control Accounts (CA).

There are three main types of organizational structures: functional, matrix, and project:

- The functional organization structure is one in which each functional group has a manager over the group's function such as engineering services, and experienced individuals reside in the functional group performing tasks assigned to the group.
- The matrix organization is one in which functional professionals are grouped together to support a specific project, while simultaneously remaining a member of their functional organization. The "matrixed" individual receives assignments from the person whom they are supporting. However, the administrative needs of the matrixed individual remain the responsibility of the functional manager while on assignment to "matrixed" project.
- The project organization is one in which a project is authorized to proceed, given a budget to allocate expenditures, and has a definite start and finish date. The project organization has an appointed manager or task leader and develops an organizational structure from which they draw specific resources in order to execute the project. The individuals assigned to the project support the project execution until released by the manager, when they then return to their respective functional organization for re-assignment or to continue their functional duties.
- Another type of project organization is by industry or client. For example, an engineering firm may be organized by US federal client vs. state vs. private clients, or may be organized by transportation, water, and energy industry sectors.

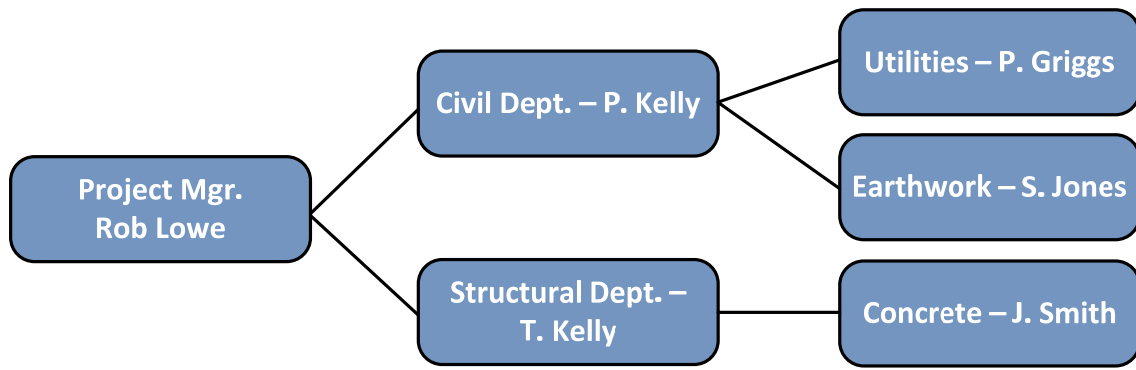


Figure 1.2—Horizontal OBS Structure

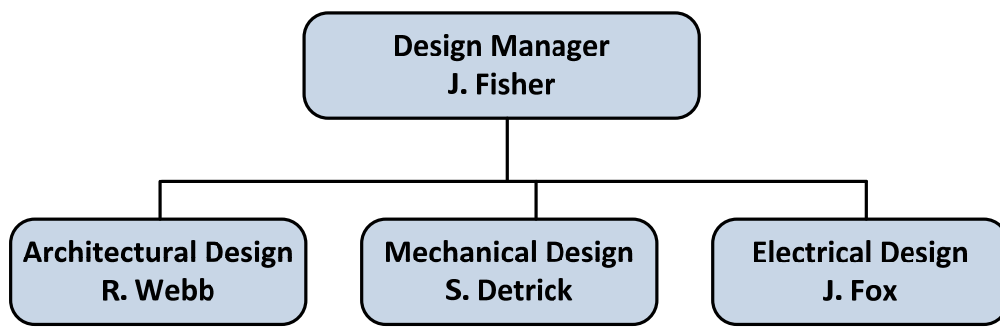


Figure 1.3—Vertical OBS

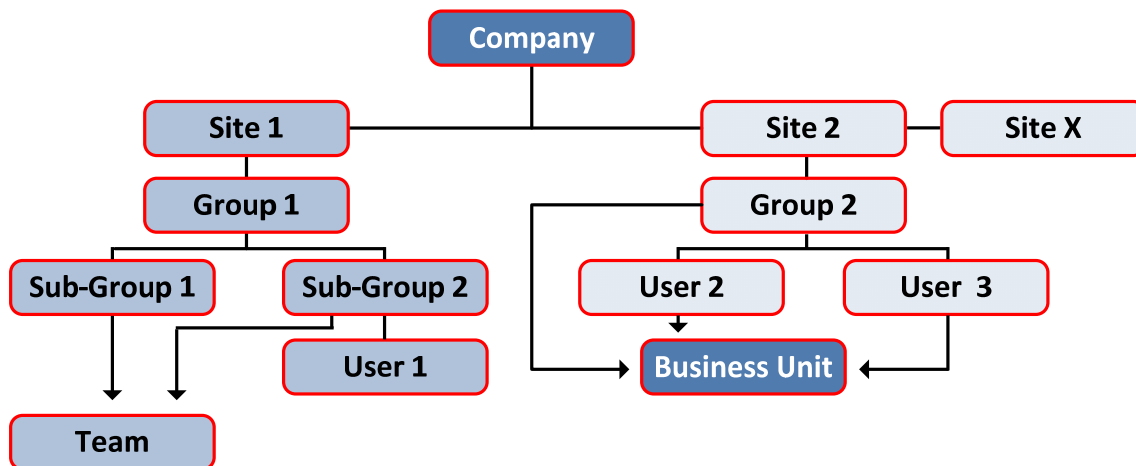


Figure 1.4—Complex OBS structure

**Terms to Know**

- *Control Account Managers (CAM);*
- *Functional organization;*
- *Matrix organization;*
- *Organizational Breakdown Structure (OBS); and,*
- *Project organization.*

**Key Points for Review**

1. Explain the differences between the OBS and WBS.
2. State the purpose of the OBS.
3. Describe the different types of organizations.

Please see **Sample Questions for Section 1.2** on page 29

**Sample Questions for Section 1.2:**

1. Which of the following is not considered a type of organization structure?
  - A. Functional organization
  - B. Matrix organization
  - C. Project organization
  - D. Delivery organization
  
2. Which organizational manager has administrative responsibility of an individual assigned to a project?
  - A. Functional manager
  - B. Project manager
  - C. Business manager
  - D. Human resource manager
  
3. Which organizational manager is responsible for overseeing the project performance of an individual assigned to a matrix project organization?
  - A. Functional manager
  - B. Project manager
  - C. Engineering manager
  - D. Site training manager
  
4. Which of the following statements does not reflect the use of the organization concepts discussed in this Section to develop a project execution and management plan?
  - A. The OBS is developed to define the responsibility for performing work.
  - B. The WBS is developed to sub-divide products and services into manageable work units.
  - C. The project manager is responsible for determining that the right organization has been assigned the responsibility for the right work scope.
  - D. The OBS defines the crosswalk with the WBS.

**Solutions to Sample Problems for Section 1.2:**

1. D The delivery organization relates to design of a project, not EVM.
2. A The functional manager is responsible for the personnel that are assigned to the team. This is demonstrated by the personnel who manage the staff that work under a CAM's authority.
3. B The project manager is responsible for the performance of the staff working on the project and must verify that the staff is performing the assigned work.
4. D The RAM defines the crosswalk between the OBS and the WBS.

## Section 1.3 Responsibility Assignment Matrix (RAM)

### Introduction

The *Responsibility Assignment Matrix (RAM)* is a matrix of the intersection of the OBS and the lowest level of the WBS and is usually represented by a graphic that has the WBS on one axis and the OBS on the other axis. The intersection of WBS work scope with OBS responsibility is defined as the *Control Account (CA)*. The CA level is where the data elements used to perform EVM analysis; i.e., *Budgeted Cost for Work Scheduled (BCWS)*, *Budgeted Cost for Work Performed (BCWP)*, *Actual Cost of Work Performed (ACWP)*, Budget at Completion (BAC) and *Estimate at Completion (EAC)*, are collected and rolled-up through the structures of the WBS and OBS for problem identification and management control decision making. A senior-level resource is assigned responsibility for the CA and is defined as the *Control Account Manager (CAM)*. The CAM accepts the responsibility for the successful accomplishment of the CA’s scope, schedule, and budget.

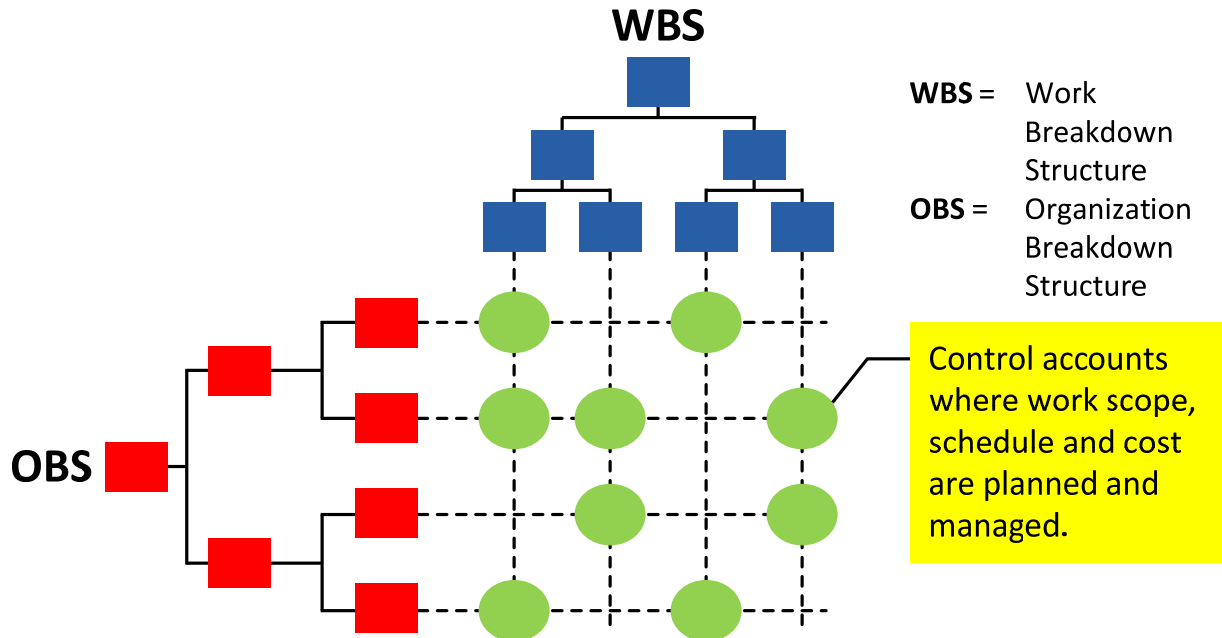


Figure 1.3.1—Example of Intersection of OBS and WBS

Responsibility Assignment Matrix			Software			Hardware and Tooling			
			Design	Test	Integrate	Design	Test	Integrate	Manuf.
Company	Department	Manager	1.1	1.2	1.3	2.1	2.2	2.3	2.4
ACME LAUNCH CORP.	Software	Finch	X						
	Hardware	Ortega				X			
	Test	Haggerty		X			X		
	Integration	Johnson			X			X	
	Production	Simon							X

Figure 1.3.2—Example of a RAM

JOB TITLES:	Prog.Mgr	Proj.Mgr	Prj.Cntrl	Engineer	ES&H	Architect
WBS ELEMENTS	Ken S.	John P.	Julie O.	David J.	Cathy J.	Subcontr.
1.0 Program Mgmt						
1.1 Strategic Planning	R	C	I			
1.2 Project staffing	A	R	I			
1.3 Reports & analysis	I	A	R	C		
2.0 Conceptual Design		A		C		R
2.1 Design criteria	A	R		C	C	I
2.2 Budget & schedule		A	R			
2.3 Design mgmt.		R		C	I	
2.4 Technical input		A		R	I	C
2.5 Develop design		A	I	C	I	R

**Figure 1.3.3—Responsibility Assignment Matrix Identified by Type of Responsibility**

Figure 1.3.3 shows a RAM that pinpoints the level of responsibility. In figure 1.3.3, R mean Responsible; A is Accountable to manage the work; C is for Consulted; and I means Informed.

When the RAM identifies the dollar value associated with the *Control Account (CA)*, it is called a “dollarized” RAM and is used to identify CAs that might be too large or too small for effective management. When this occurs, either the OBS or WBS, or both, are collapsed or extended to result in a managerially significant *Control Account*. The CA is important because it is the point at which technical performance, schedules, and costs are integrated. The RAM includes the functional organization and the named CAM. The RAM will be updated as required based on changes in the CAM, WBS, OBS, and scope of work. See an example of a dollarized RAM in figure 1.3.4.

WBS	Control Account Number	Control Account Name	Control Account Manager	Org	Budget
1.2.1	1.2.1	Program Management	Janet Cash	1010	1,837,384
1.2.2.1	1.2.2.1	Initial System Design	Jay Fredman	1070	2,138,500
1.2.2.2	1.2.2.2	Systems Design Support	Jay Fredman	1070	9,517,996
1.3.1	1.3.1	Acceptance Test Planning	Jan Carlson	107I	1,400,297
1.3.2	1.3.2	Environmental Tests	Jan Carlson	107I	74,987
1.3.3	1.3.3	Mock-ups	Jan Carlson	107I	410,087
1.3.4	1.3.4	Test & Evaluation Support	Jan Carlson	107I	348,944
1.4.1	1.4.1	Training Services	Mary Cohen	103A	1,586,991
1.4.2	1.4.2	Facilities	Mary Cohen	103A	1,364,819
1.5.1	1.5.1	Engineering / Technical Pubs	Randy Howlin	102A	577,021
1.5.2	1.5.2	Management Data	Randy Howlin	102A	269,291
		Total – Distributed Budget			19,526,317
		Management Reserve	Marsha Johnson	1010	2,342,685
		Total – Contract Budget Base			21,869,002

**Figure 1.3.4—Dollarized RAM**

Development of the WBS, OBS and RAM are an interactive process. The WBS or OBS structure may be raised or lowered until the desired level of the RAM is defined. Once complete the RAM and related WBS and OBS are baselined and changes are subject to change control.

**Terms to Know**

- *Responsibility Assignment Matrix (RAM);*
- *Organization Breakdown Structure (OBS)*
- *Dollarized RAM;*
- *Control Account (CA);*
- *Control Account Manager (CAM);*
- *Budget at Completion (BAC); and*
- *Estimate at Completion (EAC).*

**Key Points for Review**

1. Understand the relationship between the OBS and WBS.
2. Understand the purpose of the RAM.
3. Understand the data reflected on the RAM.

**Sample Questions for Section 1.3:**

1. What is the name of the responsible individual or position where the WBS and OBS intersect, as shown on the *Responsibility Assignment Matrix* (RAM)?
  - A. *Project Manager*
  - B. *Project Engineer*
  - C. *Control Account Manager (CAM)*
  - D. *Accounting Manager*
  
2. Which of the following is not part of the RAM relationship?
  - A. *Work Breakdown Structure (WBS)*
  - B. *Organizational Breakdown Structure (OBS)*
  - C. *Schedule of Values*
  - D. *Control Account*
  
3. Which of the following is not addressed by the control account relationship in the RAM?
  - A. Technical performance
  - B. Schedule
  - C. Cost
  - D. Pricing
  
4. The sum of the dollars in a dollarized RAM is equal to?
  - A. The CBB
  - B. The PMB
  - C. The sum of the CA budgets
  - D. The sum of the direct and indirect budgets

**Solutions to Problems for Section 1.3:**

1. C The CAM is the responsible person to manage the work where the WBS and OBS intersect, as shown on the RAM.
2. C A schedule of values is not part of the WBS, OBS, RAM, or *Control Account*. It is a basis of cost control.
3. D Pricing is not part of the control process.
4. C The values in a dollarized RAM are the CA budget values that may or may not contain some or all of the indirect costs at the discretion of the PM. The CBB and PMB contain direct and indirect costs.

## Section 1.4 – Work Authorization (WA)

### Introduction

Work authorization is a formal process related to assigning the approved work scope, schedule, and budget to various levels of the organization. Each level of authorization is agreed to by the parties involved so that there is not any question as to what is required to authorize work. The work authorization approvals normally involve two types: outside or customer/customer/owner (hereinafter referred to as customer) authorization and internal authorization within the organization performing the work. The customer authorization is applicable to items such as the basic contract, contract change notices, and supplemental agreements. The internal authorization will vary based on individual company policies and procedures starting at the highest level of management down to the CAM. The sublevel managers have an established level of authorization based on company policy and can delegate their authority to subordinate managers as they deem appropriate. The above organizational process flow of work authorization is captured in *Work Authorization Documents* (WADs) that take many forms. They are the documents by which governments, companies, and organizations provide the processes, directions, policies, procedures, and signature authority to commence work. A WAD should contain the name of the CAM, the scope of work, budget in terms of hours, equipment and materials required, deliverables, schedule, milestones, start and end dates, and signatures of the CAM and PM. Specific examples of WADs include the *Project Work Authorization* (PWA) and the *Control Account Work Authorization* (CAWA). The PWA authorizes the scope, schedule and budget for the program/project manager (PM). The CAWA authorizes the scope, schedule and budget for the CAM. The normal flow of work authorization is from the customer to the organization to the PM to the CAM as defined by the OBS.

At the organization or project level where the work scope is executed, a CAWA is developed for authorizing work to each CAM. It includes the scope of work to be performed and the associated budget and schedule. The CAWA is a contract between the PM and the CAM and carries the task definition, its start and completion dates, the total task budget, defined delivery milestones, and the WBS element that will be used to summarize costs for the task. A CAWA completed and signed by the PM and the CAM for a specified project scope is the formal authorization document issued to perform the stated work.

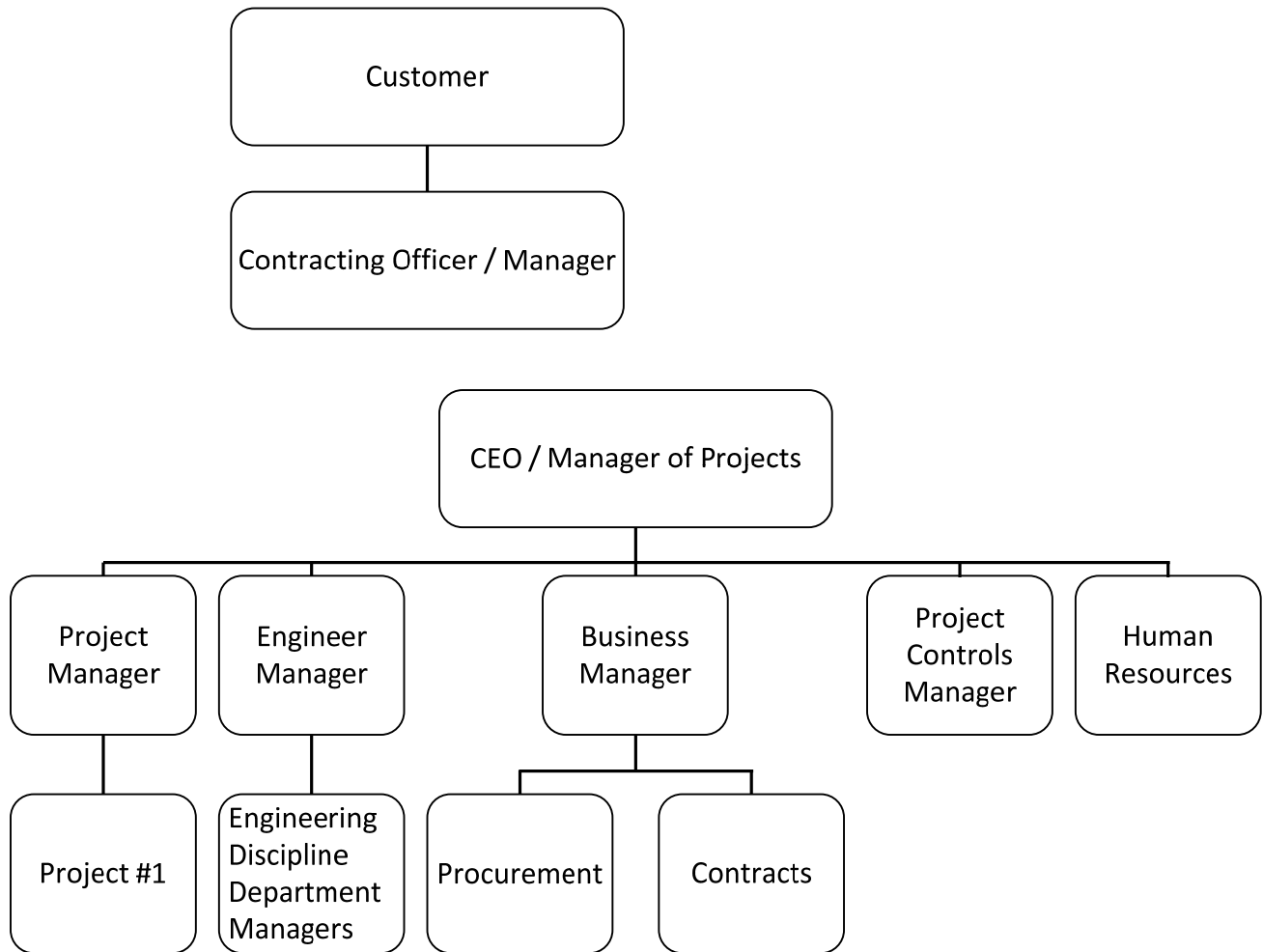
### Terms to Know

- *Work Authorization Document* (WAD);
- *Project Work Authorization* (PWA); and,
- *Control Account Work Authorization* (CAWA).

### Key Points for Review

1. What is the purpose of work authorizations?
2. When is work authorized?
3. How do work authorizations relate to the execution of work?

The following figure 1.4.0 Organizational Chart pertains to the sample questions of Section 1.4:



**Figure 1.4.0—Organizational Chart**

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## **Sample Questions for Section 1.4:**

1. A company has bid on a *Request for Proposal* (RFP) and won the contract. Of the following list of customer managers, which one has the authority to award the contract in normal circumstances?
  - A. Project Controls Manager
  - B. Procurement Manager
  - C. Contracting Manager
  - D. General Counsel
  
2. A company has won a contract and received the *Notice to Proceed* (NTP) or *Authorization to Proceed* (ATP) by the customer. The engineering design phase has been authorized, and the project manager has directed the design work to commence. In some organizations, which one of the following managers has the authority to assign specific work to the engineering personnel on the project?
  - A. Project Manager
  - B. Contracting Officer
  - C. Engineering Manager
  - D. Customer Representative
  
3. During the execution of the contract scope the contractor encounters a “soft-spot” during the excavation and has to bring in extra fill to bring the elevations up to grade. This situation was not shown on the excavation drawing or in the soil boring report supplied by the customer. The contractor prepares a contract change order for the additional scope. Which one of the following managers has the authority to approve the change notice?
  - A. Customer Project Manager
  - B. Customer Contracting Manager
  - C. Contractor Engineering Manager
  - D. Contractor Customer Representative
  
4. The *Control Account Work Authorization* (CAWA) or Work Authorization Document (WAD) is the “contract” of the scope, plan, and schedule between the \_\_\_\_\_ and the \_\_\_\_\_ for the project.
  - A. Customer and the Project Manager
  - B. Project Manager and the Control Account Manager (CAM)
  - C. Project Manager and the Functional Manager
  - D. Customer and the Control Account Manager (CAM)

**Solutions to Problems for Section 1.4:**

1. C Only the customer contracting officer or contracts manager has such authority.
2. A The project manager is responsible for assigning/authorizing the scope of work to a CAM. The functional manager is responsible for assigning a specific individual to be the CAM for the engineering effort on a specific WBS within the project.
3. B Only the customer contracting officer or contracts manager can approve changes and assign work.
4. B The project manager is responsible for issuing the CAWA, and the CAM is responsible for implementing the CAWA.

## Chapter 2.0—Planning, Scheduling, and Budgeting

### Introduction

In developing a plan for a program or project there are many considerations and constraints that require identification and evaluation. Among the elements are: resources, value engineering, stakeholders, and project variable requirements necessary to understand and implement the planning process.

An important component of the baseline is the completion of a network schedule. The schedule is used to show how the work will be accomplished and contains the lists of activities to complete the physical products, milestones, and technical performance goals. A critical path schedule is simply a network schedule that is the longest critical path through the schedule and depicts the activities, milestones, and the logic relationships of how the work will be sequenced and accomplished. The *Critical Path* (CP) is the network sequence of work to be done, which will take the longest time to complete the project and it often has zero total float. Figure 2.0 defines the EVP body of knowledge for planning, scheduling and budgeting.

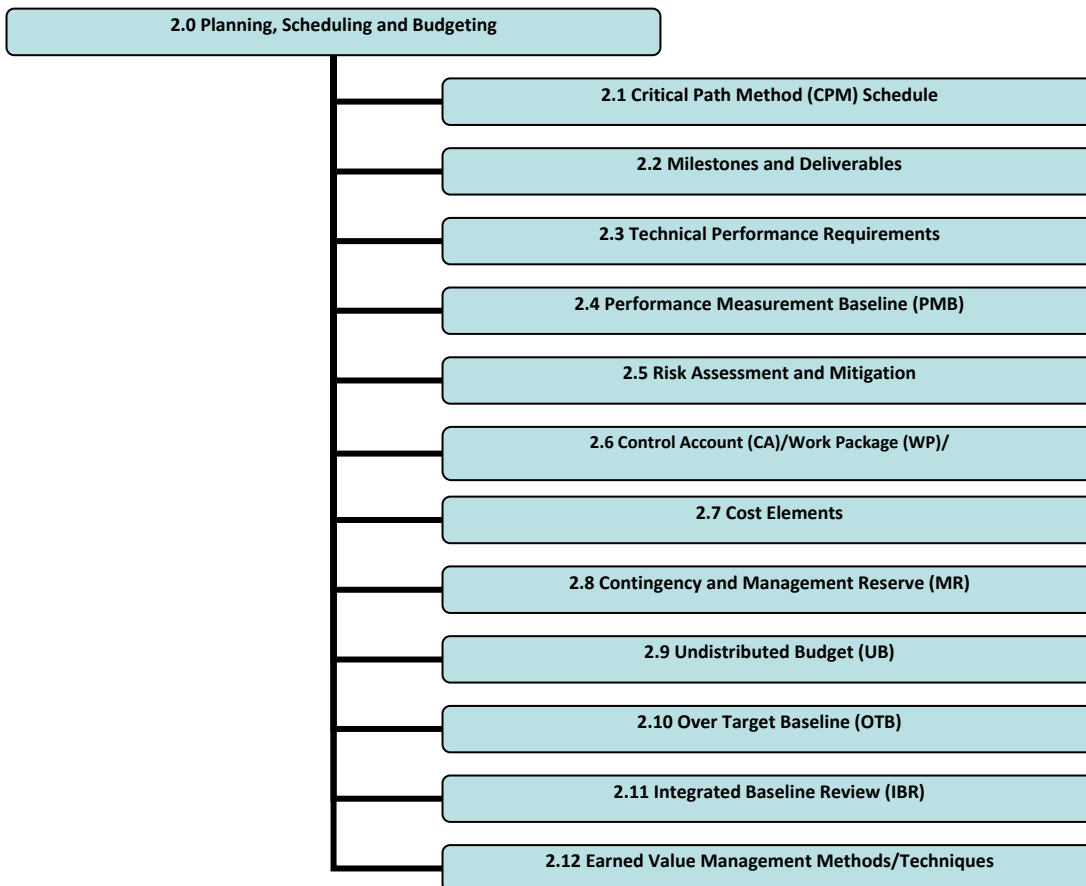


Figure 2.0—EVP Body of Knowledge for Planning, Scheduling, and Budgeting

Please see **Section 2.1 Critical Path Method (CPM) Schedule** on page 43

## Section 2.1 Critical Path Method (CPM) Schedule

### Introduction

The key learning objectives for this section are:

- Explain the different types of activity float and their impact on the critical path.
- Distinguish between critical path network activities and milestones.
- Understand the difference between *Free Float* (FF) and *Total Float* (TF).
- Explain the advantage of critical path analysis in measuring schedule progress vs. that of Gantt charts.
- Understand the relationship between the *Schedule Variance* (SV) and the *Critical Path* (CP).
- Understand the rationale for and how to conduct a *Schedule Risk Analysis* (SRA)

An important and necessary component of an EVMS is the completion of a resource loaded network schedule. The schedule is used to show how the work will be accomplished and contains the lists of activities to complete the physical products, major project events (milestones), technical performance goals, and the time phased budget and/or workers distribution effort.

A *Critical Path Method* (CPM) schedule is a network schedule that depicts the activities, milestones, and the logic relationships of how the work will be accomplished. In this regard, the CPM schedule is an important mathematical model of the work needed to complete a given project. The *Critical Path* is that series of individual activities that represents the “string” or strings of logically successive activities, which will take the longest time to complete. The CP is also defined by those activities which have the least amount of *Total Float* (TF) with zero making it most critical.

TF reflects how much an activity can slip before it impacts the project completion date. A TF that has a value equal to zero means the activity cannot slip without impacting the end date. A TF that has a negative value means the activity has impacted the end date and corrective action must be executed to mitigate or forecast the impact. The CP then defines the quickest possible project completion date. *Free Float* (FF) reflects how much the finish of an activity can be delayed without delaying the start of any successor activity.

A typical schedule may have thousands of different paths. The software calculates the float of each tasks based on the impact of the other tasks in the network. The path with the lowest total float is known is the current critical path, and tasks that are close to the same value of minimal float are known as near-critical. The critical path is dynamic based on status and may change over time.

The candidate for EVP Certification must understand the basics of CPM scheduling and how to manually calculate the critical path on a Simple Schedule. The candidate must understand CPM includes the components of CPM schedules; how they act both as schedule building-blocks and as drivers of CPM schedule mathematics; how the components are developed to arrive at an overall schedule model; and the importance and techniques of schedule updating.

A baseline schedule is established at the beginning of a project. At that point the *Total Float* of the critical path is zero or positive for near-critical. Once a baseline is established (approved), it is subject to change control. A current schedule is established when the baseline schedule is first statused with actual data. As the project moves through its' life cycle, updates to the status of activities (*Actual Start, Actual Finish, Percent Complete*) will be entered into the current schedule and the *Critical Path* will be calculated based on the current schedule. The current schedule will be compared to the baseline schedule to see if the project is proceeding according to plan. Variances from the baseline schedule need to be addressed with corrective actions and work around plans if the variance exceeds predetermined threshold values.

One key element of development and implementation of a schedule is the requirement to maintain both *Vertical* and *Horizontal Traceability*. *Vertical Traceability* refers to the ability to accurately summarize budget data with no exclusions to all levels of the project WBS. It also refers to the consistency of dates, status and revisions at all levels of the project schedule. *Horizontal Traceability* is defined as the ability to trace predecessors and successors through the entire schedule.

**Terms to Know**

- *Activity description;*
- *Activity;*
- *Arrow Diagramming Method (ADM);*
- *Backward Pass;*
- *Bar chart;*
- *Baseline schedule;*
- *Calendar unit;*
- *Constraint;*
- *Critical Path Method (CPM);*
- *Critical Path(CP);*
- *Current Schedule;*
- *Duration;*
- *Early finish (EF);*
- *Early start (ES);*
- *Forward pass;*
- *Free Float (FF);*
- *Gantt chart;*
- *Horizontal Traceability;*
- *Late finish (LF);*
- *Late start (LS);*
- *Logic;*
- *Milestone;*
- *Near Critical Path;*
- *Network;*
- *Original duration;*
- *Planning;*
- *Precedence Diagramming Method (PDM);*
- *Program Evaluation and Review Technique (PERT);*
- *Schedule Risk Analysis (SRA);*
- *Schedule update;*
- *Scheduling;*
- *Status;*
- *Total Float (TF);*
- *Vertical Traceability; and,*
- *Work Unit.*

Refer to AACE International's **TCM Framework** and **Recommended Practices** for more detailed information on *CPM scheduling*. Visit [www.aacei.org](http://www.aacei.org)

**Key Points for Review**

1. Define what a bar chart (“Gantt chart”) is, and explain the steps in preparing one.
2. Define PERT, and summarize how such a schedule is developed.
3. Define CPM and common schedule components.
4. Define, compare, and contrast the ADM and PDM approaches to scheduling and how such schedules are developed.
5. Describe the different types of logical relationships that can be used to define the work flow between activities (finish-to-start; finish-to-finish; start-to-start; start-to-finish).
6. Explain coding techniques that can be used in schedules.
7. Define the purpose of forward and backward passes, and explain the calculations used to complete the passes.
8. Define FF and TF.
9. Define the critical path, and how it is identified in the schedule.
10. Define constraints, and discuss how constraints can be effectively used and misused in schedules.
11. Discuss schedule updating and the reasons for it; discuss time intervals for updating schedules; and discuss procedures that should be used in updating schedules.
12. Determine the shortest time within which a program or project can be completed.
13. Identify those activities that are critical and cannot be slipped or delayed.
14. Show the potential slippage or delay available for activities that are not critical.
15. Define major milestones

## **Sample Questions for Section 2.1**

1. When constructing a PERT schedule, each schedule activity is assigned three durations. These durations represent:
  - A. *Total Float, Free Float, and Lag.*
  - B. *Original duration, remaining duration, and percent complete.*
  - C. There should not be three durations; each schedule activity should have only one duration when doing a PERT schedule.
  - D. *Optimistic duration, pessimistic duration, and most likely duration.*
  
2. You have performed a schedule update. You have reviewed the update, and all the schedule mechanics appear correct. The TF value now shown on the “*Project Complete*” milestone is *negative 15 workdays*. What does this tell you?
  - A. That the project can be delayed by 15 days and still meet the required completion date.
  - B. That the project is now forecasted to be completed 15 workdays behind the required completion date.
  - C. That there must be an error. There is no such thing as negative float values in CPM scheduling.
  - D. That the percent of critical path activities physically complete is greater than what is scheduled to be complete at this point for those specific activities.
  - E. That the project is progressing satisfactorily and no adjustments to the to-go work plan is required.

Questions 3 through 5 concern the CPM network schedule shown in figure 2.1. The time unit is workdays:

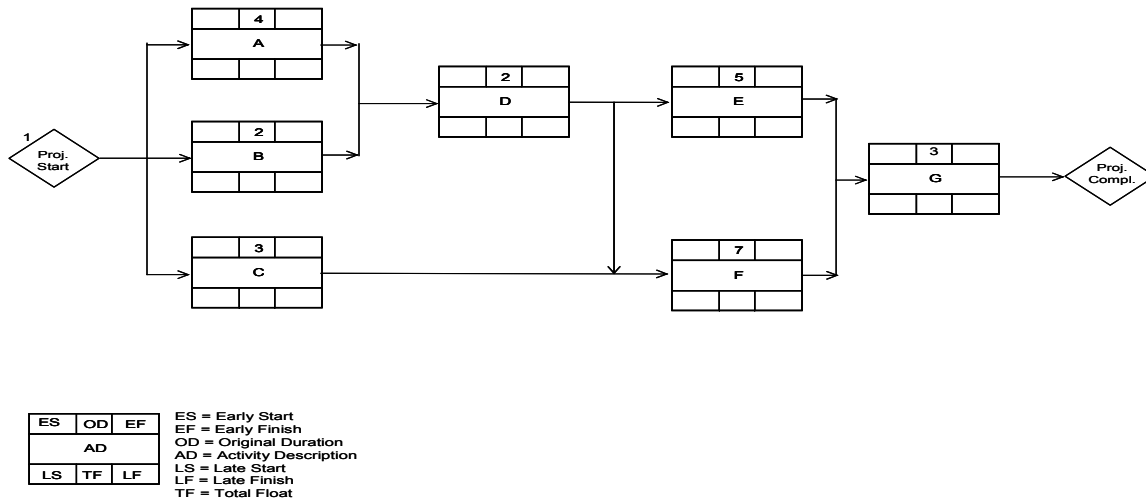


Figure 2.1—CPM Network Schedule

3. What is the total duration of this project?
4. What activities comprise this project's *Critical Path*?
5. What activity has the most TF? How much float does that activity have?
6. *Vertical Traceability* refers to:
  - A. The ability to summarize lower level WBS elements into many upper level WBS elements.
  - B. The ability to summarize WBS elements for different scopes of work into one WBS element.
  - C. Consistency of schedule dates, status and revisions from the lowest schedule detail to the top level of the schedule.
  - D. The ability to trace organizational schedules at all levels of schedule detail.
7. Total float is calculated from:
  - A. LF - ES
  - B. LF - LS
  - C. LF - EF
  - D. EF - LS
8. Which one of the following is NOT a correct statement regarding the *Critical Path*:
  - A. The longest chain or chains of activities, in terms of duration, through a network.
  - B. *Free Float* defines the *Critical Path* of the project.
  - C. A delay of any *Critical Path* activity will cause the project schedule slippage.
  - D. CPM determines the shortest time in which a program or project can be completed.
9. The *Schedule Variance* (SV) is defined as  $SV = BCWP - BCWS$ . A positive SV always indicates that the project is ahead of schedule.
  - A. True
  - B. False
10. Major milestones are determined mathematically from the network schedule.
  - A. True
  - B. False
11. A project's completion date will slip by the amount equivalent to the cumulative delay of critical path activities.
  - A. True
  - B. False

---

## **Solutions for Problems in Section 2.1:**

1. D PERT reflects the optimistic duration, pessimistic duration, and most likely duration.
2. B The project is behind schedule. Negative total float equates to a current schedule that will not meet the project's required completion date.
3. 16 workdays.
4. A-D-F-G
5. Activity C TF = 3 workdays. Its' FF is also 3 workdays.
6. Schedule dates, status and revisions must be traceable through all levels of the schedule.
7. C LF-EF. Total float is equal to the difference between the activity's LF and EF, or the difference between the activity's LS and ES.
8. B "*Free Float* defines the *Critical Path* of the project" is False. *Total Float* is used to define the *Critical Path* of the project.
9. B False. A positive SV generally indicates a favorable schedule performance. However, a project could achieve a positive SV by accomplishing more non-critical path activities while the *Critical Path* activities were falling behind the plan. A combination of earned value measurement and CPM schedule tracking is a powerful and effective project schedule measurement tool.
10. B False. Major milestones are key events of a project without durations. They are typically set by the stakeholders.
11. A True.

## Section 2.2 Milestones and Deliverables

### Introduction

An important component of the project management plan is the list of deliverables and milestones for the project. Project level deliverables and milestones are normally required by contract documents and are identified at the top level of the schedule, often called the *Integrated Master Schedule (IMS)*. The term “deliverable” is sometimes used interchangeably with “milestone,” however the two are distinct items. Completion of a deliverable need not be denoted with a formal milestone in the network, but a group of those deliverables (e.g., the last delivery of a production lot of 30 deliverables) might be. Milestones and deliverables are used extensively in Fixed Price Contracting in the form of a Schedule of Values in order to justify the payment schedule issued by the Contractor for their performance.

A milestone is a scheduled event that marks the accomplishment of a specified effort or objective. Milestones may occur at any level of the schedule. In scheduling terms, milestones are an event with zero duration that marks the start, interim step, or the end of one or more activities.

A deliverable is a contract or management requirement that identifies a physical product. Deliverables across the breadth of the project scope and schedule represents a widely varying set of products, including economic studies and alternative selection; requests for proposals; contract documents and purchase orders; white papers, decision documents, and reports; environmental documents; technical models and design documents; acquisition of real estate to accommodate the project improvements; installation of permanent materials and equipment in place; punchlists; start-up plans and system performance verification documents; project closeout reports; and as-built drawings. A deliverable may be associated with a milestone, but a milestone is not necessarily a deliverable.

While the completion of both deliverables and milestones is an indicator of progress, milestones are the scheduling tools that objectively measure progress to some level of accuracy. This is an important aspect. The start and completion of an activity are considered milestones. A deliverable is usually composed of several activities whose completion is indicated by one or more milestones. The completion of that activity bounded by a series of milestones can be measured through those milestones. As an example the activity is defined by several milestones, no credit for completing the activity is counted with the completion of intermediate milestones. However, only when all of the intermediate milestones AND the milestone associated with the completion of an activity is may be viewed as 100% complete. An activity may also have interim milestones that can be weighted by the cost or resources required to accomplish the milestone in relation to the cost or resources required to complete the activity. When converted to a percent, it is called physical percent complete. By using these weighted milestones, progress for an activity can be measured as those milestones are achieved and an overall progress value for the given activity can be derived. Larger scale key milestones representing comprehensive project achievements are important tools in focusing management attention, reporting, and in managing the critical path of the project or program.

The candidate for EVP Certification must understand the differences between deliverables and milestones; the various types of milestones and their uses in scheduling, measuring progress, and reporting; and the calculation of progress percentages using weighted milestone methods. Although deliverables and milestones are different, they are related and both terms are used in conjunction with each other.

### **Terms to Know**

- *Deliverable;*
- *End Item;*
- *Interim deliverables;*
- *Integrated Master Schedule (IMS);*
- *Major milestone;*
- *Milestone;*
- *Milestone level;*
- *Milestone payment;*
- *Milestone plan;*
- *Milestone report;*
- *Milestone schedule;*
- *Product*
- *Progress milestone; and,*
- *Schedule of Values.*

### **Key Points for Review**

1. Define, compare, and contrast milestones and deliverables.
2. Discuss the use of milestones in project plans, contracts, schedules, and EVMS.
3. Calculate progress in terms of physical percent complete using interim milestone concepts.
4. Calculate the physical percent complete using a weighted milestone method.

**Sample Questions for Section 2.2:**

1. Which of the following best represents a deliverable?
  - A. On the project schedule, an event entitled, "Begin start-up sequence."
  - B. Attending required safety meetings.
  - C. Level-of-effort project management services within a given contract.
  - D. The project *Environmental Impact Report* (EIR).
  
2. One of the major milestones on your flood control dam project is "30 percent design complete." You are the lead scheduling engineer responsible for assembling the schedule, and you have decided that you will place a constraint on this milestone to help properly manage it. What type of constraint would you likely use?
  - A. Finish no-later-than
  - B. Start no-earlier-than
  - C. Mandatory start
  - D. None of the above
  
3. You have decided to use the weighted milestone method to measure progress on a major report. Your first milestone for this type of report is entitled, "*Make Preliminary Draft Presentation*," and the milestone dictionary for your project states that delivery of this type of presentation earns the consulting firm working for you 50 percent progress. The consultant is authorized to use a subjective assessment of percent complete in the activities that precede this presentation. In the latest monthly report, the consultant has reported that this presentation was actually made on the last day of the month (which you have verified), and they have claimed progress of 65 percent for this report overall. What percent complete should you report in your published project monthly report?
  - A. 65 percent.
  - B. The average between 65 percent and 50 percent, say about 57 percent
  - C. You must first do a detailed audit of their deliverables before you can report anything
  - D. 50 percent

Questions 4 and 5 are based on table 2.2.0:

<b>Real Estate Acquisition Process</b>				
<b>Milestone #</b>	<b>Description</b>	<b>Total Weighted %</b>	<b>% Actually Complete To-Date</b>	<b>Weighted % Complete To-Date</b>
1	Right of Way Plan Completed	15%	100%	
2	List of Parcels Obtained	15%	90%	
3	Surveys Completed		85%	
4	Legal Descriptions Completed	10%	70%	
5	Appraisals Completed	10%	65%	
6	Need Justifications Completed	5%	60%	
7	Negotiations Completed.	10%	40%	
8	Purchase Funds Placed in Escrow	5%	40%	
9	Title Transfer Documents Executed	10%	0%	
10	Funds in Escrow Released	5%	0%	

**Table 2.2.0—Real Estate Acquisition Process**

4. Your project is a rail transit project involving the purchase of various real estate parcels. You have documented the process and have decided to use a weighted milestone approach to measuring progress. You have asked a junior cost engineer to tabulate data from your latest status report, which included the table above, but you notice that a total weighted percent value for milestone #3 is missing. What should that value be?
- A. 20 percent
  - B. 15 percent
  - C. 10 percent
  - D. 5 percent
5. Activities involving appraisals, negotiations, and placement of funds into or release of funds from the project escrow account are being handled by a separate consulting firm. You need to determine the percent they have earned of their consulting contract value, if you are to process their firm's invoice. What is the consultant's percent earned for their part of the work, according to data in table 2:2.0?
- A. 64 percent
  - B. 42 percent
  - C. 13 percent
  - D. Impossible to tell from table 2:2.0

**Solutions for Problems on Section 2.2:**

1. D The project environmental implementation report (EIR) is the only direct deliverable.
2. A Finish no-later-than dictates the latest allowable completion date. (Overall constraints should be held to a minimum, per proper schedule maintenance.)
3. D You report based on the established weighted milestone from the baseline, 50 percent, not what the contractor dictates.
4. B The sum of the values in the total weighted percent column must equal 100 percent. The other total weighted percent values sum to 85 percent; so milestone #3 is 15 percent.
5. B Milestone #5, Appraisals, shows 10 percent x 65 percent = 6.5 percent of all work complete; Milestone #7, Negotiations, shows 10 percent x 40 percent = 4 percent of all work complete; Milestone#8, Funds into Escrow, shows 5 percent x 40 percent = 2 percent of all work complete; and Milestone #10, Funds Released, shows 5 percent x 0 percent = 0 percent complete. The consultant has 10 percent + 10 percent + 5 percent + 5 percent = 30 percent of all work assigned, and 6.5 percent + 4 percent + 2 percent = 12.5 percent of their work is complete. The consultant has earned  $12.5/30 = 0.417 \approx 42$  percent of the consultant's possible value.

## Section 2.3 Technical Performance Requirements

### Introduction

Critics of EVMS often claim that there is nothing in the EVMS guidelines that requires the final product to meet specific criteria. That is not a correct assumption. The EVMS guidelines assume that contract requirements are sacrosanct – they cannot be changed or “not met” without the customer’s written approval. Without customer approval, the contractor must continue to expend the resources and effort needed to meet the contract requirements. Any changes to the contract must be approved by the customer or its representative through the Contract Addendum and Modification process.

Within the EVMS guidelines, the requirement is to ensure that all contract requirements are captured in the contract Statement of Work (SOW) or Scope of Services (SOS)/Scope of Facilities (SOF) or WBS Dictionary which describes the scope of work in the contract. It is the work scope that is represented by the *Contract Budget Base (CBB)*, which is always equal to the established value, whether or not negotiated, for authorized work. EVMS stresses that the WBS Dictionary should not contain any work scope that is not required by the contract. There are exceptions whenever a customer offers an incentive for technical performance above requirements, but that does not mean that the requirements need not be met.

Technical performance reflects the basis of performance measurement by establishing a set of milestones with a value for status updates and determining progress. The measurements reflect measurable and achievable points that reflect a value (0 to 100%) for completing the *Work Package*. This physical progress is then assigned a value based on the BCWS or *Budget at Completion (BAC)* for that CA.

### Terms to Know

- *Budget at Completion (BAC)*.
- *Budgeted Cost of Work Scheduled (BCWS)*
- *Control Account/Work Package (CA/WP)*;
- *Contract Budget Base (CBB)*;
- Scope of Work (SOW; and,
- *Technical performance*.

### Key Points for Review

1. Technical performance reflects measurable and achievable scope of the *Work Package*.
2. Technical scope is used to determine the physical progress of the *Work Package*.

Please see **Sample Problems for Section 2.3** on page 59

**Sample Problems for Section 2.3:**

1. Technical performance requirements are used as indicators to measure progress.
  - A. True
  - B. False
  
2. Earned value management at a minimum is an integration of:
  - A. Technical performance, cost control and accounting, resource loading, and risk management.
  - B. Technical performance, resource planning with schedules, and cost.
  - C. Technical performance, cost control and accounting, planning, and risk management.
  - D. Technical performance, resource planning with schedule, cost control, and accounting.
  
3. Identify by "yes" or "no," if the following are technical performance requirements:
  - A. Installation of 1,000 LM/LF pipe
  - B. Completion of an aircraft major assembly
  - C. Delivery of *Environmental Impact Study* (EIS) to customer
  - D. Completion of a vacuum test on a superconducting magnet
  - E. Issue design package
  - F. Issue baseline schedule and performance metrics

**Solutions for Problems in Section 2.3:**

1.     A     True. They are combined with products, milestones, or other control point indicators to define progress management.
  
2.     B     Technical performance, resource planning with schedules, and cost are the fundamentals of EVM, without which a proper EVMS cannot be established. Risk management includes all of the above three elements.
  
3.     All    All can be technical performance goals, if they can be measured as a scope of work.

## Section 2.4 Performance Measurement Baseline (PMB)

### Introduction

The *Performance Measurement Baseline* (PMB) is the assignment of budget and time phased schedule to work scope. It is equal to the *Contract Budget Base* less *Management Reserve* (MR). It is established to measure the actual performance of the work against the established budget. The PMB is the basis of EVM and is the best measure for evaluating progress.

The PMB will be broken into *Control Accounts* (CAs), *Summary Level Planning Packages* (SLPPs) and *Undistributed Budget* (UB). The UB is a temporary holding account for scope and its associated budget that should be allocated to either an SLPP or CA as soon as is practical. SLPPs are an aggregation of work and budget for far-term efforts that can be assigned within reporting level WBS elements, but not down to the CA level. Therefore, it is not part of UB. CAs may contain both *Work Packages* (WPs) and *Planning Packages* (PPs), which are documented in a *Control Account Plan* (CAP). Work that cannot be assigned to a WP is assigned to PPs.

The CAP represents the formal plan for each Control Account Manager (CAM) to complete the defined technical scope. It is planned within the authorized CA start and completion dates and within the authorized budget. The summation of CAPs and SLPPs equals the time-phased part of the PMB. *Undistributed Budget* is not time-phased, but it is considered as part of the PMB because it has scope and budget. Generally, it is placed at the end of the time-phased part of the PMB, but should be distributed as soon as practical.

The PMB needs to be established as early as possible in the project life cycle in order to integrate the technical scope, cost and budget. Since some of the work may not be detailed at the beginning of the project, the PMB can contain SLPPs for work to be done in the future. By definition, the end point of the time-phased PMB equals the *Budget at Completion* (BAC). The term BAC can be used at any cost level; e.g. PMB, Control Account, Work Package. Therefore it is always recommend to distinguish the level with the term such as "PMB BAC" or "Control Account BAC."

After contract award, the emphasis turns to activities necessary to provide a smooth transition from proposal to performance of the contract effort. The project team is concerned principally with structuring the work to be performed and assigning WBS work scope to responsible organizations. These activities are accomplished by integrating the *Statement of Work* (SOW) with the WBS, developing the *WBS Dictionary*, and assigning responsibility (establishing the organization) for planning, executing, and controlling the work using the *Responsibility Assignment Matrix* (RAM). Ideally, much of this work should be performed in the proposal phase, so that the transition takes place as quickly as possible and in accordance with contract documents.

The baseline must be established and approved. The baseline implementation process involves structuring the three main management objectives (schedule, budget, and scope of work) into a cohesive, integrated environment. This is known as the PMB, which represents the sum of *Distributed Budget* (DB) and *Undistributed Budget* (UB), including all associated indirect costs against which contract performance is measured. It does NOT include *Management Reserve* (MR); however, in some industries the PMB includes Contingency. Contingency is usually calculated through the Risk

Management process. A baseline implementation schedule is then published. In some cases contingency comes from savings generated through efficiencies in project execution once actual cost is recorded and BAC minus EAC results in a positive variance. Typically, contingency is managed by the Owner while MR is managed by the contractor, although in some cases, the Project Manager or Director is allowed to manage those contingency funds.

Baseline implementation is completed within a timeframe directed by the contract. Subcontractor information must be integrated into the prime contractor's PMB in a timely manner. Implementation of the baseline may undergo several revisions before it is finalized. Once established, it is subject to strict change control. Formal change control does not begin until the project manager approves the final baseline. If the customer must approve the PMB, this must be listed as a contract requirement. For some contracts, the customer may also mandate a specific date by which the baseline is to be established.

### **Terms to Know**

- *Authorization to Proceed (ATP)/Notice to Proceed (NTP);*
- *Budget at Completion (BAC);*
- *Contingency;*
- *Control Account (CA);*
- *Control Account Plan (CAP);*
- *Control Account Manager (CAM);*
- *Contract Budget Base (CBB);*
- *Management Reserve (MR);*
- *Performance Measurement Baseline (PMB);*
- *Planning Package (PP);*
- *Summary Level Planning Package (SLPP);*
- *Time-Phased Scope;*
- *Total Allocated Budget (TAB);*
- *WBS Dictionary; and,*
- *Work Package (WP).*

### **Key Points for Review**

1. The CBB minus MR is used to establish the PMB.
2. The PMB represents the time-phased scope, schedule, and associated budget through the end of the contract. It is made up of the UB, CAs and SLPPs.
3. Included in the CBB are any budgets set aside for MR.
4. The establishment of the PMB should be the priority after the ATP. It is developed from the CBB into the schedule for complete cost/resource loading.

**Sample Problems for Section 2.4:**

1. The PMB is developed from the \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
  - A. Scope, schedule, basis of estimate
  - B. Requirements, plan, budget
  - C. Scope, schedule, budget
  - D. Plan, milestones, resources
  
2. The contract value of your project is \$5,000,000. Fee = \$500,000 and MR = \$30,000. Which of the following accurately states the baseline for your project?
  - A. CBB = \$5,000,000, PMB = \$5,000,000
  - B. CBB = \$5,500,000, PMB = \$4,970,000
  - C. CBB = \$5,000,000, PMB = \$4,500,000
  - D. CBB = \$5,000,000, PMB = \$4,970,000
  
3. The CBB is equal to the PMB plus UB.
  - A. True
  - B. False
  
4. Summary Level Planning Packages (SLPPs) have \_\_\_\_\_.
  - A. Scope only
  - B. Scope, schedule, and budget
  - C. Scope and budget, but not schedule
  - D. Budget only
  
5. The PMB is composed of Distributed Budget and Non-Distributed Budget and Management Reserve.
  - A. True
  - B. False

**Solutions for Problems in Section 2.4:**

1. C A defined scope of work, a network schedule, and a budget are the basic requirements for a PMB.
2. D CBB = \$5,000,000, PMB = \$4,970,000.
3. B The CBB is equal to the PMB plus MR.
4. B An SLPP has all three: scope, schedule, and budget.
5. B False – MR is not part of the PMB.

## Section 2.5 Risk Assessment and Mitigation

### Introduction

One of the key reasons to use EVM is for *Risk Assessment*, *Risk Identification*, *Risk Analysis*, and for the development of *Risk Mitigation* plans. The users of EVM data and information must understand how the risk assessment process relates to the application of EVM. This section will discuss the basic steps of a risk management process. The key learning objectives include:

- Assess WBS elements for potential risk events and their probability of occurrence and impact to scope, schedule and cost.
- Develop responses to mitigate project risks.
- Identify the person who is accountable to manage risks.

### Terms to Know

- *Internal and external risks;*
- *Risk analysis;*
- *Risk assessment;*
- *Risk identification;*
- *Risk management;* and,
- *Risk mitigation.*

### Key Points for Review

1. Risk Management
  - A. Planning;
  - B. Identification;
  - C. Assessment;
  - D. Analysis; and,
  - E. Mitigation.
2. Risk Assessment and WBS relationship.
  - A. Develop the WBS at a level of detail sufficient to facilitate the assessment of technical, schedule and cost risk events.
  - B. Need to decompose WBS to a lower level to align risk events with WBS elements to help monitor and manage risk events.
3. Formal and informal risk managements.

#### **Formal Management:**

- A. Applied to large, complex, or multi-year, multi-million projects.
- B. Qualitative vs. quantitative approach to risk management.

- C. Quantitative risk analysis uses mathematical techniques and models to numerically establish the probability of risk and consequences of risk. Typical techniques are simulation, sensitivity analysis and decision-tree analysis.

**Informal Management:**

- D. Applied to small or less-complex projects.
- E. Project manager engages stakeholders to explore their perception of risks (problems and opportunities) surrounding the project.
- F. Based on the problems and opportunities identified, the PM and *Integrated Product Team* (IPT) develop a detail task outline, and authorize budget from MR to implement the mitigation plan, if appropriate, to reduce the impact of risk events.

**Sample Problems for Section 2.5:**

1. The risk management process includes all the following steps except:
  - A. Risk identification
  - B. Risk assessment
  - C. Risk analysis
  - D. Risk elimination
  
2. Projects can control all the following risks except:
  - A. Design errors because of untrained personnel
  - B. Price changes because of market forces
  - C. Cost over-run because of excessive changes
  - D. Ineffective contractor because of flawed selection process
  
3. To effectively manage project risks, the WBS elements may have to be decomposed to lower levels to align risk events with individual WBS elements?
  - A. True.
  - B. False.
  
4. All projects should perform formal risk assessments?
  - A. True.
  - B. False.
  
5. For a small or less complex project, which one of the following is a practical approach to manage risks?
  - A. Do nothing
  - B. Formally assess risk
  - C. Informally assess risk
  - D. Develop responses only when risks actually happen

**Solutions to Problems in Section 2.5:**

1. D Risk elimination. Risk mitigation is the final step of the risk management process. A risk mitigation plan could include avoidance, reduction, transfer, hedging and insurance. It is neither practical nor cost effective to eliminate all project risks.
2. B Price change because of market forces is an external risk. A project cannot control the occurrence of an external risk but can mitigate the impact if such risk occurs.
3. A True. During the risk assessment, the team may determine that the WBS needs to be decomposed to lower levels to align risk events with individual WBS elements to help monitor and manage risk events and responses.
4. B False. All projects have some limitation on resources (money or people). To manage project risk, it is a good practice to perform risk assessment. However, depending on the project size and complexity, it is not always practical to perform a formal risk assessment.
5. C Informal risk assessment. For small or less complex projects, an informal risk assessment might be the right approach for the project manager to discuss with stakeholders to surface potential risks and develop detail task outline to manage the impact of risk events.

## Section 2.6 Control Accounts/Work Packages/Planning Packages

### Introduction

The Control Account (CA) is where work is authorized, schedules are developed, budgets are established, performance is measured, and actual costs are collected. *Work Packages* (WP) and *Planning Packages* (PP) are the next lowest division of work within the *Control Account*. Like the CA, both WPs and PPs have scope, schedule, and budget. *Actual costs* (AC/ACWP) are required by the *Guidelines* to be collected at the CA level or lower. However, most contractors have determined that variance analysis is easier to accomplish if actual costs are collected at the WP level. *Work Packages* are near term effort that is sufficiently defined to enable reasonably accurate performance measurement. They are short in duration and have performance measurement techniques that can objectively measure performance at least once a reporting period. Work can be performed on a *Work Package*. A PP is effort that cannot be defined in the detail sufficient for a WP and, therefore, is longer in length. It does not have a performance measurement technique and cannot be yet performed. It is important to note the WPs may be further subdivided into activities or tasks. *Control Accounts*, WPs and any subdivisions, and PPs must be identifiable in the schedule.

A CA is a management control point at which budgets (resource plans) and actual costs are accumulated and compared to earned value for management control purposes. A CA is a natural management point for planning and control since it represents the work assigned to one responsible organization element and one element or a portion that element of program work breakdown structure.

The purpose of defining CAs is to decompose the project scope into work elements that can be planned accurately and managed effectively. CAs do not span multiple WBS or multiple OBS elements.

The CA is the basic building block of the EVMS. It is the control point where technical scope, schedule, and cost elements are integrated. It is also the point where work progress is measured, where actual costs are collected, where variance analysis occurs, and where corrective action will be initiated.

Because a CA represents the work assigned to one responsible organizational element in the WBS, it is a natural control point for cost and schedule planning and control. *Control Accounts* are initially established at the lowest WBS level and are at, or below, the reporting level. There may be more than one CA per lowest level WBS; therefore, for ease of identification, the CA identification number is often an extension of the WBS identification number. The CA may then be further broken down into *Work Packages* (WPs) and *Planning Packages* (PPs), which may also be assigned an even lower-level extension of the WBS identification number. Each CA is uniquely identified by its own number and is the primary management control point at which budgets are established, actual costs are accumulated, and performance is measured.

*Control Account* levels are influenced by the way the work is managed and performed. The CAM who exercises operational control over the resources to be expended in performance of the *Control Account* work is assigned the responsibility for the work. Since CAs are identified by the intersection point of the lowest level of the WBS to the lowest level of the OBS, only one organizational element can be responsible for each control account. *Control Accounts* and their related budget, performance, and actuals, can be summarized by organizational element where required for reporting and analysis (e.g., *Contract Performance Report (CPR)*, Format 2).

The attributes of an appropriate CA are the following:

- There is a single CA accounted for at each intersection of the lowest level of the WBS and lowest level of the OBS (clearly identified in the *Responsibility Assignment Matrix* or RAM). The exception to this general requirement is that multiple control accounts may be required to separate by EVM Technique or Element of cost. Examples include separating LOE versus discrete type work packages and separation of material from labor type resources.
- Any supporting activities are clearly identified.

The CAs are defined by integration of the OBS and the WBS and represents a defined work scope given to a single organization unit. Multiple CAs may exist within a single WBS depending on the number of organizations authorized to do work within the WBS element scope.

The level of control account may vary significantly between a Guideline approach and commercial practice. Responsibility may be defined on smaller projects at the project management WBS Level 1. As a project grows in size and complexity the structure is expanded. In a commercial non-guideline approach typically, the scopes of these projects are decomposed two levels, and performance is then measured at the lower level. This practice mirrors the *Integrated Product Team (IPT)* approach wherein multiple functional organizations are part of a team that is responsible for an entire lowest level WBS element. It is common for multiple organizational units of the same project team to charge costs against a shared task. This practice is driven by lack of flexibility of some lower-cost project financial management systems. In other cases, it results from the absence of contractual requirements to manage work using CAs and to report project performance using an EVMS.

WPs are an element of control within *Control Accounts*. The number, size, and duration of work packages in a control account are defined by management need, company policy, as well as size and complexity of the project. Not all *Control Accounts* will require multiple WPs for effective planning and control. Progress is measured at the WP level based on the EV technique that has been assigned to it. EV techniques are discussed in more detail in Section 2.11 of this study guide.

A *Planning Package* is a logical aggregation of work somewhat like a work package, usually for future efforts that can be identified and budgeted, but which is not yet planned in detail at the WP level.

A PP is used as a budget and time placeholder within a CA. The PP budget is time-phased and consistent with schedule due-dates. The PP is broken down into WPs as deliverables and products are defined in more detail and the time to start work draws nearer. It is common practice that conversion of PPs into WPs occurs three to six months prior to becoming the current accounting

month. This conversion practice is often referred to as the *Rolling Wave Period*. Each enterprise will select the conversion methods that best meet the needs of each project.

*Planning Packages* are normally used on large, complex, projects with lengthy durations. For smaller projects, of low complexity and shorter duration, PPs are typically not used nor is the terminology familiar to project teams. Typically, the scope of small projects is decomposed down to two levels and performance is measured at the lowest level. This practice is driven by the financial management system constraints and the absence of customer-mandated requirements to plan and manage the work using CAs, WPs and PPs.

### **Terms to Know**

- *Control Account (CA)*;
- *Integrated Product Team (IPT)*;
- *Planning Package (PP)*;
- *Responsibility Assignment Matrix (RAM)*;
- *Work Scope*;
- *Work Package (WP)*; and,
- *Work Breakdown Structure (WBS)*.

### **Key Points for Review**

1. What is a *Control Account*?
2. What are the characteristics of a *Control Account*?
3. How does a control account help manage project performance?
4. When would multiple *Control Accounts* exist in one WBS element?
5. How many WBS elements should a *Control Account* encompass?
6. When would you normally expect not to use *Control Accounts* and why?
7. What is a *Work Package*?
8. What are the characteristics of a *Work Package*?
9. How does a *Work Package* help manage project performance?
10. When would you expect to use *Work Packages* and why?
11. What is a *planning package*?
12. What are the characteristics of a *Planning Package*?
13. How does a planning package help with *Control Account* management?
14. When would you expect to use *Planning Packages* and why?

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## **Sample Problems for Section 2.6:**

1. *Control Accounts* are where \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ requirements are integrated, planned and managed?
  - A. Cost, schedule, and performance
  - B. Cost, schedule, and risk
  - C. Cost, schedule, work scope
  - D. Budget, scope, and change
  
2. *Control Accounts* are based on a single element from \_\_\_\_\_ and \_\_\_\_\_?
  - A. The OBS and RAM
  - B. The WBS and RAM
  - C. The OBS and WBS
  - D. The WBS and PMB
  
3. The CBB represents the time-phased scope, schedule, and associated budget through the end of contract.
  - A. True
  - B. False
  
4. A work package is the point at which work is planned, progress is measured, and earned value is determined.
  - A. True
  - B. False
  
5. Work packages are detailed near term plans within a \_\_\_\_\_.
  - A. Control Account
  - B. Planning unit
  - C. Worker-hour
  - D. Budget
  
6. How many work packages are recommended per control account?
  - A. 3
  - B. 2
  - C. 1
  - D. None of the above
  
7. Work can be performed on planning packages.
  - A. True
  - B. False

8. *Planning Packages* are summaries that reflect \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
- A. Work, scope, budget
  - B. Dollars, hours, package
  - C. Scope, budget, schedule
  - D. Dollars, hours, other measurable quantities
9. The *Planning Package* is refined as deliverables and products are \_\_\_\_\_ in sufficient detail to be converted to a *Work Package*.
- A. Planned
  - B. Defined
  - C. Analyzed
  - D. Established
10. Which of the following is not a characteristic of a *Planning Package*?
- A. It has a defined scope of work
  - B. Actual costs can be collected for it
  - C. It has a defined schedule
  - D. It has a defined budget

---

## **Solutions to Problems for Section 2.6:**

1. C The CAs is the responsible individual of scope, schedule, budget (cost), and responsibility--basically the means for a project to establish a managerially-effective point of control.
2. C The CA lies within the intersection of the OBS and WBS, and it requires the assignment of responsibility for the account from the RAM.
3. B The PMB represents the time-phased scope, schedule, and associated budget through the end of contract.
4. A True, the work package is the fundamental basis of planning, and determining work accomplishment.
5. A Work packages are the detailed planning within a *Control Account*.
6. D There is no set number of work packages assigned to a *Control Account*; the actual quantity is based on the requirements to accurately plan the scope of work.
7. B False, the work has to be converted to a work package before it can commence.
8. D Planning packages have a scope, budget, and schedule as does a work package, but they have not been authorized for performance because they are not in sufficient detail to be characterized as a work package.
9. B Work within a planning package has to be defined in detail to be converted to work packages.
10. B Work cannot be performed on a PP; therefore, actual costs cannot be collected.

## Section 2.7 Cost Elements

### Introduction

Cost elements are the “building blocks” of the WBS elements, in that they capture the specific cost items that will be required for performing the work scope. Key learning objectives include the following:

- Understand the basic cost elements of labor, material, subcontracts, and other direct costs (ODC).
- Distinguish when cost elements are directly or indirectly applied to an activity or asset.
- Understand the *Work Package* budget consisting of budgets for cost elements estimated to complete the work scope.
- Understand how to apply earned value calculations to cost elements.
- Understand sensitivity analysis as it is applied to cost elements.
- Understand the direct and indirect costs associated with cost elements (i.e., direct, G&A, Commissioning, material handling, overhead, etc.).

Many organizations and agencies have developed standardized cost element structures for their programs/projects. The cost element structure is also designed to standardize the systems, facilitating the cost estimating validation process. The sample cost elements that have been defined for an automated information system include: labor (personnel); travel; other organization support; materials (hardware and software); testing; facilities; initial spares; warranties; training; and contract leasing.

Sensitivity analysis can be performed on those cost elements that represent the highest percentage of cost within the budget. These elements are referred to as the “*Program or Project Cost Drivers.*” The *Program or Project Cost Drivers* should be analyzed for their sources of uncertainty and potential impact on the total costs. The key cost elements should be tested for sensitivity in order to cross-check the *Basis of Estimate and Assumptions* that were used in developing the budget.

**Terms to Know**

- *Activity Based Costing (ABC);*
- *Cost accounting;*
- *Cost driver;*
- *Cost element;*
- *Cost element structure;*
- *Cost estimating;*
- *Cost forecasting;*
- *Cost trending;*
- *Direct cost;*
- *Indirect cost;(needs more definition and description)*
- *Fixed cost;*
- *Life-cycle cost;*
- *Other direct costs (ODC)*
- *Variable cost.*

**Key Points for Review**

1. Know the elements of cost.
2. Know how costs are structured.
3. Explain how costs are accounted for.
4. List and explain the activities that enable cost to be managed properly.

**Sample Problems for Section 2.7:**

1. Typical project cost elements include all the following except:
  - A. Labor
  - B. People
  - C. Materials
  - D. Other costs
  
2. Which one of the following is typically a direct cost?
  - A. Accounting
  - B. Office supplies
  - C. Product construction or assembly
  - D. Utility services
  
3. Codes of accounts have a standard structure that applies to all industries.
  - A. True
  - B. False
  
4. Cost trends are established from budgets.
  - A. True
  - B. False
  
5. In a firm fixed price (lump sum) work, the total EV equals to the sum of all costs for accomplished work ( $CV = 0$ ).
  - A. True
  - B. False

**Solutions to Problems in Section 2.7:**

1. B People. The labor cost is a cost category. However, the number of people is a resource but not a cost category.
2. C Product construction or assembly is directly attributable to a final cost objective and, therefore, is a direct cost.
3. B False. Code of accounts has a standard and consistent format unique to each company or organization. It is structured to meet needs of the end users. There are recommended best practices to structure code of accounts. However, there is no structure applicable to all industries.
4. B False. Cost trends are established from historical cost accounting information.
5. A True. By definition of firm fixed price or lump sum for a subcontract or material, the cost variance is zero because the same amount will be paid regardless of the amount expended by the supplier. Also it is important to note that the amount earned and paid must equal the Schedule of Values approved in the contract documents.

## Section 2.8 Contingency and Management Reserve

### Introduction

Contingency is a reserve held by the owner/customer for adding scope to the contract usually for those things that enhance the function of the product like design changes, material substitutions, etc. and for covering approved change orders that impact cost and schedule. Events that might add scope to the contract are identified during a risk assessment or by experienced estimators and project managers that have experience with similar work scopes to that being estimated, and can occur during the execution phase of a project due to omissions and errors in scoping documents or due to poor engineering design. Management reserve is held by the contractor to cover unforeseen new work that is within the scope of the contract. Examples of unforeseen scope are increased tests required to prove performance to contract requirements and rework, or unforeseen conditions like rock excavation not picked up during subsurface evaluation.

Management Reserve (MR) is an amount of the total budget withheld for management control purposes rather than being designated for the accomplishment of a specific tasks or set of tasks. It has no work scope and is not time-phased. Based upon the RP 75R-13, this is because the PMB is required to have scope, schedule, and budget integration at all times. The risks identified in the register do not fulfill this requirement since, by definition, they may or may not occur. Therefore, MR cannot be directly linked to specific risks in the risk register which are not fully integrated into the PMB. It must be for events that are not specified within the project scope.

MR is the part of the CBB that provides management flexibility to cover cost growth within the currently authorized work scope, rate changes, and other project unknowns and uncertainties. The use of MR to offset accumulated cost variances is not in compliance with ANSI/EIA 748 and is not allowed. MR may be held at the total project level or distributed and controlled at lower levels, but it is reconcilable to the total contract level. MR is not used to absorb contract changes and must not be viewed by the customer as a source of budget for added work scope.

In the same manner as contingency, which is not part of the typical contract, but can be part of the customer's PMB if it is a government agency, MR is not part of the performance measurement baseline and is excluded from earned value calculations.

The terms "Management Reserve" and Contingency are used in different context in different communities and industries. This can create significant confusion in discussion of ownership and use. Specifically, owner level cost reserve for the management of project uncertainties is referred to as contingency and the contractor's cost reserve is referred to as management reserve.

These variances result in a series of terms: Management Reserve, Cost Contingency, Schedule Margin, and Schedule Contingency, which are summarized in table 2.8.0.

Level Owner/Customer	Terms Used in ANSI/EIA-748 EVM	Terms Used in Common Commercial Practice
Owner	Contingency	Management Reserve
Contractor	Management Reserve	Cost Contingency

**Table 2.8.0 – Comparison of Terms for Schedule and Budget Reserves Created and Managed on the Contractor and Owner Level for Managing Cost and Schedule Uncertainties for a Project.**

As an example, contingency and it is used primarily on lump-sum contracts to cover authorized scope growth. When the customer adds new scope, typically the contract is amended to describe the approved new scope and associated changes to the budget and schedule duration. Also in these cases, MR is a fund, controlled by the customer/owner for changes to the project or product outcome that affects the total scope and funding appropriated for the project

### **Terms to Know**

- *Allocation*;
- *Contingency*; and,
- *Management Reserve (MR)*.

### **Key Points for Review**

1. Definition of *Contingency*
2. Reason for contingencies
3. Definition of *Management Reserve (MR)*
4. Reason for MR
5. Uses of MR
6. Compare and contrast MR and contingency for both large, complex federal projects and smaller, non-federal projects.

**Sample Problems for Section 2.8:**

1. Contingency is allocated by whom?
  - A. By the project manager
  - B. By the customer
  - C. By the program manager
  - D. It is dictated by contract
  
2. Contingency is part of what scope of the non-government contract process?
  - A. CBB
  - B. PMB
  - C. CA
  - D. None of the above
  
3. When does the contractor monitor contingency in the project?
  - A. When added to the CBB by approved change order
  - B. From inception
  - C. When added to the PMB by approved change order
  - D. None of the above
  
4. The contingency is allocated to the contractor following approval of contractor-prepared change proposals. Upon receipt of contingency budget from the customer, the contractor allocates the budgets to control accounts in the performance measurement baseline.
  - A. True
  - B. False
  
5. Management reserve is part of the PMB and is included in EV calculations.
  - A. True
  - B. False
  
6. Management reserve is to be used to support which scope of work?
  - A. Contract changes
  - B. Additional funding
  - C. Unplanned activity within contract scope
  - D. None of the above

7. Management reserve should be commensurate with the \_\_\_\_\_ identified by the project and withheld for management control purposes.
- A. Percentage allocation of budget
  - B. CBB
  - C. Planned scope
  - D. Level of risks
8. Management reserve and contingency are both part of the CBB?
- A. True
  - B. False
9. Project control logs should reflect what?
- A. MR, UB, PMB, and CBB
  - B. Contingency, UB, PMB, and CBB
  - C. MR, Contingency, PMB, and CBB
  - D. MR, Contingency, UB, and PMB
10. The ANSI/EIA 748 Guideline always dictates the method customers and/or owner must use for contingency and management reserve?
- A. True
  - B. False

Please see **Solutions to Problems for Section 2.8** on page 84

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## **Solutions to Problems for Section 2.8:**

1. B Contingency is owned by the customer and, therefore, can only be allocated by the customer.
2. D Contingency is not part of the contract and, therefore, is not part of anything within the contract such as CBB, PMB, and CA.
3. A The contractor is not required to monitor contingency until it is added to the contract as budget for additional work scope. However, when the customer so requests, the contractor can assist with monitoring contingency.
4. A When contingency is allocated by the customer via change order for additional work scope, the PM is authorized to further allocate the work scope and budgets to the PMB and *Control Accounts*.
5. B MR is not part of the PMB until allocated by an internal change.
6. C MR is to support scopes of work that may not have been foreseen when the project was baselined. This percentage will be higher or lower based upon the value of the scope. It should be stressed that government contracts can use MR to appropriate more funding during an allocation shortfall.
7. D MR is a percentage based on the planned scope, and it is higher or lower based upon the degree of risk definition at the time of the project baselining process.
8. B Contingency is allocated by contract and requires a change order, MR is allocated by the PM based upon internal change management, no customer approval required. The CBB is equal to the sum of the PMB and MR.
9. A The log reflects the CBB, divided into the PMB, with *Distributed Budget (DB)*, *Undistributed Budget (UB)*, and MR allocated in the log. Contingency is not part of the CBB and therefore not included in project logs.
10. B False – The ANSI/EIA is only a guide not a statute or law.

## Section 2.9 Undistributed Budget (UB)

### Introduction

*Undistributed Budget (UB)* is associated with specific work scope or contract changes that have not yet been assigned to a control account or a summary level planning package. It also is a repository for work scope and budget that has been removed from distributed budget as a result of a *Stop Work Order (SWO)*.

*Undistributed Budget* for added scope that has been negotiated should be appropriately allocated as quickly as practical, usually in the following accounting month. Another example of applying undistributed budget is when the customer and/or owner has included Alternative Scope in the contract SOW; and, becomes part of the contract scope authorization or distributed budget when added to the contract by change order or contract modification to execute the Alternative Scope.

*Undistributed Budget* for added scope that has not been negotiated is usually called *Authorized Unpriced Work (AUW)*. The contractor's estimate of the budget required for the authorized work scope is used as the preliminary budget to be placed in UB *Authorized, Unpriced Work (AUW)* is defined as work authorized prior to the work being negotiated. The work is initially placed in UB. Budget and work scope for near term work is authorized to *Control Accounts*. If negotiations are not complete by the time the initial authorization nears completion, another increment of budget and work scope is authorized to *Control Accounts*. When the authorized work scope is negotiated, the amount remaining in UB is adjusted for the difference between the estimated budget and the negotiated budget. The resultant UB amount is allocated to MR and to *Control Accounts*.

For Stop-Work Orders (SWOs), the budget and the work scope that had been halted remains in UB until contractual direction from the customer is received as to the disposition of the halted work. Disposition could be removal of the scope and budget from the contract, restart of the scope, or to continue with a modified work scope and/or budget.

### Terms to Know

- *Authorized Unpriced Work (AUW)*;
- *Change management*;
- *Stop Work Order (SWO)*; and,
- *Undistributed Budget (UB)*.

### Key Points for Review

1. Definition of UB
2. UB contents
3. Definition of AUW
4. How AUW is distributed
5. Definition of SWO
6. How a SWO is implemented

Please see **Sample Problems for Section 2.9** on page 87

**Sample Problems for Section 2.9:**

1. If the approved Control Account budget equal \$1,100,000, the *Undistributed Budget* is \$100,000, and the *Management Reserve* is \$0, what is value of the CBB?
  - A. \$1,100,000
  - B. \$1,200,000
  - C. \$1,000,000
  - D. None of the above
  
2. *Undistributed Budget* that is not allocated either to working budgets or to management reserve should be appropriately allocated by the next accounting month.
  - A. True
  - B. False
  
3. *Undistributed Budget* is part of the *Performance Measurement Baseline*, but is excluded from the calculation of BCWP.
  - A. True
  - B. False

**Solutions to Problems for Section 2.9:**

1.     B     Planned (*Distributed Budget*) plus *Undistributed Budget* plus *Management Reserve* = CBB.
  
2.     A     Budget and work scope has to be authorized to be earned, so it should be authorized to the *Control Accounts* as soon as possible.
  
3.     A     *Undistributed Budget* is part of the *Performance Measurement Baseline*, but it is excluded from BCWP calculations because it has not been allocated to work packages within *Control Accounts*.

## Section 2.10 Over-Target Baseline (OTB)

### **Introduction**

An *Over-Target Baseline* (OTB), also known as formal reprogramming, may arise when contract performance deviates from the plan to such an extent that the original plan no longer serves as a reasonable measurement device Contract Budget Base (CBB). In this case, formal reprogramming to a budget that exceeds the CBB may be necessary. The OTB is the sum of the CBB and the recognized over-run. (Also Refer to *Section 5.0, Revisions and Data Maintenance*)

A major consideration for reprogramming is an analysis of the remaining work and remaining budget. The fact that a contract is over-running to date and is projecting an over-run at completion is not the most important factor in the decision. Changing a baseline merely to compensate for variances already experienced is inappropriate and is not allowed.

Prior to requesting the procuring organization to recognize an OTB, the following conditions are taken into consideration:

- The available contract budget for the remaining work is decidedly insufficient.
- The completion of the work is less than 85 percent.
- General guidance: At least six months of substantial work remain after reprogramming. And,
- *Guidelines* are in place to implement the change, including the extent of the reprogramming, the WBS elements affected, the base month for the reprogramming, ground rules, performance measurement during the implementation of the reprogramming effort and establishment of *Management Reserve* (MR).

If these conditions are satisfied, then the change to the budget and schedule are recorded as though a change in contractual scope had been received.

**General Guidance:** Changes to the baseline budget are fully documented and traceable and reconciliation from OTB to the CBB is provided at the bottom of Format 1 of the Contract Performance Report (CPR). The process for implementing an OTB is the Baseline Change Proposal or BCP. The process requires that the BCP be approved by an Authorized Baseline Change Control Board established during the Project Charter or Project Management Plan.

It is also important to note that the CPR format is a standard format primarily used in US government work, similar types of reports are used in commercial and international, but not a standard format.

**Terms to Know**

- *Contract Budget Base (CBB)*;
- *Over-Target Baseline (OTB)*;
- *Management Reserve (MR)*; and,
- *Performance Measurement Baseline (PMB)*.

**Key Points for Review**

1. Demonstrate understanding of the relationship between the CBB and the OTB.
2. Have clear understanding of the purpose and restrictions related to an OTB.
3. Understand where OTB data is referenced on the CPR.

**Sample Problems for Section 2.10:**

1. During the life of a project situations may arise whereby available budgets for the remaining work are insufficient to ensure valid performance measurement. Under these circumstances, the total budget allocated to work to enable valid performance measurement will exceed the CBB. This result is referred to as the OTB.
  - A. True
  - B. False
  
2. Guidelines are in place to implement the change, including the extent of the reprogramming, the WBS elements affected, the base month for the reprogramming, ground rules, performance measurement during the implementation of the reprogramming effort and establishment of contingency?
  - A. True
  - B. False
  
3. When can an OTB be issued after the project has started?
  - A. When the difference between the ETC and the original budget is significant
  - B. When the difference between the EAC and the remaining budget is significant
  - C. When the difference between the ETC and the remaining budget is significant
  - D. When the difference between the EAC and the original budget is significant
  
4. Advance notification to the appropriate parties is not required, prior to implementation of an OTB?
  - A. True
  - B. False
  
5. The \_\_\_\_\_ represents the formal plan for the *Control Account Manager(s)* to accomplish the authorized work assigned within the time defined by the project schedule and within the authorized budget?
  - A. CAP
  - B. OTB
  - C. CBB
  - D. PMB

**Solutions to Problems for Section 2.10:**

1.     A     An OTB arises when the ETC for the remaining work exceeds the CBB. The CBB can be exceeded, when formal approval has been received from the Customer.
2.     B     The guidelines are in place up to the contingency, which is allocated per the contract.
3.     C     An OTB arises after a project has commenced and scope has been identified. Projects cannot start with an OTB, as the amount should have been funded prior to starting work.
4.     B     An OTB requires formal approval from the customer, prior to implementation.
5.     D     The PMB is the completed formal plan of the work planned and the authorizations to proceed.

## Section 2.11 Earned Value Methods/Techniques

### Introduction

The earned value concept requires that a project performance measurement plan be created and implemented, usually identified as the planned value (PV) or *Budgeted Cost for Work Scheduled* (BCWS). Typically, earned value (EV) is measured using a scheduling software package against the PV to obtain a physical percent complete (EV) or *Budgeted Cost for Work Performed* (BCWP). This EV is compared to the Actual Cost (AC) or *Actual Cost of Work Performed* (ACWP) to arrive at a true measurement of the cost performance. Those three elements are the backbone for Earned Value Management; and, an EVM System cannot be implemented without all three elements. The use of PV and Actual Cost only provides a variance between the spend plan or cash flow; not an earned value or performance measurement process which is the only technique to reflect the true health of a project.

EVM provides project managers with early warning of inadequate performance that allows them to take necessary corrective action before the project spins out of control and is not recoverable. Also provides information on system performance that may make funds available to other owner projects. Management should know of potential cost overruns or if the project is behind schedule by the time 15 percent of the program is complete, in time to take corrective measures to alter an unfavorable outcome.

EVM methods provide the means to quantify the project accomplishment in terms of labor hours, dollars, or other measurable units. Although both objective and subjective methods are used, using objective instead of subjective EVM methods to measure progress provides additional insight into accurate project status.

Selecting the appropriate earned value technique is crucial to the effectiveness of earned value reporting. Earned value techniques are selected consistent with the way planned work is to be performed. The EVMS must be reviewed with the customer during the IBR. Excessive use of subjective EVM methods such as *Level of Effort* (LOE), *Expert Judgment and Percent Complete* not measured objectively may be challenged. Detailed supporting documentation is typically required during the IBR or EIR to demonstrate a clear measurement approach and strategy.

The following paragraphs provide a description of applicable EVM methods and techniques that can be used to reflect program accomplishment. There are three typical methods used most often: discrete, apportioned, and LOE. The discrete method is further subdivided into more definitive techniques.

**Discrete Method** – applies to work that can be objectively measured

1. The **Fixed Formula** technique provides easy handling of short-term activities, i.e., activities that span one to two accounting periods. Using this method the CAM simply plans for (and subsequently earns) a portion of the budget when the activity starts, and plans for/earns the remainder when the activity is complete. The 0/100 and 50/50 splits are common forms of this method; 0/100 is applicable to an activity confined to a single accounting period, 50/50 is used where the activity may start in one month and end in the next accounting month.

Splits such as 25/75, or 40/60 are also commonly used. The major requirement of this technique is that the budget be allocated to the months in the same percentages as the technique, this is very important so that the resource allocations are not skewed over the lifecycle. This EVM method requires only a simple and objective assessment of status. Procurement activities can be measured well this way.

- A. **Advantages.** This method is for short-term work packages, and requires minimal effort to status.
  - B. **Disadvantages.** Could be the source of significant false variances if the technique does not match the budget spread. Also does not allow for partial credit for in-process work.
2. **The Milestone** technique requires that the *Work Package* be defined in terms of interim milestones, at least one per accounting period. These milestones are then assigned a portion of the total budget, so together they represent the value of the entire *Work Package*. When each milestone is completed, 100 percent of the respective budget value is earned. CAMs provide the actual start for the activity and the actual finish date for each milestone. Completion of the last milestone completes the work package. Monthly milestone budgets must be planned as the budget was planned.
- A. **Advantages.** This method requires objective measurable milestones, which the customer typically prefers.
  - B. **Disadvantages.** This method does not allow partial credit for in-process work, and requires detailed milestone planning.
3. **The Percent Complete** technique requires that the CAM measure or estimate the percentage of actual physical progress that has been achieved on the WP, relative to the total value of the WP. Budget value is earned as the product of the *Percent Complete* and the BAC. The percent complete is applied to the BAC to determine cumulative BCWP.
- A. **Advantages.** This can be an objective EVT, if earned value is based on detailed schedule status or metrics, even though interim milestones do not appear on the *Work Package*.
  - B. **Disadvantages.** If detail schedule status or metrics are not used in concert with this EVT, it may yield an inaccurate subjective assessment of performance if the *Work Package* is more than two accounting months long.

Note with shorter work packages, under a month, detail may not be required. Detailed schedule status or metrics are sometimes called “quantified backup data” (QBD) and are recommended anytime the work package is greater than a month.

4. The Milestone with *Percent Complete* technique is a combination of the above two techniques. It requires that the *Work Package* be defined in terms of sequential milestones, ideally, at least one each month. These milestones are then assigned a portion of the total budget so they represent the value of the entire *Work Package*. As the work on each milestone progresses, a percent complete assessment/entry for each individual milestone is made. This method is very effective when a discrete milestone does not occur naturally each

month because it gives the CAM the ability to claim progress or completion for an interim milestone. The required input is the percent complete for each milestone. This technique is especially effective when *Work Packages* have short duration (less than six weeks) cost/resource loaded activities/tasks in the schedule that make up the *Work Package*. Completion of an activity is the interim milestone and the percent work complete in the schedule is the percent complete applied to the milestone. The time-phasing of the resources in the schedule convert to the time-phasing of the budget. The budget is earned as it was planned and the CPR SV is directly traceable back to the schedule.

- A. **Advantages.** This method requires objective measurable milestones, which the customer prefers, and allows for partial credit against milestones. This EVM can reduce excessive schedule detail by representing numerous activities as internal milestones within a single work package.
  - B. **Disadvantages.** This method requires a CAM assessment of the percent complete for each milestone.
5. The Equivalent or Actual Units Complete technique. The *Equivalent Units Complete* EVM method is used primarily in manufacturing environments and involves weighting of each step in the manufacturing process. The *Actual Units Complete* EVM method is used for repetitive tasks involving the same work; e.g., the installation of 10" valves in a pipeline.
- A. **Advantages.** This method can use the standards earned methodology which, as explained in the history above, was the genesis of the *Earned Value*.
  - B. **Disadvantages.** Actual units complete does not take into account work in process. The equivalent units' complete calculation can be complicated.

**Apportioned Method** is used to calculate earned value for tasks that are related in direct proportion to a parent work package. Apportioned effort is also referred to as factored effort or factored method. When selecting this EVM method, a parent activity, *Work Package*, or *Control Account* must also be selected to determine the percent complete for the WBS element. The percent complete for an Apportioned effort task is always equal to the percent complete of its parent.

- A. **Advantages.** This method is appropriate for work packages which mirror established cost estimating relationships.
- B. **Disadvantages.** Requires that the resources are proportionally the same between the parent and the apportioned work. This is to insure the same percentage variance in dollars as a percent as the percent complete.

**Level of Effort (LOE) method** is applicable to program activities that are supportive in nature, have no substantive physical product (other than routine management type deliverables), and have no significant schedule impact to discrete work. This method sets incremental earned value equal to the planned (budgeted) amount and precludes any schedule variance. This EV method should not be applied to activities that contain measurable work. LOE can be planned in the schedule, but special care should be taken to ensure that the critical path never goes through LOE activities.

- A. **Advantages.** Monthly budget value is earned with the passage of time and is equal to the monthly scheduled amount (BCWP = BCWS). This method usually is

used for accounts that are more time related than task oriented. This method is appropriate for sustaining tasks such as *program management*.

- B. **Disadvantages.** *Level of Effort Work Packages* is often challenged by the customer because they can distort the performance of discrete work. Ideally, most of a project's LOE is concentrated in one "leg" of the WBS (e.g., *Project Management/Systems Engineering*). Government guidance indicates that no more than 20 percent of the work in a *Control Account* may use the LOE method. At the project level, 10-20 percent LOE or less is desired, but much depends upon proper segregation of the LOE. LOE should not be mixed with other EV Techniques in the same WP.

### **Terms to Know**

- *Actual Cost/Actual Cost of Work Performed (AC/ACWP);*
- *Budget at Completion (BAC);*
- *Cost Performance Index (CPI);*
- *Cost Variance (CV);*
- *Earned Value/Budgeted Cost for Work Performed (EV/BCWP);*
- *Estimate at Completion (EAC);*
- *Estimate to Complete (ETC);*
- *Planned Value/Budgeted Cost for Work Scheduled (PV/BCWS);*
- *Schedule Performance Index (SPI);*
- *Schedule Variance (SV);*
- *To Complete Performance Index (TCPI);* and,
- *Variance at Completion (VAC).*

### **Key Points for Review**

1. Know the industry-accepted EVM methods and techniques.
2. Describe when to apply the various EVM methods and techniques, based on the scope of work.
3. Explain the impact on the generated EV and resulting variances when selecting the various EVM methods and techniques.
4. State the algorithm associated with each EVM method and technique.

**Sample Problems for Section 2.11:**

Given the following information:

WBS Element	UoM	Budgeted Quantity Total	Actual Quantity To-Date	BCWS PV	BCWP EV	Percent Complete
03110 Formwork	SF	4,000	3,000	6,000	_____	_____
03210 Rebar	Ton	10	6	900	_____	_____
03310 Place & Finish	CY	800	640	1,600	_____	_____
Subtotal Slabs at grade					_____	_____

**Table 2.11.0 — Information for Sample Problems for Section 2.11**

1. What is the earned value (EV/BCWP) for WBS Elements 03110, 03210, and 03310?
2. What is the percent complete for WBS Elements 03110, 03210, and 03310?
3. Given: BCWS equals \$1,500,000; BCWP equals \$1,575,000; ACWP equals \$1,490,000. Which of the following is a true statement?
  - A. The project is under-running and ahead of schedule
  - B. The project is under-running and behind schedule
  - C. The project is over-running and ahead of schedule
  - D. The project is over-running and behind schedule
4. The EV reporting for level of effort activities is based on the following principle:
  - A. EV (BCWP) is equal to actual cost (ACWP); no cost variations can exist
  - B. EV (BCWP) is equal to scheduled (BCWS); no schedule variations can exist
  - C. EV (BCWP) is equal to quantity installed
  - D. None of above
5. If CPI = 1.0 and SPI = 0.95 which one of the following statements is correct?
  - A. The project is under-running and ahead of schedule
  - B. The project is under-running and behind schedule
  - C. The project is over-running and ahead of schedule
  - D. The project is over-running and behind schedule

**Solutions to Problems in Section 2.11:**

1. 4,500, 540, 1280.
2. 75 percent, 60 percent, 80 percent.
3. A  $CV = BCWP - ACWP > 1.0$  and  $SV = BCWP - BCWS > 1.0$ . CV and SV are differences, as stated in the formulas here, in terms of measured units. It is CPI and SPI for which ratios  $<$  and  $>$  1.0 are important. For example, if  $CPI = BCWP \div ACWP > 1.0$ , then cost performance is deemed acceptable. But even if an index exceeds the threshold for acceptability—if it is, say, greater than 1.1—then it will surely draw much attention.
4. B No schedule variations can exist:  $SV = 0$ . Whatever effort is provided by the level of effort, if such effort meets contractual requirements, is exactly on-schedule:  $SPI = 1.0$ .
5. B The project is under-running and behind schedule.

## Section 2.12 Integrated Baseline Review (IBR)

### Introduction

An Integrated Baseline Review (IBR) is a formal review conducted by the customer's project manager and sometimes by a customer representative that has expertise in the area, and project team.

This term applies to US government projects but the processes are similar for commercial Baseline Reviews. For the IBR, the prime contractor defends its' technical, schedule and cost baselines to the customer. Sometimes major subcontractors are requested to participate both for the customer and prime contractor responsible for preparing the baseline. IBRs are typically required following contract award to verify the technical content of the PMB and the accuracy of the related resources (budgets), schedules, and technical ground rules and assumptions. In other words, is the PMB contractually compliant, reasonable, and achievable? Other objectives are to give the customer a sense of ownership in the baseline and confidence that the contractor has set up performance measurement requirements that will accurately report cost and schedule variances and the reasons for them.

An IBR is a formal and collaborative review process during which the PMB and related work scope, budgets, and schedules are evaluated. An objective of an IBR is to establish and maintain a mutual understanding of the risks inherent in a project's PMB. An IBR serves as a means for communication, review, and ultimate acceptance of the PMB.

An IBR may also be performed when the project enters a new phase of the contract, or, at the discretion of the customer's project manager, when a major modification to an existing contract significantly changes the existing PMB, or when a significant shift in the content or time-phasing of the PMB occurs. The intent is for the IBR to be a continuous part of the process of program management by both the customer and the contractor.

General Guidance: IBRs should be conducted within six months of contract award and are continued on an on-going basis, depending on changes to the PMB.

The IBR consists of the following jointly executed project management activities:

- PMB assessment;
- IBR preparation;
- IBR execution; and,
- Management processes.

The objectives of the IBR:

1. Ensure that the technical content of the *Control Accounts (CAs)* and *Work Packages (WP)* is consistent with the contract scope of work, the WBS, and the *WBS dictionary (See pg. 10)*.
2. Establish a logical sequence of effort planned consistent with the contract schedule.
3. Validate activity durations as achievable, given the resources applied.
4. Validate that the planned resources are available and that the resource profile is achievable.

5. Assess the validity of allocated *Control Account*, *Work Package*, planning package budgets, both in terms of resources and time-phasing.
6. Assess the EVMS and related processes and procedures, i.e., material management, subcontractor management, EAC process, etc.
7. Conduct a technical assessment of the *Earned Value* methods and techniques that will be used to measure progress to assure that objective and meaningful performance data will be provided.
8. Establish a forum through which the project team (including the customer) can gain a sense of ownership of the cost/schedule management process.

**Terms to Know:**

- *Estimate at Completion* (EAC);
- *Integrated Baseline Review* (IBR);
- *Performance Measurement Baseline* (PMB); and,
- *Work Breakdown Structure* (WBS).

**Key Points for Review:**

1. Know the core documents required during an IBR.
2. Understand the goals and objectives of an IBR.
3. Know when to conduct an IBR.
4. Know who is involved in conducting the IBR.

**Sample Problems for Section 2.12:**

1. Preparation for the IBR includes \_\_\_\_\_ that identifies key responsibilities, required \_\_\_\_\_, training, review dates, review \_\_\_\_\_, risk evaluation criteria, documentation needs, disposition of findings, and procedures for risk identification, documentation, and incorporation into project risk management planning.
  - A. Planning, technical expertise, scope
  - B. Manager, technical expertise, cost
  - C. Planning, resource allocation, results
  - D. None of the above
  
2. Which technical issues and risks identified during the IBR should be reviewed and assessed?
  - A. Schedule
  - B. Cost
  - C. Management process
  - D. All of the above
  
3. The IBR process consists of the following jointly executed project management activities:
  - A. PMB assessment, IBR preparation, PMB execution, management processes
  - B. PMB development, IBR preparation, IBR execution, management processes
  - C. PMB assessment, IBR preparation, IBR execution, management processes
  - D. PMB development, IBR processes, PMB execution, management processes
  
4. An objective of the IBR is to enable managers to effectively use the project PMB to assess performance and understand inherent risks.
  - A. True
  - B. False

**Solutions to Problems for Section 2.12:**

1.     A     The IBR is based on preparation and is meant to evaluate and provide recommendations to the program and not to penalize or critique.
2.     D     All processes should be reviewed and assessed during the review.
3.     C     PMB assessment, IBR preparation, IBR execution, and management processes are the fundamentals of a successful review.
4.     A     An IBR is meant to be a productive assessment and evaluation of the contractor's plan to effectively and efficiently execute the project.

## Chapter 3.0—Accounting Considerations

### Introduction

EVMS is not an accounting system, and EVMS guidelines do not suggest changes to accepted accounting practices or principles. Under the ANSI 748 C, September 2013, the EVM system uses actual cost data (AC/ACWP) from the company accounting system as appropriate for accurate reporting of program costs and performance. Aspects of the accounting process must be coordinated with *Control Accounts* and other budgeting processes, so that direct comparison and analysis can be performed. Many private sector contractors use an Activity Based Costing accounting system and with cost collection, cost estimating databases and bid preparation documents that are linked electronically using the WBS/CBS structure at the Activity level.

Accounting identification requires establishing a “clean” and certain method of cost collection within the *Control Accounts*. The intent of the guidelines are met by importing actuals at the Control Account or lower level, as long as it rolls up to one and only one CA. Identification of the methodology of collection of direct cost, by elements, into CAs is a fundamental EVMS requirement.

Some firms may include the overheads/markups within the labor rate, and some will identify them separately. This section of EVMS relates to the development of the actual cost definition, versus the accounting definition. Actual cost in EVMS will generally include the accrued cost in the accounting system if the contractor uses the accrual accounting method, which is one of the accounting methods allowed by the *Generally Accepted Accounting Principles* (GAAP) – the other is cash accounting, which are also in compliance with International Financial Reporting Systems (IFRS). An accrual is a cost that is included in the Actual Cost (AC)/ Actual Cost Work Performed (ACWP) for work that has been performed, has been invoiced, and the invoice has not made it through the owner or buyers company’s accounting system for payment yet. If the invoice has not been submitted or if the contractor does not use the accrual accounting method, the contractor’s project team must set up a system for collecting “*Estimated AC/ACWP*” and then subsequently reversing the “*Estimated AC/ACWP*” when the actual costs are recorded in the accounting system in a later period. If accruals are not included in the ACWP, the BCWP will be artificially higher, and a false positive CV will be shown. This could lead to inappropriate corrective action.

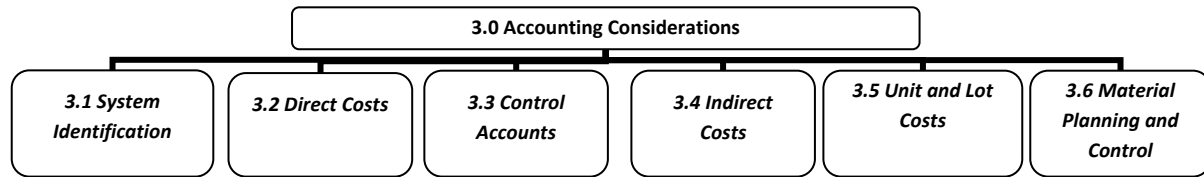
The *EVMS Guideline* (ANSI/EIA-748 C) states that the AC/ACWP for the work must be credited in the same month that the BCWP is earned. That may mean the use of negative “*Estimated AC/ACWP*” when material has been paid for, but has not been used to enable collection of Earned Value (EV)/ Budgeted Cost Work Performed (BCWP). In the commercial sector the use of activities for materials delivered and stored are allowed and that they are billed for the time period thus there is minimal variance on the cost and orientation is to the schedule variance.

### Terms to Know

- *Accrual*;
- *Actual Cost of Work Performed (ACWP)*;
- *Actual Cost (AC)*
- *Budgeted Cost of Work Performed (BCWP)*;
- *Earned Value (EV)*
- *Estimated ACWP*; and,
- *Generally Accepted Accounting Principles (GAAP)*.

**Key Points for Review**

These elements are outlined in figure 3.0 and described in the following sections.



**Figure 3.0—EVP Body of Knowledge for Accounting Considerations**

## Section 3.1 System Identification

### Introduction

The *ANSI/EIA 748 C Guidelines* address the following general requirements:

- Record direct costs in a manner consistent with the budgets in a formal system controlled by the general books of account.
- Summarize direct costs from control accounts into the work breakdown structure without allocation of a single control account to two or more work breakdown structure elements.
- Summarize direct costs from the *Control Accounts* into the contractor's organizational elements without allocation of a single *Control Account* to two or more organizational elements.
- Record all indirect costs, which will be allocated to the contract. Identify unit costs, equivalent unit costs, or lot costs when needed.

For material, the *ANSI/EIA 748 C Guidelines* require that the accounting system will provide:

- Accurate cost accumulation and assignment of costs to *Control Accounts* in a manner consistent with the budgets by using recognized, acceptable costing techniques.
- Cost performance measurement at the point in time most suitable for the category of material involved, but no earlier than the time of progress payments or actual receipt of material.
- Full accountability of all material purchased for the program including the residual inventory.

The accounting system structure is defined by the *Contractor's Cost Accounting Standards (CAS) Disclosure Statement*. The intent of this discussion is to ensure there is a timely and accurate transfer of actual cost information from the accounting system into the EVMS cost tool.

The accounting system must be capable of accounting for all resource expenditures on an "applied" basis (i.e., on an "as-used" or "as-consumed" basis). This requirement creates few difficulties in the categories of direct labor (where time cards or other time measurement devices are used) or other direct charges (where services are rendered on some type of monetary per-unit basis). In the area of material accountability, there is considerable variation among the respective processes of accounting for material usage. Recognizing the absence of uniformity in material methodologies, the CAS provides relaxed interpretations as to what constitutes an "applied" basis of material accounting, as well as alternatives for acceptance on an "other-than-applied" basis.

**Terms to Know**

- *Activity Based Costing/Activity Based Management;*
- *Control Account;*
- *Cost Accounting Standards (CAS);*
- *Disclosure statement;*
- *Direct cost;*
- *Federal Acquisition Regulations (FAR);*
- *Generally Accepted Accounting Principles (GAAP);*
- *Indirect cost; and,*
- *International Financial Reporting System (IFRS).*

**Key Points for Review**

1. Identify what the accounting system must do and how the data is structured.
2. Define the standards and confirm what a disclosure statement is.
3. State differences between an accounting system and an EVMS.
4. Understand the full integration of the common WBS numbering system down to the activity level.
5. Define the applied basis of material accounting.

**Sample Problems for Section 3.1:**

1. The accounting system structure is defined by the contractor's *CAS Disclosure Statement*?
  - A. True
  - B. False
  
2. Accountability for material includes:
  - A. Installed, purchased, inventory
  - B. Installed, stored, inventory
  - C. Installed, in transit, inventory
  - D. Installed, purchased, in transit
  
3. When an OBS is used, the program can then summarize direct costs from *Control Accounts* into the WBS.
  - A. True
  - B. False
  
4. *Direct Cost* is the only cost recorded in the accounting system.
  - A. True
  - B. False
  
5. Accurate cost accumulation and assignment of costs to control accounts in a manner consistent with the \_\_\_\_\_ using recognized, acceptable, costing techniques?
  - A. *Control Accounts*
  - B. *WBS*
  - C. *Budgets*
  - D. *PMB*

**Solutions to Problems for Section 3.1:**

1.     A     The first thing that is identified when responding to the *Guidelines* is that there is a *CAS Disclosure Statement* that has been independently audited and approved.
  
2.     A     Based upon Federal acquisition Regulation (US government projects) and GAAP, purchased, received and accepted, in inventory, and installed are the main accounting classifications for materials. *ANSI/EIA 748 C* does not allow *Earned Value* to be credited before it has been received and accepted.
  
3.     B     False. The use of the OBS allows summarization of ACWP by the performing organizations.
  
4.     B     *Direct cost* is just one element of the accounting system.
  
5.     C     *Budget* is the basis of spreading the cost and measuring and establishing EVM methodologies.

## Section 3.2 Direct Costs

### Introduction

Direct costs are any costs that may be identified specifically with a particular cost objective. Generally, they are labor, material, equipment, subcontract, and other direct costs (ODC) such as travel.

Generally, direct costs are the result of measurable items with identification of significant cost elements as needed for internal management and control of the subcontractors. This can include ODCs and other costs, which are directly attributed to the completion of the work, exclusive of overheads.

Direct costs are those which can be identified specifically with a particular sponsored project and which can be directly allocated to such activities relatively easily and with a high degree of accuracy. For example, the materials needed for a refinery project, the salaries of the individuals who work on the project, cost of subcontractors who execute specialty scopes of work, and travel expenses for those individuals comprise direct costs.

Direct costs are necessary to meet the project-specific and technical requirements.

### Terms to Know

- A. *Apportioned*;
- B. *Control Account Plan (CAP)*;
- C. *Direct Costs*;
- D. *Generally Accepted Accounting Principles (GAAP)*;
- E. *Indirect Costs*;
- F. *Retroactive Adjustments*; and,
- G. *Variance Analysis*.

### Key Points for Review

1. Ability to identify direct versus indirect costs.
2. Ability to apply direct cost to control accounts and EVMS.

Please see **Sample Problems for Section 3.2** on page 111

**Sample Problems for Section 3.2:**

1. *Control Accounts* should be placed in which format to establish the CAP?
  - A. Distributed by curve
  - B. Resource loaded into the schedule
  - C. Allocated by weighting
  - D. None of the above
  
2. What set would be considered direct costs?
  - A. Concrete, rebar, masonry, and pumping subcontractor
  - B. Concrete, rebar, mason, overhead, and G&A
  - C. Concrete, rebar, subcontractor, and profit
  - D. Travel, masonry, concrete, and G&A
  
3. Direct costs are necessary to meet project-specific and technical requirements.
  - A. True
  - B. False

**Solutions to Problems for Section 3.2:**

1. B A resource loaded schedule is the preferred method for developing the data included in the CAP. In those instances when there is no resource loading of the schedule, the time-phasing of the resources in the CAP must be relatable to the baseline schedule.
2. A All the items are associated with readily measurable quantities and costs that can be time-phased with status recurrently established.
3. A Technical scope with direct scope, phase, and budget.

## Section 3.3 Control Accounts (CAs)

### Introduction

The *Control Accounts* (CAs) ensure accurate summarization of the ACWP through the WBS. Allowable costs collected within the *Control Account by Cost Element* must summarize from the *Control Account* level through the WBS, to the top level without being allocated to two or more higher-level elements. A carefully developed WBS and a corresponding cost collection structure should prevent any single element's data from being summarized to multiple higher-level elements. However, this rule does not preclude common item purchases from a single CA being used on multiple parts of the project.

The *Control Accounts* also ensure accurate summarization through the OBS. The same requirement for accurate cost summarization applies to the project organization as well. A carefully developed project OBS and cost collection structure will assure accurate data summarization for management.

The EVM system should ensure that ACWP for apportioned effort is collected properly, so that valid comparisons to BCWP for the apportioned effort may be made.

It is essential that all actual costs used for variance analysis come directly from or be reconcilable with the accounting system. This is especially true for firms subject to Sarbanes-Oxley. In some cases, it may be necessary to use *Estimated ACWP* to avoid significant artificial variances that might be created by the time lag of costs being recognized by the accounting system.

The accounting system must control retroactive changes to actual costs. Retroactive adjustments to costs should only be made for routine accounting adjustments or for correction of errors. Any direct or indirect cost adjustments must be made in a timely manner in accordance with *Generally Accepted Accounting Principles* (GAAP).

### Terms to Know

- *Apportioned effort*;
- *Control Account Manager (CAM)*;
- *Direct costs*;
- *Cost Element*;
- *Indirect costs*;
- *Retroactive adjustments*; and,
- *Variance Analysis (VA)*.

### Key Points for Review

1. Ability to identify a *Control Account*.
2. Ability to recognize the summarization and accuracy.
3. Ability to identify the three key areas of a *Control Account*.
4. Ability to analyze the performance indexes based on the key areas.

Please see **Sample Problems for Section 3.3** on page 115

**Sample Problems for Section 3.3:**

1. *Control Accounts* are the points where the WBS tasks and organizational responsibilities intersect, and they are best defined as being \_\_\_\_\_.
  - A. Where a single organizational element is responsible for a single WBS element
  - B. Where the organization is responsible for single WBS element
  - C. Where a single organizational element is responsible for multiple WBS elements
  - D. Where the organization is responsible for multiple WBS elements
  
2. Who is assigned the responsibility for ensuring accomplished work is accomplished within the CA?
  - A. Project Manager
  - B. Program Manager
  - C. Project Controls
  - D. Control Account Manager (CAM)
  
3. The CA is the highest level of performance measurement necessary for program management.
  - A. True
  - B. False
  
4. Control Accounts are the focus for work \_\_\_\_, work \_\_\_\_, and work \_\_\_\_:
  - A. Control, authorization, and performance measurement
  - B. Planned value, authorization, and management
  - C. Authorization, management, and performance measurement
  - D. Authorization, control, and performance measurement

**Solutions to Problems for Section 3.3:**

1.     A     Any CA corresponds to a single OBS element and a single WBS element.
2.     D     The CAM is responsible for the CA, including the actual cost and representing the correct methodologies into the CA.
3.     B     The PMB, which summarizes all control accounts, is the highest level of performance measurement.
4.     D     Controls accounts are focus for work authorization, control, and performance measurement, which is analyzed by the CAM and acted upon, if necessary, by the PM.

## Section 3.4 Indirect Cost Management

### Introduction

This section discusses requirements that apply to the contractor's process of establishing, implementing, controlling and evaluating indirect budgets and costs that are incurred and allocated to the individual projects. Since indirect costs are normally managed by organizational levels where costs are not project specific, there should be some method for assigning the appropriate values for indirect budgets and costs to all affected projects.

Managerial responsibility for indirect cost must be assigned for the indirect cost pools, as well as for the company as a whole. The contractor establishes an indirect budget process which includes the formal assignment of duties and limits of responsibility, a description of the indirect cost system, and policies and procedures applicable to the establishment and control of indirect costs. Assignment and control of the indirect resources must be clearly defined and should be commensurate with the authority to approve or to avoid the expenditure of resources.

The PMB should include indirect budgets, which are assigned based on allocations as defined in the *CAS Disclosure Statement*. All elements of the PMB that have direct budgets should have indirect allocations as part of the total assigned budget.

Realistic time-phased budgets and forecasts for indirect costs must be established by organization or burden pool and then compared to the direct business base to determine the rates to be applied. The contractor should apply the most appropriate indirect rates so that a valid PMB can be established. Indirect budgets should be reviewed at least annually or when major changes are identified in factors affecting indirect costs.

Actual indirect costs are collected for allocation to individual contracts. Overhead costs represent expenses which benefit more than a single contract. The accounting process should record all allocable indirect costs consistent with the provisions of the contractor's disclosure statement. The contractor's procedures and/or EVMS description should specify the level at which indirect cost information will be allocated to individual contracts, usually at the *Cost Element, Account or Charge Number* level.

Variations in indirect costs should be analyzed at least monthly. The contractor establishes controls to ensure that the actual indirect costs are compared to indirect budgets, and the resulting information is compared to the current business base to determine if the rates being applied are still appropriate. Specific control procedures should be implemented to ensure variations are identified, reported, and addressed by the appropriate level of management. Such controls increase the likelihood that potentially significant variations are communicated and considered in the development of the project EAC.

The most current information is used in preparing indirect rates including historic experience, contemplated management improvements, projected economic escalation, and anticipated business volume. This analysis will ensure a valid projection of project costs. Comparing indirect budgets to

estimates of final indirect costs will reveal where significant differences occur. These variances must be analyzed to determine the causes and appropriate corrective actions.

Typical indirect costs are overhead, burden, and general and administrative (G&A) costs.

### **Terms to Know**

- *Applied Indirect Cost Rate;*
- *Burden;*
- *Control Accounts;*
- *Direct costs;*
- *Estimate at Completion (EAC);*
- *Generally Accepted Accounting Principles (GAAP);*
- *General and Administrative (G&A)*
- *Indirect costs;*
- *Indirect Cost Allocation;*
- *Overhead;*
- *Performance Measurement Baseline (PMB); and,*
- *Variance Analysis (VA).*

### **Key Points for Review**

1. Explain the differences between direct and indirect costs.
2. Give four examples of both direct and indirect costs.
3. If indirect cost variances occur, how should the CAM react?
4. Know how to calculate and forecast indirect rates.
5. Know how to review PMB direct and indirect costs.

**Sample Problems for Section 3.4:**

1. Indirect costs should not be incorporated into the PMB?
  - A. True
  - B. False
  
2. When should indirect rates be validated?
  - A. Annually
  - B. Project closeout
  - C. Periodically during the company's fiscal year
  - D. Never
  
3. Indirect costs are directly correlated to direct costs?
  - A. True
  - B. False

**Solutions to Problems for Section 3.4:**

1. B Indirect costs are included in the PMB. The PMB reflects the *Distributed Budget* (DB) and *Undistributed Budget* (UB).
2. C Normal adjustment of indirect rates occurs annually. However, periodic reviews are necessary within the fiscal year to ensure that at the end of the fiscal year, the year-end adjustments will be minimized.
3. A Indirect costs are directly related to the direct costs through the use of applied rates.

## Section 3.5 Unit and Lot Costs

### Introduction

Identification of measurable costs is a requirement, if applicable and required by the contract/project. This cost is based on the overall cost and quantity that in turn provides the ability to track costs on various per unit bases. Based on management needs or preferences, EVMS can provide valuable information based on any variety of units (per widget, per distance, per unit volume, etc). This information allows the program to focus efforts on reducing costs.

Unit cost derives from a measurable work item quantity with a set, assigned price. This price can be inclusive of labor, material, equipment, subcontracts, ODCs and applicable markups. This sum of all allocable item costs is then divided by the quantity of work expected to be done. The unit cost should have a basis and assumption explanation for the scope.

Lot cost is a grouping of similar items into large quantities and values.

The requirement by most systems are that the accounting system accurately accumulates costs and assigns them to appropriate control accounts using recognized and acceptable costing techniques.

### Terms to Know

- *Lot costs;*
- *Unit costs; and,*
- *Unit pricing.*

### Key Points for Review

1. Track cost by unit.
2. Determine best unit cost measurement.
3. Track lot cost.

Please see **Sample Problems for Section 3.5** on page 123

**Sample Problems for Section 3.5:**

1. What is the most correct representation of unit costs?
  - A. Quantity of piping spools delivered divided by budget cost
  - B. Lot and percent complete
  - C. Worker-hours/month
  - D. Budget cost divided by quantity of piping spools delivered
  
2. Quantity of tanks produced during a fiscal year is a measurement of lot cost.
  - A. True
  - B. False

**Solutions to Problems for Section 3.5:**

1. D Budget cost divided by quantity of piping spools delivered is the only appropriate example of a unit cost.
2. A Lots are usually defined as a quantity delivered or produced within a given period. Lot prices are used when it is impractical to collect unit prices.

## Section 3.6 Material Planning and Control

### Introduction

While material costs are identified as a *Cost Element* in *Section 2.7*, planning and control of these is an important area in implementing EVMS.

Material costs should be recorded on an as-applied basis. This means the costs should be recorded at the point in time where the material is applied to the work in progress. However, there may be exceptions to this approach. BCWP for material cannot be credited any earlier than the point of receipt. BCWP must be credited in the same period that the work is completed and that the ACWP is applied. A basic rule is that EV for material must be taken in accordance with how it was planned and consistent with when it is received. If the BCWS was placed in accordance with when the material is to be received, BCWP must also be taken upon receipt of the material. Where BCWP has been earned and the ACWP has not yet been entered into the accounting system, the organization must use “estimated ACWP” or “accruals” in management and customer reports in order to avoid false cost variances.

In order to be able to provide detailed and accurate data for variance analysis, the EVMS should provide the following capabilities:

1. The planning of material costs (BCWS) for WPs and PPs within a CA must be consistent with the contract scope of work and schedule commitments.
2. Recognition of BCWP and ACWP at the time purchased materials are issued for fabrication from the warehouse by the vendor/supplier and when fabricated items are issued from the project warehouse for assembly and therefore available for the project to use.
3. Accumulation of material costs incurred (ACWP) using acceptable costing techniques and material accountability.
4. The ability to segregate, identify and analyze the causes of usage and price variances for all types of material.
5. The ability to determine and analyze unit and lot costs, if required (See *Section 3.5 of this study guide*).

### Material Types

Materials are divided into two categories for planning and variance analysis purposes: production and non-production materials. Production materials are those materials that are directly incorporated into the deliverable end items. Production materials are planned and purchased in accordance with contract requirements and placed in the warehouse upon receipt and acceptance.

Non-production material includes engineering materials, tooling materials and purchased tooling. This material is planned (BCWS/PV) and earned (BCWP/EV) at point of receipt. ACWP is similarly recorded and reported at the point of receipt. In the event that invoices have not been paid, Estimated ACWP/AC may be used (based on purchase order and invoice information) until costs are formally entered in the accounting system.

### **Material Classification**

Material is also divided into two classifications for EVMS purposes:

- **“High Dollar”**—Material that is planned and earned using discrete earned value techniques, and is usually tracked using a material or equipment part number. This classification should represent approximately 80 percent of the material costs for the project, while encompassing approximately 20 percent of the material items. BCWS/PV is developed by taking the quantities from the *Purchase Order* (PO) and multiplying them times the budget unit price.  $BCWP/EV = \text{Budgeted Unit Price of the item received} \times \text{the actual quantity received}$ .  $ACWP/AC = \text{PO Unit Price of the item received} \times \text{the actual quantity received}$ .
- **“Low Dollar”**—Material that is planned and earned as percent complete, Apportioned effort, or *Level of Effort* (LOE). It may be planned as items in aggregate, or in homogenous groupings (fastening hardware, lubricants, personal protective equipment, coatings, etc.). This classification represents approximately 20 percent of the material costs for the project, but contains approximately 80 percent of the material items. BCWS/PV is developed by grouping the material items into a single WP, and using planned receipt dates for time phasing. If the percent complete earned value technique is used, percent complete is calculated using the formula  $\text{percentage complete} = ACWP/EAC \times 100$ . This is often referred to as the PERT cost formula and its use is discouraged. If used, the EAC must be analyzed monthly for potential changes to avoid a large change in a single month that could result in negative BCWP/EV. BCWP/EV for apportioned and LOE WPs are calculated using the relationships already established in the EVMS.

There are several different methods of determining high dollar value.

1. Determine the extend price of each material item in the Bill of Material (BOM). Rank by extend cost and determine where approximately 80% of the costs is. Review any items within the 80% range for obvious high quantity low dollar parts that may not be relivant. Also review the items in the 20% that are low dollar high unit cost to determine if they should be included.
2. Determine classes of material to determine high versus low doller requirements. For example high dollar value computer purchases should almost always be high dollar EVM requirements, and miscellaneous nuts and bolts may be high dollar but almost always Low Dollar planned.

### **Material Variance Analysis**

There are two types of variances that may occur in material: *Price Variance* (PV; not to be confused with *Planned Value*) and *Usage Variance* (UV).

*Price Variance* = (Earned Price per unit - Actual price per unit) X Actual quantity issued or received.

*Usage Variance* = (Earned quantitiy - Actual quantity) X Earned price per unit.

Price versus usage variance is typically required on high dollar value material. Note – failure for a project to identify high dollar value verses low dollar value material, primarily means that all material should be planned as high dollar value.

**Terms to Know**

- “High Dollar” Materials;
- “Low Dollar” Materials;
- Material Classification;
- Material Types;
- Non-production Materials;
- Price Variance (PV); and,
- Production Materials;
- Usage Variance (UV).

**Key Points for Review**

1. Know the definitions of the *Material Types*.
2. Know the definitions of the *Material Classifications*.
3. Know how to develop BCWS for the *Materials Types* and *Classifications*.
4. Know how to determine BCWP and ACWP for the *Materials Types* and *Classifications*.
5. Know how to calculate *Price Variance (PV)* and *Usage Variance (UV)* for the *Materials Types* and *Classifications*.

Please see **Sample Problems for Section 3.6** on page 129

**Sample Problems for Section 3.6:**

1. The *Earned Price* for a material item is \$25; the *Actual Price* for the same item is \$20; 150 of the material items have been received. What is the *Price Variance (PV)*?
  - A. (\$750) Unfavorable
  - B. \$3,750 Favorable
  - C. \$750 Favorable
  - D. \$3,000 Favorable
  
2. The *Earned Quantity* for a material item is 275; the *Actual Quantity* for the same item is 350; the *Earned Price* per unit is \$45. What is the *Usage Variance (UV)*?
  - A. (\$3,375) Unfavorable
  - B. B \$3,375 Favorable
  - C. \$28,125 Favorable
  - D. \$15,750 Favorable
  
3. The *Planned Quantity* to date for a material item is 1,500; the *Unit Price* for the item is \$30; 500 of the items have been received. What is the BCWS and BCWP for this material item?
  - A. BCWS = \$1,500; BCWP = \$500
  - B. BCWS = \$1,500; BCWP = \$45,000
  - C. BCWS = \$750,000; BCWP = \$15,000
  - D. BCWS = \$45,000; BCWP = \$15,000
  
4. “*High Dollar*” material items may be planned using the *apportioned effort* or *Level of Effort (LOE)* earned value techniques.
  - A. True
  - B. False
  
5. “*Low Dollar*” material items comprise approximately 20 percent of the material cost and approximately 80 percent of the number of overall material items.
  - A. True
  - B. False

**Solutions to Problems for Section 3.6:**

1. C  $(\text{Earned Price per unit} - \text{Actual Price per unit}) \times \text{Actual quantity received or issued} = (\$25 - \$20) \times 150; \$5 \times 150 = \$750$  Favorable.
2. A  $(\text{Earned quantity} - \text{Actual quantity}) \times \text{Earned Price per unit} = (275 - 350) \times \$45; -75 \times \$45 = (\$3,375)$  Unfavorable.
3. D  $\text{BCWS} = (1,500 \times \$30) = \$45,000; \text{BCWP} = (500 \times \$30) = \$15,000.$
4. B False; “High Dollar” material items should be planned using *Discrete* EV techniques.
5. A True.

## Chapter 4.0—Analysis and Management Reports

### Introduction

The following information should be generated, on at least a monthly basis, at the CA and other levels as necessary for management control using actual cost data from, or reconcilable with, the accounting system:

1. Comparison of the amount of EV/BCWP and the amount of PV/BCWS for work accomplished. This comparison provides the *Schedule Variance (SV)*. SV must be computed at least monthly.
2. Comparison of the amount of the EV/BCWP and the amount of the AC/ACWP for the same work. This comparison provides the *Cost Variance (CV)*. CV must be computed at least monthly.
3. Division of the EV/BCWP by the PV/BCWS. This division provides the *Schedule Performance Index (SPI)*. This division may be done using just the period (monthly) data (current period SPI) or cumulative data from project inception (cumulative SPI). The SPI may be computed at the project level, any level within the OBS/WBS, or at the CA level.
4. Division of the EV/BCWP by the AC/ACWP. This division provides the *Cost Performance Index (CPI)*. This division may be done using just the period (monthly) data (current period CPI) or cumulative data from project inception (cumulative CPI). The CPI may be computed at the project level, any level within the OBS/WBS, or at the CA level.
5. Comparison of the BAC and EAC. This comparison provides the *Variance at Completion (VAC)*.
6. Division of the budgeted work remaining (BAC-BCWP) by the *Estimate to Complete (EAC-ACWP)* provides the *To Complete Performance Index (TCPI)*. That is the cost efficiency required for the work remaining to achieve the EAC. When compared to the CPI, it is used as a test of reasonableness of the EAC. A special case of this formula is to substitute the BAC for the EAC in the denominator of the formula. The result is the cost efficiency required in the future to achieve the BAC.

CAMs must address the significant differences between planned and actual schedule performance (schedule variance) and planned and actual cost performance (cost variance), and provide the reasons for the variances in the detail needed by program management. The determination of what is significant is typically defined using “variance thresholds” usually defined between the contractor and stakeholders. These may take the form of percent deviations, budget values, a combination of these, or any other measure of significance. Variance threshold parameters often vary with the levels of the OBS or WBS to account for the small budgets at lower levels and the nature of the work.

CAMs must be able to segregate labor efficiency variances from labor rate and indirect rate variances. The formulas for the calculation are similar to the material formulas and are as follows:

$$\text{Rate Variance} = (\text{Earned Rate} - \text{Actual Rate}) \times (\text{Actual Hours})$$

$$\text{Efficiency Variance} = (\text{Earned Hours} - \text{Actual Hours}) \times (\text{Earned Rate})$$

The above data elements and associated variances must be summarized through the OBS and WBS to support management needs and any customer reporting specified in the contract.

Managerial and corrective actions are implemented as the result of earned value information.

Revised EACs based on performance to date are developed based on past performance, commitment values for material, and estimates of future conditions. Compare this information with the performance measurement baseline to identify the VACs important to company management and any applicable customer reporting requirements, including statements of funding requirements.

As discussed in Section 2.12 of this study guide, an *Integrated Baseline Review (IBR)* may be required and is usually conducted within six months after contract award, depending on customer and contractual requirements. It verifies the technical content and the practicality of the related budget and schedule. The IBR also ensures shared understanding of the risks embodied in the subcontractor's management control systems and plans, and it develops a plan to reduce such risks. This is accomplished by reviewing data produced through the described EVMS to evaluate cost and schedule data timeliness and validity in order to verify the completeness and achievability of the subcontractor's baseline. At a minimum, each month the CAM evaluates the subcontractor report submittals relating to subcontractor progress status. The CAM is also responsible for the integrity of the subcontractor's EV information, which includes the PMB, actual costs, and forecasts. Inconsistencies are addressed with the subcontractor and could result in disapproving the subcontractor's submitted reports.

### **Terms to Know**

- *Actual Cost of Work Performed (ACWP);*
- *Actual Cost (AC);*
- *Budgeted Cost for Work Scheduled (BCWS);*
- *Budgeted Cost for Work Performed (BCWP);*
- *Budget at Completion (BAC); Cost Performance Index (CPI);*
- *Cost Variance (CV);*
- *Earned Value (EV);*
- *Integrated Baseline Review (IBR)*
- *Planned Value (PV)*
- *Schedule Performance Index (SPI);*
- *Schedule Variance (SV);*
- *Variance at Completion (VAC); and,*
- *To Complete Performance Index (TCPI).*

The applicable EVP body of knowledge for analysis and management reports is shown in figure 4.0.

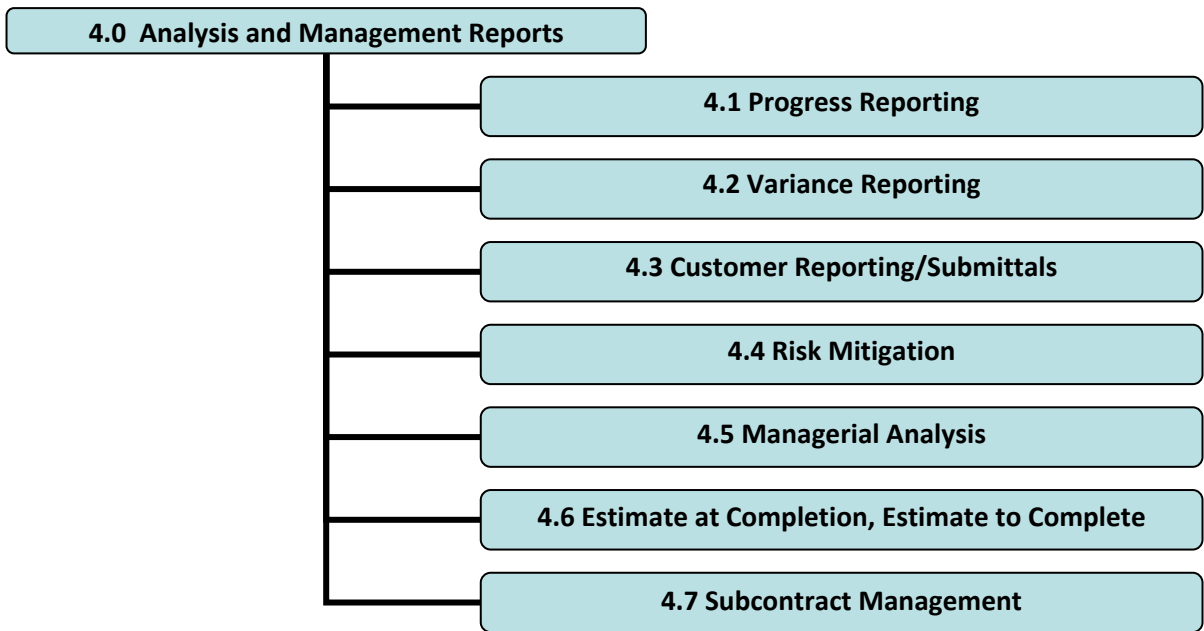


Figure 4.0—EVP Body of Knowledge for Analysis and Management Reporting

Please see **Section 4.1 Progress Reporting (BCWS, BCWP, ACWP)** on page 135

## Section 4.1 Progress Reporting (BCWS, BCWP, ACWP)

### Introduction

Understand key elements of an earned value management system. Key learning objectives are:

Understand the five key elements used in EVMS

Use different methods to measure work progress (See *Section 2.12 of this study guide*).

Understand the source of data to establish or determine BCWS, BCWP, ACWP, BAC, and EAC

### Terms to Know

- ACWP/AC;
- BCWS/PV;
- BCWPEV/;
- BAC;
- EAC; and,
- WBS.

### Key Points for Review

1. **BCWS/PV**
  - A. Sum of the budgets for work scheduled to be accomplished plus the budget for the level-of-effort in the relevant time period
  - B. The BCWS/PV establishes the basis for determining the BCWP/EV when the work is completed
  - C. The baseline for performance measurement is the cumulative value of BCWS/PV over time
  
2. **BCWP/EV**
  - A. Sum of the budgets for completed portion of in-progress work, plus the budget for the level-of-effort in the relevant time period
  - B. The BCWP/PV is based upon the BCWS/PV
  - C. The earned value is determined using the progress measurement method defined during the CA planning or the conversion of a planning package to a work package.
  - D. When work is complete the BCWP/EV will equal the BCWS/PV
  
3. **ACWP/AC**
  - A. The total costs incurred in accomplishing work during a given time period
  - B. The actual value is based on the costs captured or work hours recorded
  - C. When the actual cost cannot be known due to accounting delays an estimated cost may be used for EVM analysis Any estimated values are replaced with the actual cost when these are known

4. **BAC**
  - A. The cumulative value of BCWS/PV at the end of the project
  - B. Also the cumulative value of the PMB
  - C. The planned budget to complete the scope of work
  
5. **EAC**
  - A. The estimate of the final cost at project completion which may be computed, generated by the workforce, or other means
  - B. The sum of the ACWP/AC plus the ETC
  
6. **Work Progress Measurement**
  - A. Objective measurements to determine work performed
  - B. Measured by *Earned Value* methods and techniques as described in Chapter 2 Section 2.11.
  
7. **Earned Value Data Sources**
  - A. PMB
  - B. Project execution plan and schedule update
  - C. Project cost report (monthly, weekly as appropriate)
  - D. Weekly or monthly work-hour report
  - E. Accounting reports

**Sample Problems for Section 4.1:**

1. Which one of the following progress measurements yields the most reliable estimate of work performed?
  - A. Incremental milestone
  - B. Units completed
  - C. Cost ratio
  - D. Fixed formula
  
2. Which one of the following provides the baseline for earned value measurement?
  - A. WBS
  - B. ACWP/AC
  - C. BCWS/PV
  - D. BCWP/EV
  
3. When ACWP/AC and BCWP/EV are compared, it is done using the same accounting periods. It is possible that work may be recorded as BCWP/EV, while the actual costs for the work have not made through the financial system and do not appear in the recorded costs provided from the accounting system. These costs must be estimated (estimated ACWP/AC) or accrued to generate an accurate picture of the cost variance.
  - A. True
  - B. False
  
4. The following data were obtained from the contractor’s report regarding the production of 3,100 meters of superconducting cable. The budget unit labor rate is 2.0 hrs/meter.

Week	Unit	Plan Qty	Actual Qty	Actual Hrs	BCWS/PV (Hrs)	BCWP/EV (Hrs)	ACWP/	Cum BCWS	Cum BCWP	Cum ACWP
							AC (Hrs)			
1	M	100	80	220						
2	M	150	140	320						
3	M	200	220	450						
4	M	300	280	500						
5	M	450	400	750						
6	M	550								
7	M	600								
8	M	400								
9	M	250								
10	M	100								

**Table 4.0—Data Collected From Contractor’s Report**

- a. From above incomplete report, calculate BCWS, BCWP and ACWP for week 1.
- b. Also calculate the cumulative BCWS, BCWP and ACWP at the end of week 3.

## Solutions to Problems for Section 4.1:

1. B Unit completed. The unit completed such as linear meters of pipe installed is based on the physical quantity accomplished of a repeated task that reflects the most objective and reliable measurement. (P 14.1, S&K5)
2. C BCWSPV. By definition, BCWS/PV represents the baseline for comparison with BCWP/EV.
3. A True.
4. The budget unit labor rate of 2 WH/M is used to determine the BCWS/PV and BCWP/EV. ACWP/AC is based on the actual WH expended to install the pipe as shown in table 4.0.

### Solution 4A

Week	Unit	Plan Qty	Actual Qty	Actual Hrs	BCWS/PV Hrs	BCWP/EV Hrs	ACWP/AC Hrs
1	M	100	80	220	2x100=200	2x80=160	220

### Solution 4B

The cumulative BCWS/PV, BCWP/EV and ACWP/AC are derived from the weekly data

Wk	Plan Qty	Actual Qty	BCWS/PV (Hrs)	BCWP/EV (Hrs)	ACWP/AC (Hrs)	Cum BCWS/PV	Cum BCWP/EV	Cum ACWP/AC
1	100	80	2x100=200	2x80=160	220	200	160	220
2	150	140	2x150=300	2x140=280	320	200+300=500	160+280=440	220+320=540
3	200	220	2x200=400	2x220=440	450	500+400=900	440+440=880	540+450=990

## Section 4.2 Variance Reporting

### Introduction

This section provides information on understanding performance variance analysis and the resulting corrective action required to execute the project closer to the plan. Key learning objectives are:

- Explain how to use *Variance Analysis* to provide early warning.
- Determine likely causes of a performance variance, given a scenario.
- Recommend a corrective action to reverse an unfavorable performance trend.

There are potentially four variances and variance analysis required: (1) current and (2) cumulative cost variances, and (3) current and (4) cumulative schedule variances.

The first step before variance analysis is analyzed, is to determine a threshold at which formal documentation is required. This is called the variance analysis threshold. Thresholds are identified for the current, cumulative and at complete variances. There are several methods of identifying thresholds:

1. And/or \$ and Percent. Examples: 10% and \$100K means a variance is reportable when both over 10% of BAC and >\$100K. 10% or \$100K means the variance is reportable when 10% or over \$100K.
2. Top 10 or top 15 approach. The Department of Defense (DOD) Integrated Program Management Report (IPMR) DoD defaults to the top three variances of current, cumulative and at-complete cost and schedule which equates to one method of determining the top 15 approach mechanically.
3. Thresholds may be adjusted in time as the base grows. For example 10% of a billion dollar program may be too liberal when the project is 80% complete. It may need to be reduced to 2% and \$100K for example.
4. Thresholds are typically agreed to with the owner/customer.

In performing variance analysis, the CAM analyzes the variances that exceed the established thresholds and prepares a *Variance Analysis Report* (VAR). Thresholds are typically established by the customer at program onset for reportable level requirements. These thresholds are to be the minimum thresholds required for variance analysis. However, tighter thresholds may be established by the program manager at the CA level with advice from project controls to ensure they are established at a level appropriate for any specific program management issues (e.g., risk, resources, visibility). Variance thresholds can be set for both percentage and budget (dollar, euro, etc.) value variances. Thresholds are rarely based on indices.

Variance analysis is performed at the level of detail (the CA level) and by cost element necessary for a comprehensive explanation of the variance. The CA is also the level where appropriate material price and usage variances and labor rate and efficiency variances are analyzed. The analysis includes a statement of the variance, the root cause of the variance, the impact on cost, schedule, other control accounts, the entire project (completion dates and EACs), and any corrective actions. The corrective actions include the what, who, when, and expected results. The IPT Lead or PM

reviews and approves the CAM's variance analysis, which may also include a proposed EAC revision, before it is submitted to project controls for use in preparing customer required reports. This review process ensures that the CAM has included all the required information and has identified the appropriate corrective action.

*Variance Analysis Reports (VARs)*, schedule status, and corrective action plans are addressed in detail in periodic project review meetings, normally conducted monthly. These meetings are forums for investigating and resolving problems not resolved during day-to-day contact. Status is verified, decisions are documented, and action items are assigned and recorded in the meeting minutes. Follow-up is exercised against open action items at subsequent project review meetings. Variances that require follow-up and/or corrective action must be documented and communicated through appropriate program reporting channels, up to and including Summary CPR or IPMR Format 5 submittals, program management reviews, and program status reports.

### **Terms to Know**

- *Variance threshold levels;*
- *Variance Analysis Report (VAR); and,*
- *Contract Performance Report (CPR), Format 5 (US Government).*
- *Integrated Program Management Report, Format 5 (US Government).*

### **Key Points for Review**

1. Periodic versus cumulative performance variances.
  - A. Periodic performance provides early warning and the movement of the variance since the previous month, but is subject to a wider range of variation. It provides a reasonable time for the CAM to take corrective action.
  - B. Cumulative performance offers a more reliable performance trend indication. It and the indices calculated based on cumulative form a basis to test the estimates to complete *Control Accounts* and the project.
2. Set appropriate variance threshold levels.
  - A. The variance threshold tolerance level for the project control team is lower than the level that triggers a special report to the project manager.
  - B. Threshold levels vary by the experience and comfort of project control team and project manager. These threshold levels should be defined at the onset of the project, but may be changed as conditions warrant.
3. Schedule performance analysis tree (when  $TF > 0$ ).
  - A.  $SPI > 1.0$  ahead of schedule on critical path; more work being done than planned.
  - B.  $SPI = 1.0$  ahead of schedule on critical path; total work volume is as planned.
  - C.  $SPI < 1.0$  ahead of schedule on critical path; shortfall on non-critical activities.
  - D. SPI may also be computed at lower levels of the WBS/OBS to provide insight to detailed schedule performance

4. Schedule performance analysis tree (when  $TF = 0$ ).
- A.  $SPI > 1.0$  critical path on schedule; more work being done on non-critical activities.
  - B.  $SPI = 1.0$  critical path on schedule; total work volume is as planned.
  - C.  $SPI < 1.0$  critical path on schedule; shortfall on non-critical activities.
  - D.  $SPI$  may also be computed at lower levels of the WBS/OBS to provide insight to detailed schedule performance
5. Schedule performance analysis tree (when  $TF < 0$ ).
- A.  $SPI > 1.0$  critical path activities behind schedule; total work more than planned indicating excessive attention to non-critical activities.
  - B.  $SPI = 1.0$  critical path activities behind schedule; total work volume as planned indicating too much attention to non-critical activities.
  - C.  $SPI < 1.0$  critical path activities behind schedule; total work less than planned indicating more overall effort is required.
  - D.  $SPI$  may also be computed at lower levels of the WBS/OBS to provide insight to detailed schedule performance
6. Cost performance analysis.
- A.  $CPI > 1.0$  indicates that the project cost is under-running at that point in time. The reasons for an under-run may be positive *Rate* and *Efficiency variances* for *Labor* costs; and, positive *Price* and *Usage variances* for *Materials*, *Other Direct Costs (ODCs)*, *Subcontracts* and *Purchased Services*.
  - B.  $CPI = 1.0$  indicates that the project costs are as planned at that point in time. However, there may be  $CPI$ s at lower levels of the WBS that would be a point of concern for the PM.
  - C.  $CPI < 1.0$  indicates that the project is over-running at that point in time. The reasons for an over-run may be negative *Rate* and *Efficiency variances* for *Labor* costs; and, negative *Price* and *Usage variances* for *Materials*, *Other Direct Costs (ODCs)*, *Subcontracts* and *Purchased Services*.
  - D.  $CPI$  may also be computed at lower levels of the WBS/OBS to provide insight to detailed cost performance
7. Variance at Completion analysis.
- A.  $BAC - EAC =$  positive number indicates that the project is expected to under-run at completion.
  - B.  $BAC - EAC = 0$  indicates that the project is expected to be completed at the budget amount.
  - C.  $BAC - EAC =$  negative number indicates that the project is expected to over-run at completion.

8. *Variance Analysis Report.*
- A. Calculate the performance metrics (variances and indices).
  - B. Explain the significance and impact to the final project outcome for those variances exceeding established variance thresholds.
  - C. Describe reasons for performance variances and their root causes of deviation for those variances exceeding established variance thresholds.
  - D. Recommend corrective action if required.
  - E. Assign the CAM to be responsible for execution of the corrective action plan.
  - F. Re-assess the progress at the next project update.

**Sample Problems for Section 4.2:**

1. The latest report indicates  $TF = 0$  for the project. Furthermore, the cumulative SPI is greater than 1.0. What is your assessment of the project status?
  - A. Critical path activities behind schedule; total work more than planned indicating excessive attention to non-critical activities
  - B. Critical path on schedule; more work being done than planned
  - C. Ahead of schedule on critical path; more work being done than planned
  - D. Critical path on schedule; shortfall on non-critical activities
  
2. The project controls manager informs you that your project has a positive TF, and the cumulative SPI is 0.92. As a project manager, what action would you take?
  - A. Since the overall project is ahead of schedule, no corrective action is needed
  - B. Keep the current pace on the critical path activities and focus energy on completing non-critical path activities
  - C. Authorize project wide overtime to focus on all project activities
  - D. Divert resource from the critical path activities to focus on the completion of all non-critical path activities
  
3. A project control team should report *any* performance variance to the project manager immediately.
  - A. True
  - B. False
  
4. The *Variance Analysis* is typically conducted at which level?
  - A. The highest level to determine the overall project status
  - B. The level where the project team is competent to perform
  - C. Any level of your preference
  - D. The *Control Account* level
  
5. A VAR may include all of the following items except:
  - A. Overall project critical path activities status
  - B. SPI, CPI, and TCPI
  - C. Resource plan
  - D. Recommended corrective action

**Solutions to Problems for Section 4.2:**

1. B Greater than 1.0 is under-run or ahead of schedule, and less than 1.0 is over-run or behind schedule. The TF is 0 so the critical path is on schedule. The SPI is  $> 0$  so overall more work is done than planned at this point.
2. B The critical path is ahead of schedule since the TF is  $> 0$ . But the SPI is  $< 0$  so some work has not be completed as planned. This off critical path work needs to be addressed or the critical path may change.
3. B If the variance level does not exceed the predetermined project control team threshold level, then the team could execute corrective action to reverse the unfavorable performance, before calling it to the PM's attention. Variances are expected but should not exceed thresholds.
4. D Variance analysis is performed at the level where performance measurement is first performed, the *Control Account* level, and is then summarized into the higher levels of the WBS and OBS.
5. C The resource plan is a definition of the resources required, but is not a time-phased plan or *Control Account*.

## Section 4.3 Customer Reporting/Submittals

### Introduction

Customer reporting requirements will vary by contract. Each public entity will refer to its regulations or guidance documents, while commercial owners will align the reporting requirements per corporate or project guidelines. Submittals of EVM reports and their requirements should be clearly identified in the contract. (If not initially provided, the earned value professional should recommend contracting managers that it be included but anticipate added costs if not included in the original contract.) Graphs, reports, schedules, software, and means of delivery are all aspects which must be considered. The submittal process should also designate approvers, reviewers, allowable report approval durations, and document control requirements. Without contractual stipulations for these matters, excessively costly schemes might be requested later.

For the US Department of Defense (DoD), the *Contract Data Requirements List* (CDRL) and Data Item Descriptions (DIDs) will detail what documents and reports are required, how many are needed, how often they will be published, and in what format. DID DI-MGMT-81466A-MAR 30, 2005, defines the requirements for the Contract Performance Report (CPR) as is shown in Appendix C. DID DI-MGMT-81466B defines the requirements for the Integrated Program Management Report (IPMR). The IPMR is replacing the CPR in newly issued contracts. As a part of project closeout documentation, the storage and turnover of EVMS data and reports should be clearly agreed upon before the first report is prepared.

### Terms to Know

- *Contract conditions;*
- *Contract Data Requirements List (CDRL);*
- *Contractor Performance Report (CPR);*
- *Federal Acquisition Regulation (FAR);*
- *Integrated Program Management Report (IPMR); and,*
- *Reporting Criteria.*

### Key Points for Review

1. How are the reporting criteria approved?
2. What are the approved means of submittals?

Please see **Sample Problems for Section 4.3** on page 147

**Sample Problems for Section 4.3:**

1. Which of the following comments would accurately reflect the customer reporting requirements?
  - A. Reporting performance, schedule and methodologies are directed by the customer.
  - B. Reporting EVM performance data should reflect the customer's needs and the contractor current systems.
  - C. Reporting systems should be dictated by the contractor and contract.
  - D. None of the above.
  
2. If an EVMS meeting ANSI 748 is a contract requirement then EVM performance data reporting is required.
  - A. True
  - B. False

**Solutions to Problems for Section 4.3:**

1. B There is dictated standards, but the use of company standards as agreed between customer and contractor are a solid basis for implementation.
2. B The customer must specify when and how they want the EVM data reports. US DoD DID DI-MGMT-81466A and DID DI-MGMT-81466B define reporting formats are commonly used by US Government agencies.

## Section 4.4 Risk Mitigation

### **Introduction**

EVM can be used as the logical framework and response to the identification of program risks. The mitigation plan is based on risk assessments and makes predictions of the actual spend and completion and ways to maintain the performance baseline.

Risk management shares a common framework with EVM. Both include the WBS, identification of budget, schedule, and project definitions. When combined with organizational structure and responsibility management, one has the basis to identify overall risks within the program.

Through the EVMS, managers monitor progress to date, and, based on this, can determine if a risk has materialized. The manager can then execute mitigation efforts to reduce the impact.

Risk mitigation commences post-contract award on two key tracks:

1. Monitoring progress
2. Forecasting project over-runs

Timely and thorough VARs can support good risk mitigation.

Mitigation of risk is performed through ongoing qualitative and quantitative analysis on the program. Quantitative is the direct outputs of cost and time-scale analysis. Mitigation should result in a well-structured register of actions to take for each listed risk. Mitigation should first attempt to recover within the existing project cost and schedule limits. Only if that is otherwise impracticable, should additional funds or schedule time be requested.

### **Terms to Know**

- *EAC*;
- *Forecasting*;
- *Risk impact*;
- *Risk opportunity*;
- *Risk mitigation*; and,
- *WBS*.

### **Key Points for Review**

1. Identification of potential risk impacts based on EVM data.
2. Development of risk mitigation plans.
3. Analysis of risk impact on program costs.
4. Monitoring progress and forecasting impacts.

Please see **Sample Problems for Section 4.4** on page 151

**Sample Problems for Section 4.4:**

1. At which of the following points would you implement a risk mitigation?
  - A. Pre-contract award
  - B. Post contract award
  - C. Contract closeout
  - D. None of the above
  
2. What is considered an event that might require risk mitigation?
  - A. Procurement delayed because of material shortage
  - B. Customer requested additional scope of work
  - C. Procurement delayed due to hurricane
  - D. Work delayed due to customer financing
  
3. When a risk impact is identified, the PM should immediately move budget from the MR to prevent an over-run.
  - A. True
  - B. False
  
4. Risk mitigation requires development of alternative scenarios or remedial \_\_\_\_\_, which apply resources in new, different ways to enhance the probability of achieving project objectives.
  - A. Impacts
  - B. Strategies
  - C. Assessments
  - D. Issues
  
5. Which method is the best to analyze cost and schedule variances with risk mitigation using the EVMS?
  - A. Qualitative
  - B. Cause and effect
  - C. Quantitative
  - D. PMB Review

**Solutions to Problems for Section 4.4:**

1. B *Risk Mitigation* is based on a review of work in progress. Planned mitigations are steps that can be used when risks are identified and actually occur.
2. A To have an event that can be mitigated means that there has to be control. One cannot mitigate events or actions that are not in one's control.
3. B Simply identifying the potential risk impact is not a reason provide budget from MR to implement a mitigation plan. The movement of budget from MR to proceed with the mitigation plan is determined by the PM based on a cost/benefit analysis. The PM may decide to accept the risk without mitigation.
4. B Strategies are plans to assist in mitigating events.
5. C Quantitative is an ability to measure, assess, initiate, and implement.

## Section 4.5 Managerial Analysis

### Introduction

Data generated from an EVMS provides the current, cumulative, and at-completion performance status at the control account, total project, and intermediate levels if needed. Variances to plan are captured by various metrics and indices including the *Schedule Variance (SV)*, *Cost Variance (CV)*, *Schedule Performance Index (SPI)*, *Cost Performance Index (CPI)*, and *To Complete Performance Index (TCPI)*. While common practice is to collect actual costs at the work package level, this is not required by ANSI 748 and can generate additional EVMS implementation costs. Work packages are a tool to refine the planning (BCWS) and progress measurement (BCWP). ANSI 748 intends that SV, CV, and variance analysis be conducted at the CA level, not below, even if the data is available at the WP level.

The *schedule variance (SV)* is the difference between the value of work performed and the work scheduled and indicates an ahead of schedule, behind schedule, or on schedule status. The formula to calculate schedule variance is  $SV = BCWP/EV - BCWS/PV$ . The *cost variance (CV)* is the difference between the value of work performed and the actual cost, and indicates a cost under-run, over-run, or on-target status. The formula to calculate cost variance is  $CV = BCWP/EV - ACWP/AC$ .

Variances that exceed the variance thresholds must be explained and corrective action plans generated. Extreme positive or negative variances may indicate poor planning, improper assignment of EVM methods, inaccurate tracking, or poor management. Also, the variances that equal zero can be a warning sign that the EVM data is not correct and may be manipulated. It's rare that any project follows its plan exactly. Zero variances are a cause for concern. Causes of zero schedule variances might be that the BCWP is not being calculated correctly and is simply being set equal to the BCWS/PV, or the majority of the Control Accounts are using the LOE EV method. Normally, LOE Control Accounts are limited to 10-15 percent of the total BAC amount. Cause of zero cost variance might be as a result of the BCWP/EV being set equal to the ACWP/AC.

In the case of Firm Fixed Price Contracts (FFP) contracts, the contractor may choose to not reveal internal ACWP/AC. In this case the EVMS reports to the customer may show ACWP/AC equal to BCWP/PV which will result in a zero cost variance as reported to the customer. Internally the contractor should use ACWP/AC to monitor their internal costs.

The *Schedule Performance Index (SPI)* is a measure of the *schedule efficiency* to date, or how well calendar time is being used. The SPI measures the value of work performed against that of the work scheduled. The formula for the *Schedule Performance Index* is  $SPI = BCWP(EV)/BCWS(PV)$ . Less than 1.0 is unfavorable and indicates a behind schedule status. An SPI greater than 1.0 is favorable and indicates an ahead of schedule status. An SPI of 1.0 indicates an on schedule status. However, the SPI does not provide any information regarding the *Critical Path* of the project. In addition, some BCWP/EV might be reported from performing work out of sequence and ignoring the project network. Therefore knowledge of which work is reporting BCWP/EV is important.

The *Cost Performance Index* (CPI) is a measure of the *cost efficiency* to date. The CPI measures the value of work performed against the actual cost. The formula for the *Cost Performance Index* is  $CPI = BCWP(EV)/ACWP(AC)$ . A CPI less than 1.0 is unfavorable and indicates a cost over-run. A CPI greater than 1.0 is favorable and indicates a cost under-run. A CPI of 1.0 indicates an on cost status.

The comparison of the BAC and the EAC represents the *Variance at Completion* (VAC). A positive number indicates an under-run at project completion. A negative number indicates an over-run at project completion.

The *To Complete Performance Index* (TCPI) is a measure of what cost efficiency must be maintained for the remainder of the project in order to complete the project for the EAC amount.

$$TCPI_{EAC} = (BAC - EV_{CUM}) / (EAC - AC_{CUM}).$$

A  $TCPI > 1.0$  is a forecast of favorable cost performance to complete the remaining work. A comparison of CPI to TCPI is equivalent to saying, "We have performed at this efficiency (CPI) up to now, and we expect to perform at that efficiency (TCPI) from now to project end to make the EAC." TCPI may also be calculated using BAC to determine the required CPI to complete the work to the BAC value.

**Industry Reference:**

*ANSI/EIA 748 C Guideline 23:* "Identify, at least monthly, the significant differences between planned and actual schedule performance and planned and actual cost performance, and provide the reasons for the variances in the detail needed by program management".

**Terms to Know**

- *Cost Performance Index* (CPI);
- *Cost Variance* (CV);
- *To Complete Performance Index* (TCPI);
- *Estimate at Completion* (EAC);
- *Estimate to Complete* (ETC);
- *Schedule Performance Index* (SPI);
- *Schedule Variance* (SV); and,
- *Variance Analysis*.

**Key Points for Review**

1. Understand the core metrics and indices.
2. Know the formulas for calculating the core metrics and indices.
3. Understand the linkage between variances and project status reporting.
4. Understand how core metrics and indices are used to test CAM and project level forecasts of cost at completion and completion dates.

**Sample Problems for Section 4.5:**

1. Which of the following basic analysis comments would you make with a CPI of 1.07 and SPI of 1.0 on the closing of the project?
  - A. Schedule was completed on time, and cost over-ran budget
  - B. Schedule was completed on time, and cost under-ran budget
  - C. Do not know whether schedule was completed early, on time, or late, but the cost under-ran the budget
  - D. Do not know whether schedule was completed early, on time, or late, but the cost overran the budget
  
2. When reporting the variances you should not go into the details of cause and effect.
  - A. True
  - B. False
  
3. If the value of deliverable on a contract is \$50,000.00 and the earned value of the performance is 20 percent and the actual cost accrued 15 percent what is the correct status?
  - A. \$10,000 earned, \$15,000 actual, cost variance \$5,000.
  - B. \$10,000 earned, \$7,500 actual, cost variance \$2,500.
  - C. \$10,000 earned, \$5,000 actual, cost variance -\$5,000.
  - D. \$10,000 earned, \$7,500 actual, cost variance -\$2,500.
  
4. Which of the following is most commonly selected as the point in time for calculation of performance measurement for procurement, so as to not skew the performance measurement metric?
  - A. Invoice
  - B. Delivery
  - C. FOB or milestone payment
  - D. None of the above

**Solutions to Problems for Section 4.5:**

1. C At the completion of the project, the value of SPI is always equal to 1.0 because at that time the BCWP/EV will equal the BCWS/PV making the SPI 1.0. Thus the final SPI is not an indication of whether the project finished early, on, or behind schedule. However, the final CPI does indicate whether the final cost was over, on, or under budget. A CPI greater than 1.0 at completion indicates the budget was under-run.
2. B The details are the basis of really understanding the program, so that decision-making can be effective.
3. B Earned = \$10,000; actual = \$7,500; cost variance = \$2,500; so the project is under-running the plan.
4. B Delivery of the equipment or materials is the most commonly selected point in time.

## Section 4.6 Estimate at Completion (EAC), Estimate to Complete (ETC)

### Introduction

This section provides information to understand methods for determining EAC and ETC for the project. Key learning objectives are:

- Know the data and formulas to calculate the EAC and the ETC.
- Select an appropriate method to calculate EAC and ETC.
- Understand the reason to use more than one method to derive a realistic EAC.

Comparisons of planned versus actual performance, combined with variance analysis and knowledgeable projections about the future, may indicate a need to revise current estimates for the cost at completion. An EAC is defined as the sum of the ACWP to date (cumulative) plus the ETC for the remaining authorized work (i.e.,  $EAC = ACWP_{CUM} + ETC$ ).

EACs that consider risk and use predictive performance measures increase the probability that the project can be executed within the reported EAC. The value of these financial reporting requirements is enhanced when EACs are analyzed at least monthly and updated as required. Monthly EAC reviews are essential for accurate management decisions, including the proper planning of a project's future funding requirements.

EACs are typically developed at the CA level and are summarized within the PMB and for "roll-up" in the WBS. An EAC review is required, at a minimum, when one of the following conditions exists:

- During the annual, project-wide, comprehensive EAC review (at least once annually, a bottom-up ETC is developed).
- When a periodic review is required.
- When the cumulative CPI differs significantly from the *To Complete Performance Index* (TCPI) indicating that a significant change in efficiency is required to achieve the EAC.
- If a CAM or PM anticipates that a significant cost, schedule, or technical variance may be developing or an inception-to-date cost variance threshold has been exceeded.

### Terms to Know

- *Budget-at-Completion* (BAC);
- *Estimate to Complete* (ETC);
- *Estimate at Completion* (EAC);
- *Independent Estimate to Complete* (IETC);
- *To Complete Performance Index* (TCPI); and,
- *Variance at Completion* (VAC).

**Key Points for Review**

1. *Estimate to Complete (ETC).*
  - a. Several methods to develop an ETC (note that the first two methods are based upon EVM data (statistical) Independent Estimate to Complete (IETC):
    1. Method 1:  $IETC = BAC - BCWP(EV) = \text{budget at completion} - BCWP(EV)$ . This method ignores the past cost performance and assumes remaining work will be done per the budget (BCWS), and is not a favored formula.
    2. Method 2:  $IETC = (BAC - BCWP(EV)) / CPI = (BAC - BCWP(EV)) / \text{cumulative CPI}$ .
    3. Method 3: Bottoms-Up ETC detail analysis.
  - b. The ETC must be time-phased over the remaining activities to be accomplished.
2. *Estimate at Completion (EAC).* Statistical EACs are noted with an "I" in front of EAC.
  - a. Method 1:  $IEAC = ACWP(AC) + (BAC - BCWP(EV)) = \text{actual cost of work performed to date} + \text{budget remaining to be performed}$ . This method ignores the past costperformance and assumes remaining work will be done per the budget (BCWS) and is not a favored formula..
  - b. Method 2:  $IEAC = ACWP(AC) + (BAC - BCWP(EV)) / CPI$ .
  - c. Method 3:  $IEAC = BAC / CPI$  Method 3 is the same as Method 2 as long as reprogramming or replanning actions have not reset the CV to zero in any part of the project. Such an action invalidates Method 3.
  - d. Method 4:  $EAC = ACWP + ETC$  Determined by the bottom-up analysis.
3. The *To Complete Performance Index (TCPI)* can be used to check whether the BAC and the EAC are reasonably obtainable. The calculations are as follows:
  - a.  $TCPI_{EAC} = (BAC - BCWP(EV)_{CUM}) / (EAC - ACWP(AC)_{CUM})$
  - b.  $TCPI_{BAC} = (BAC - BCWP(EV)_{CUM}) / (BAC - ACWP(AC)_{CUM})$
  - c. For instance if the cumulative CPI = 0.92, and the TCPI for the EAC = 1.02, you know you are going to have to increase productivity by 10 points. The VAR's corrective action should state how the efficiency increase will happen.
4. Productivity considerations. During the last 20 percent of design, construction or project duration, the work becomes more difficult to accomplish because of the following conditions:
  - a. Work is done on a smaller scale and is less efficient.
  - b. More attention is required for details to complete the remaining tasks.
  - c. More frequent last-minute minor adjustments and changes to the remaining tasks
  - d. Personnel are mentally or physically fatigued.
  - e. Key people move on to other tasks and remaining tasks are done by new personnel. This means a new learning curve which would negatively impact the productivity.
  - f. Regardless which method is used to calculate ETC and EAC, it is prudent to make additional adjustments by including a productivity adjustment factor to provide a more realistic schedule estimate, which will impact the budget estimate.
  - g. ETC and EAC are dynamic calculations. They should be constantly updated and adjusted to yield the most realistic approximation.
  - h. Monitoring the EAC and indices (CPS, SPI) trend over several months.

## **Sample Problems for Section 4.6:**

1. Which method provides the most realistic approximation of the EAC?
  - A.  $EAC = ACWP(AC) + (BAC - BCWP(EV))$
  - B.  $EAC = ACWP(AC) + (BAC - BCWP(EV)) / CPI$
  - C.  $EAC = BAC / CPI$
  - D.  $EAC = ACWP(AC) + ETC$  determined by the bottoms-up analysis
  
2. The project budget at completion is \$10,000,000. The total earned value is \$9,000,000 with a cumulative CPI of 0.95. The project has expended a total of \$9,473,700. You are the Project Manager. Assuming you don't want to take the time or spend the resources to do a bottoms-up EAC, which one of following ETCs would you report to senior managers?
  - A.  $ETC = BAC - BCWP(EV) = 10,000,000 - 9,000,000 = 1,000,000.$
  - B.  $ETC = (BAC - BCWP(EV)) / CPI = (10,000,000 - 9,000,000) / .95 = 1,052,600.$
  - C.  $ETC = 10,000,000 - ACWP(AC) = 10,000,000 - 9,473,700 = 526,300.$
  - D.  $ETC > 1,052,600.$
  
3. From a practical project management standpoint, at a minimum, how many IEAC methods should be used to test a bottom-up ETC, and the resulting EAC?
  - A. 1
  - B. 2
  - C. 3
  - D. 4
  
4. You have a fixed price contract of \$1,000,000. The contractor has completed 20 percent of the total work and spent 25 percent of total work hours. The contractor submits an invoice for a total payment of \$250,000. Would you approve the invoice?
  - A. Yes
  - B. No
  - C. Subject to negotiation
  - D. Pending on further review
  
5. You have a cost reimbursable design contract with a consultant. The estimated budget at completion is \$30,000. The consultant has spent \$19,500. The design is 60 percent complete. Which one of following is your estimate of the EAC?
  - A. \$32,500
  - B. \$31,500
  - C. \$30,000
  - D.  $> \$32,500$

**Solutions to Problems for Section 4.6:**

1. D Bottoms-up is the most detailed analysis to derive the ETC. Combined with ACWP(AC), it should provide the most realistic EAC.
2. D Since the project is within the final 20 percent of its duration, productivity will be lower than for the project to-date. Assuming a resulting loss of 10 points in cost efficiency for the remaining work should allow a more accurate ETC to be calculated:  
$$\text{ETC} = (\text{BAC} - \text{BCWP}) / (0.95 - 0.1) = (10,000,000 - 9,000,000) / (0.85) = \$1,176,500.$$
This is the ETC value that should be presented to the senior management.
3. B Since the IEAC is an approximation technique (an estimate) it is necessary to use at least two different methods in order to appropriately test a bottom-up EAC. It would be better to use three or four IEACs to get a better spread for testing the EAC.
4. B A typical FFP or lump-sum contract requires the owner to pay the contractor based on the pre-agreed method of progress. In general, the owner pays for the value received. In this case, a payment equivalent to the 20 percent earned value (\$200,000) would be reasonable.
5. D The remaining productivity for the design work would tend to be lower than the design-to-date productivity, since there is 40 percent of the work remaining. An estimate higher than \$32,500 would be most realistic.

## Section 4.7 Subcontract Management

### Introduction

When managing subcontractors, you must document the reporting requirements for the work in the subcontract. You also must determine what the management intent of the subcontract is. For example, do you simply want to include EVM values reported by the subcontract in your report? Or do you want all of the benefits of EVMS on the subcontract?

Management of subcontractor effort is a vital part of many contracts or projects. Without an effective subcontract management process, successful execution of a project would be greatly jeopardized. The degree of subcontract management visibility and control varies with the degree of risk and impact to contract requirements. Subcontracts requiring performance measurement visibility during execution or in advance of material receipt are classified as “major subcontracts.”

Major subcontracts are normally identified in the proposal stage and require increased surveillance because of the size and nature of the specialized services and material being procured. Each major subcontract should have a subcontract administrator (SCA) designated to be an integral member of the project team. When it is deemed necessary, either because of a government requirement or a management decision, EVM reporting requirements may “flow down” contractually to a major subcontractor.

On US Government projects subcontractors with a validated EVMS are required to provide a copy of their advanced agreement with the *Cognizant Federal Agency (CFA)* to the SCA for confirmation of capability. In these instances, the subcontractor may use its EVMS and report CPR data up to the prime contractor for CPR reporting to the customer. Subcontractors without a validated EVMS must provide a written EVMS description that is used during program execution to report subcontract performance. In this instance, the prime contractor must conduct a review to ensure the subcontractor is complying with the guidelines. The prime contractor may request assistance from its customer when conditions, such as proprietary information and competitive position, restrict the prime from accomplishing a thorough review.

The subcontract should include appropriate flow-down clauses that incorporate the required detail and specificity from the SOW to ensure adequate accuracy, comprehensiveness, and timeliness of the Subcontractor’s EVMS. If the subcontractor is not required to submit formal EVM reports, then the CAM works with the subcontractor to establish the PMB, track progress, and collect actuals. The CAM maintains responsive communication with the subcontractor to share information such as schedules, technical reports, subcontractor invoices, etc.

While balancing the fact that greater reporting requirements will probably increase the price of the subcontract, one should answer the following questions. Depending on the answer, more data may be required from subcontractors.

1. Should both labor rate and efficiency variance be reported? Is it costing more because the resources are more expensive than budgeted, or is it taking more labor hours than budgeted?  
**Answer:** The subcontractor should report the effect of rate versus efficiency variances in its VARs.
2. Is it necessary to perform statistical forecasts based on past performance to get a statistically accurate EAC 20 percent into the project? Or can one just assume the EAC each center is providing is correct?  
**Answer.** The subcontractor should provide a time-phased BCWS, BCWP, and ACWP, and ETC at the reporting level(s) established by the subcontract.
3. Do you wish to apply effective correction action to projects or determine an independent EAC if a variance occurs?  
**Answer:** The subcontractor analyzes the variances that exceed thresholds by WBS and element of cost in order to analyze whether the variances are caused by labor, services, material, or subcontractor before determining if it is a price or usage variance. The subcontractor then supplies a corrective action plan. The prime's CAM analyzes the report and reconciles any concerns with the subcontractor.
4. Do you want to perform critical path analysis to make sure Subcontractors are not "picking the low fruit" (not working the critical path) for a high BCWP? Is it necessary to see the total effects on the project finish date when one center is behind schedule?  
**Answer:** The schedule should be provided in a format that can be analyzed. The subcontractor's "hand-offs" to the prime should be in the prime's schedule and the prime's schedule updated by any changes to the "hand-offs". In this manner, the Subcontractor's effect on the prime's critical path can be determined.
5. Do you plan to "crash a schedule" (working tasks normally performed in sequence concurrently to bring in a finish date) and determine the overtime costs associated with crashing a project?  
**Answer:** It is the subcontractor's responsibility to determine how to correct schedule conditions that negatively affect the prime's schedule.
6. Does this program require "vertical integration"? In other words, will contractor A rely on a product or component produced by contractor B? Technical difficulties can delay or change components required by another contractor. Much communication is required to make sure these Subcontractors communicate and adjust to changes.  
**Answer:** A communication tool such as a project portal is recommended. The portal links to relevant documents, reports, files, and web pages for all team members to use.

In a *Guideline* approach there are other considerations.

1. The prime CAM must assess the subcontractor plan, status, and forecasting. The prime CAM must include an assessment of changes required if any to the subcontractor reporting.
2. The prime CAM must determine if the subcontractor has an EVM reporting requirement. If not the CAM must develop an IMS, and work packages in the prime

tool to assess performance. The prime *Guideline* approach requires EVM implementation on the entire SOW regardless of flow down of the requirement to the subcontractor.

**Terms to Know**

- *Baseline schedule;*
- *Contract administration;*
- *Contract amendment; and,*
- *Vertical Traceability.*

**Key Points for Review**

1. How is subcontractor scope authorized?
2. What is a subcontractor VAR?
3. How do you apply templates to integrate the subcontract data?
4. What are the components of a variance analysis?
5. What levels of the subcontractor data are provided by the contractor?
6. At what level are variance analyses reported by the subcontractor?

Please see **Sample Problems for Section 4.7** on page 165

**Sample Problems for Section 4.7:**

1. Which of the following elements of a project does a subcontractor consider most useful in determining scope?
  - A. Contract
  - B. Material
  - C. Labor rates
  - D. Overhead
  
2. What would determine the detail of the data incorporated by the Subcontractor in its performance measurement system?
  - A. Type of contract and value
  - B. Project scope, schedule, and budget
  - C. Customer
  - D. Type of subcontractor
  
3. When reviewing the subcontractor reporting requirements, the prime or general contractor should dictate the structure and format for reporting.
  - A. True
  - B. False

**Solutions to Problems for Section 4.7:**

1.     A     The contract defines scope for the subcontractor.
2.     B     Subcontractor must have the scope, schedule and budget defined by the subcontract.
3.     A     If it is not dictated to the subcontractor, the data might not be provided in a required and functional format. To preclude possible claims, the subcontract should be relatively detailed in specifying data, information, formats, and frequency of reporting.

## Chapter 5.0—Revisions and Data Maintenance

### Introduction

As the project matures, many documents are created or revised to support the planned outcome. These documents become official records of the project and must be maintained throughout their lifecycle up to some finite end date. When an authorized change is received, all affected work documents should be updated in a timely manner to reflect the change. This process requires a revision to the affected official records thus requiring the revisions to be authorized and the data maintained. This process sometimes is referred to as the “paper trail” or “audit trail,” whereby the documents provide a legally sufficient history for how it started, where it has been, and how it got to where it currently is.

There are three situations where a revision to the PMB is required while executing a project. There is the external or directed change, which is directed and authorized by the customer. Second, there is the internal change consisting of re-planning within the constraints of the scope, schedule, and budget of the current project. These changes are normally based on distribution of the MR, distribution of UB, and conversion of planning packages to work packages with some time phasing of the work package budget. The third and least desirable is formal reprogramming which is done when it is realized that the existing timeline and/or budget is insufficient to complete the scope of work. When budgets for remaining work or time to complete remaining work (or both) are insufficient, the formal reprogramming revision maybe implemented resulting in a revised baseline for performance measurement of the remaining work.

### External Change

External changes are changes to the existing contract that are authorized by the customer’s proper authority. Any contract change requested by customer personnel must go through the proper authority. An external change proposed by the contractor is usually documented in a *Baseline Change Proposal (BCP)*. There are two types of external changes: authorized priced changes and authorized unpriced changes (AUW) (See Section 2.9 of this study guide).

Authorized priced changes are changes wherein the customer has authorized the contractor to proceed with the work scope and has come to a formal agreement with the contractor as to the value of the change (the *Contract Target Cost (CTC)* has been formally changed by the customer). At this point, the contractor immediately changes the CBB to be equal to the revised CTC and may enter the budget increase into *Undistributed Budget* if the budget is not immediately distributed. The amount in UB is further distributed using the same procedures that were used when the contract was originally signed. A portion of the increased value may be transferred to MR with the rest distributed to SLPPs and/or *Control Accounts* and all affected authorizations, schedules, and plans are revised. The UB value for the new scope should be fully distributed within the next full accounting month. All of these actions are tracked in the baseline logs.

*Authorized Unpriced Work (AUW)* is a change wherein the work scope has been authorized by the customer’s proper authority to be performed, but the value of the work has not yet been agreed to. When this occurs, the contractor increases the CBB by the contractor’s estimate of the value of the

work (if a BCP was submitted, it is the estimate included in the BCP if accepted as is by the customer). Because there is no agreed to value, only a portion of the budget in UB is distributed to CAs to initiate the near term work. Only CA impacted by the change should receive additional budget. This piecemeal distribution continues until the final value is agreed to and has been formally authorized by a change to the CTC. Upon the CTC change, the CBB and the amount remaining in UB are adjusted for the difference between the contractor's estimate and the negotiated value. Then the remaining scope and budget in UB is distributed to SLPPs and/or CAs with, at the PM's discretion. A small amount may be transferred to MR at the PMs discretion. The remaining UB value should be fully distributed within the next full accounting month. All of these actions are tracked in the baseline logs.

### **Internal Change**

An internal change is a change to the PMB that is not a change to the CBB. It is either a change internal to the PMB (usually a transfer of SLPPs to *Control Accounts* or PPs to WPs) or involves use or replenishment of MR. (Replenishment of MR using unspent budget from closed CA is not a universally accepted practice since it zeros a positive cost variance and should be discussed with the customer.) These changes are usually initiated by CAMs via a *Baseline Change Request* (BCR), which is processed through a formal change procedure for review and approval by the PM. A log tracks BCPs through the process and documents the final approval / disapproval. Approved BCPs are documented in the baseline logs.

### **Formal Reprogramming**

Formal reprogramming results in an *Over Target Baseline* (OTB). It occurs when contract performance deviates from the plan to such an extent that the original plan cannot achieve the contract objective no longer serves as a reasonable measurement device.

Once reviewed and, if required, approved by the customer, it is implemented by incrementing the PMB and possibly MR such that the sum of the PMB and MR exceeds the CBB, which is not changed. The original *Total Allocated Budget* (TAB) is increased by the amount of the OTB. The original CCB value is not affected. The reprogramming action may including a complete "start over," which involves setting BCWS and BCWP equal to ACWP (sets CV and SV equal to zero), or it may simply go forward with the current variances, or something between the two alternatives. Regardless, all changes are formally documented and logged. The results are reported in the CPR.

### **Baseline Change Logs**

Changes to the baseline schedule and cost must be tracked. The project should be able to trace changes from the beginning of the project to the current period. The logs should be updated whenever a change is approved to the baseline. The following elements should be traceable within the log:

- Contract Target Costs (CTC)
- Performance Measurement Baseline (PMB)
- Management Reserve (MR)
- Undistributed Budget (UB)
- Distributed Budget (DB)

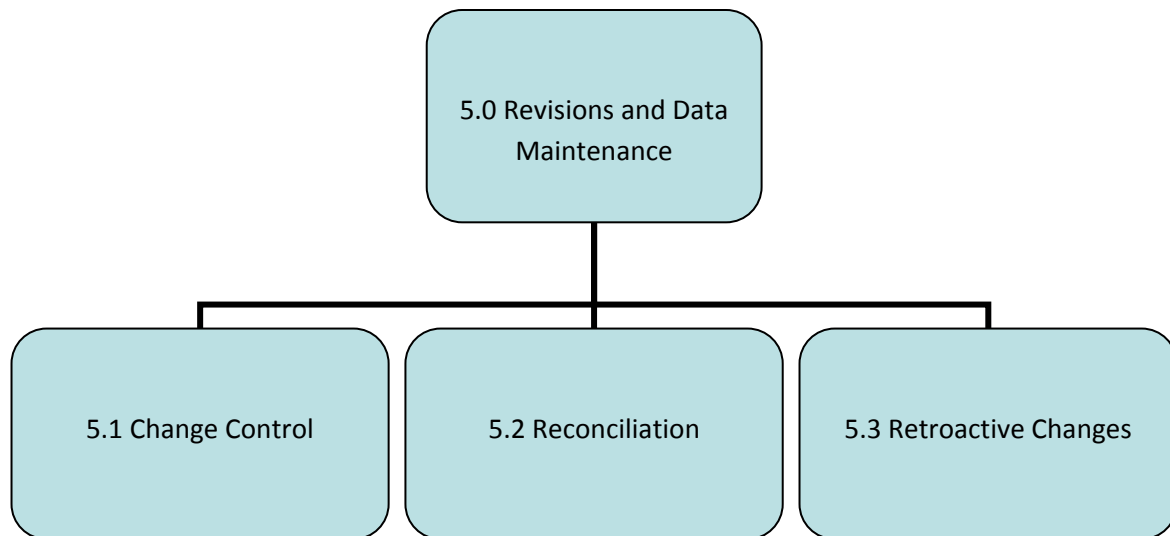
**Terms to Know**

- *Archives;*
- *Baseline Change Proposal (BCP);*
- *Baseline Change Request (BCR);*
- *Baseline logs (e.g., CBB log, UB log, MR log);*
- *Formal Reprogramming;*
- *Information system database;*
- *Over Target Baseline (OTB);*
- *Official records;*
- *Total Allocated Budget (TAB); and,*
- *Undistributed Budget (UB).*

**Key Points for Review**

1. What defines official documentation?
2. What is the definition for the internal change system?
3. How is reprogramming accomplished?
4. What is the basis for an archival process?

The EVP body of knowledge for revisions and data maintenance is shown in figure 5.0.



**Figure 5.0—EVP Body of Knowledge for Revisions and Data Maintenance**

Please see **Section 5.1 Change Control** on page 171

## Section 5.1 Change Control

### Introduction

The most singular component of change control is a matter of review and approval of what is new or revised work scope versus original contract base scope. Only approved and signed contract change orders will be incorporated into the original baseline contract. The revised contract baseline will contain the revised monetary base, revised work scope, revised schedule and revised management plan. The progress measurement base for a given reporting period for CPI and SPI calculations will be current after change order approval.

To accomplish effective change control, the work scope must be clearly and completely defined in the contract, through the *WBS Dictionary* (See section 1.1), and to the *Control Account*. Otherwise, it is difficult to determine whether a “change” is really a change or is included with already authorized work.

Changes should also be made when there are significant differences in how the work scope will be performed. An example is a change from make to buy or a change in methodology that makes EVM on the previous methodology unrealistic.

Conversion of PPs to WPs is a common occurrence that needs to be documented, but may not need the formal approval of the PM. Unless the scope, schedule, or budget authorization of the control account is changed, the CAM should be allowed to be the approval authority for the conversion. The *Rolling Wave* concept introduced in Section 2.6 of this study guide applies to the PP to WP conversion process.

Unopened WPs should be restricted from changes once their start dates are near to the current accounting period. Contractors often set a “freeze period” within which a WP cannot be changed without special approval from the PM. Example freeze periods are “cannot change in the current accounting month” and “cannot change in the current accounting month plus the next month.” Opened WPs (WPs that have performance and actual costs) may be changed under special circumstances approved on a case by case basis by the PM. An example would be a test failure that requires the remaining work in the package to be re-designed to a new configuration. The preferred method is to set the BCWS and BAC of the WP equal to the BCWP and move the budget that was not performed (the old BAC minus BCWP) to UB for redistribution to a new WP with the revised work scope. Any difference between the new budget and the budget that moved to UB is covered by a use or replenishment of MR. Such a change must be communicated to the customer, usually in *Format 5* of the CPR.

Retroactive changes are generally not allowed except in cases of correction of errors, routine accounting adjustments, effects of customer or management directed changes, or to improve the baseline integrity and accuracy of performance measurement data. One common retroactive change is the replacement of estimated costs (accrual costs) with actual costs once they are known; for example when payment to a subcontractors is made and accounted to the project long after the work was completed.

The change control process, forms, and required approvals are typically documented in an EVM System Description that is approved by the contractor's senior management. Records of all changes should be retained so that it is possible to trace the modification to the PMB from the original to the current PMB.

**Terms to Know**

- *Authorization;*
- *Base work scope;*
- *Change order request;*
- *Directed change;*
- *Freeze Period; and,*
- *Rolling Wave.*

**Key Points for Review**

1. What defines a change order?
2. What aspects of a project typically will not be modified by a change order?
3. How are correct monetary bases for CPI and SPI calculation assured?
4. What is the most significant document for adding non-contracted work scope?
5. What is the basis for an approved change order?

**Sample Problems for Section 5.1:**

1. Which statement best describes a situation that justifies a change order?
  - A. The cost of installing a piece of equipment increased by \$5,000.00
  - B. The customer authorized an additional 1,200 square feet to the facility
  - C. A request to increase the engineering hours by 280 was submitted to the PM
  - D. The installation of drywall took two additional weeks by the subcontractor
  
2. The customer is walking down the work area and tells the superintendent to replace the brick veneer specified on the drawing with river stone. Which change control attribute best describes the customer's action.
  - A. Authorization
  - B. Directed change
  - C. Verbal or informal change request
  - D. Formal change request
  
3. Which statement best describes the definition of change control?
  - A. A chronological list of tasks that add cost to the project
  - B. A chronological list of tasks that add schedule duration to the project
  - C. A chronological list of items used to justify claims against the contract
  - D. An approved change control management system that documents authorized scope, schedule, and budget additions or revisions to an established approved project baseline

**Solutions to Problems for Section 5.1:**

1. B Customer direction to do additional work, and there providing funding and time to complete.
2. C Verbal requests are informal change requests that do not change the contract. The customer who made the request verbally must process the request through the proper contracting channels to convert the request into a formal change request. The contractor will respond by proposing the estimated cost and schedule impacts. The results of the negotiation will be processed via a change order.
3. D An approved change control management system that documents authorized scope, schedule, and budget additions or revisions to an established approved project baseline.

## Section 5.2 Reconciliation

### Introduction

Reconciliation documentation requires a correct and updated data base for calculation of cost and schedule (CPI and SPI) factors. If any portion of the project accounting database used in calculating CPI and SPI is from an external source, a periodic review of the data posted to the accounting system should be accomplished by an independent audit.

Current budget and baselines must be reconciled to prior budgets in terms of authorized changes to work scope and internal re-planning to match current management plans. Reconciliation efforts encompassing financial accounting data will be accomplished by that department. The following items should be examined:

- Validate and verify that software programs (both internal and external) are of the expected version or release.
- Review retroactive accounting changes to past reporting periods including reasons and approvals.
- Verify that the PMB is consistent with approved scope and approval documentation.
- Review accounting data to reflect actual project invoices, corporate financial systems, and accruals for work and material expended but not yet paid Estimate ACWP/AC for work performed that has not been accrued or paid by the accounting system.
- Verify budget changes to the original estimate are consistent with change orders, distribution of MR and/or UB, and are documented and approved.
- Verify schedule changes to the original schedule are consistent with change orders, or re-planning and are documented and approved.
- Verify that subcontractor performance matches reported period work in-place, by appropriate independent management review.
- Anticipate and address conditions that might lead to perceptions of report inconsistency, if statements or data really do not contradict other entries, but they might appear to the customer to do so.

All concerned should be very sensitive to the possibility of reporting errors. If discrepancies are discovered by the customer after the report is published, confidence in the EVMS and the professionals running it will inevitably degrade. It takes much work to regain the customer's confidence. In repeated circumstances, the errors might be viewed as a breach of contract.

**Terms to Know**

- *Accruals;*
- *Audits;*
- *Database information;*
- *Indirect rates;*
- *Progress measurement; and,*
- *Validation.*

**Key Points for Review**

1. Explain the difference between the data date and baseline schedule date.
2. Locate the source of an indirect rate.
3. Explain the difference between an accrual and invoice payment.

**Sample Problems for Section 5.2:**

1. What is a recognized method to validate a project's financial data?
  - A. Preparation of business taxes for the Governmental and State Tax Services
  - B. Audits
  - C. Request for proposal from an owner or customer
  - D. Procurement contracts
  
2. Which statement best describes the definition of an estimated ACWP/AC?
  - A. Invoice payment
  - B. Performance measurement technique
  - C. The cost of completed work before the accounting department has paid associated salaries or invoices.
  - D. An independent cost estimate of schedule work
  
3. What term best describes the resolution of current budget and original budget in terms of authorized changes to work scope and internal re-planning to match current management plans?
  - A. Reconciliation
  - B. Best management practice
  - C. Audit
  - D. Baseline change proposal (BCP)
  
4. Which statement best describes the definition of burden when considering financial data?
  - A. Indirect rates
  - B. Escalation factor
  - C. Wage rates
  - D. Sales tax

**Solutions to Problems for Section 5.2:**

1. B Audits. They are used in both commercial and government projects.
2. C. The cost of completed work before the accounting department has paid associated salaries or invoices.
3. A Reconciliation is to review and confirm that data elements can be traced and reconciled. In the question, the trace is from the original budget to the current budget.
4. A Indirect rates that place a percentage burden on the direct costs.

## Section 5.3 Retroactive Changes

### Introduction and Learning Objectives

The ANSI/EIA 748 C Guideline for retroactive changes is as follows:

*“Control retroactive changes to records pertaining to work performed that would change previously reported amounts for actual costs, earned value, or budgets. Adjustments should be made only for correction of errors, routine accounting adjustments, effects of customer or management directed changes, or to improve the baseline integrity and accuracy of performance measurement data.”*

If work has been performed ( $BCWP/EV > 0$ ) and reported, the  $BCWS/PV$  and  $ACWP/AC$  for that  $BCWP/EV$  generally cannot be changed retroactively and neither can the  $BCWP$  be changed retroactively. There are exceptions as noted in the ANSI/EIA 748 C Guideline. Previous data which found to be erroneous may be corrected with approval. However, changes to simply reduce variances are not permitted. When correcting past reported the data the customer should be advised as to the cause and why the new values should be considered.

The guideline does not prevent changing or moving budget that has not been performed or scheduled. For example, a *Work Package* was not opened on its start date because a change was in process that would re-plan all of the work for the *WP* and its successors. The *WP* now has  $BCWS/PV$  in the past, but there is no  $BCWP/EV$ . The  $BCWS/PV$  may be re-planned into the future with the entire re-plan. Although allowed, it should be reported to the customer because the monthly report may show a negative  $BCWS/PV$  in the current period.

Any authorized change to the baseline must be applied in the current reporting period and the variance or anomaly must be explained, even if the change was due to a historical event.

This change will impact the current period, but the cause can be explained in a variance report. If a change in history were allowed, it would generally invalidate the current period, since most actions and records are considered closed after the business month end date.

### Terms to Know

- Business month end;
- Historical data;
- Reporting period; and,
- Variance analysis.

### Key Points for Review

1. How can a retroactive change be implemented?
2. When and where should you explain a retroactive change?

Please see **Sample Problems for Section 5.3** on page 181

**Sample Problems for Section 5.3:**

1. Your project controls engineer discovers a set of invoices missed and not in your accruals from three months earlier. How would you correct the problem?
  - A. Correct the past reports with approval from the customer
  - B. Incorporate into current period and make notation in report
  - C. Revise the number in the prior period and note in report
  - D. A or B
  
2. Where would you explain a retroactive change?
  - A. Correction box at beginning of report
  - B. Variance analysis section
  - C. Monthly write-up
  - D. Executive summary
  
3. Which statement best describe the major reason for retroactive change?
  - A. Document all history
  - B. Corrections in proper time
  - C. Accuracy in data management
  - D. It is required by *ANSI/EIA 748 C*
  
4. Retroactive changes to BCWS/PV and BCWP/EV are a common occurrence in project reporting, so there is no need to make a special issue.
  - A. True
  - B. False

**Solutions to Problems for Section 5.3:**

1. D. A or B
2. B. An adjustment is a variance notation, as it a normal part of the process.
3. C. The adjustments and notations reflect accuracy in data management.
4. B. Changes to BCWS/PV and BCWP/EV are handled in the current period, not retroactively. Minor retroactive changes to the ACWP/AC may be made when costs have been charged to the wrong WBS or organization.

## Appendices

Appendix A Earned Value Checklist

Appendix B Earned Value Professional (EVP®) Matrix

Appendix C EVP® Exam Written Memorandum

Please see **Appendix A: EV Checklist** on page 185

## Appendix A: EV Checklist

### EARNED VALUE MANAGEMENT SYSTEM IMPLEMENTATION SELF-ASSESSMENT

The following is a list of guidelines that are defined by ANSI/EIA-748 C September 2013 and required to be met under a formally validated *Earned Value Management System* (EVMS). Following each guideline is a list of exhibits that may be used to demonstrate compliance to the guideline.

Note: There are five main categories within which each of the guidelines are uniquely categorized: organization; planning, scheduling, and budgeting; accounting considerations; analysis and management reports; and revisions and data maintenance.

Every criterion is assessed to be in one of three status categories: meets standard; not demonstrated; or action item.

#### 1. ORGANIZATION

- 1.1 Define the authorized work elements for the program. A work breakdown structure (WBS), tailored for effective internal management control is commonly used in the process.  
**Requirement / Check:** WBS structure and dictionary.
- 1.2 Identify the program organizational structure including the major subcontractors responsible for accomplishing the authorized work, and define the organizational elements in which work will be planned and controlled.  
**Requirement / Check:** OBS structure and/or organizational chart.
- 1.3 Provide for the integration of the company's planning, scheduling, budgeting, work authorization and cost accumulation processes with each other, and as appropriate, the program work breakdown structure and the program organizational structure.  
**Requirement / Check:** *Contract and/or Modification(s), RAM, CAP, Control Account Work Authorization (CAWA), Cost loading of project schedule.*
- 1.4 Identify the company organization or function responsible for controlling overhead (indirect costs).  
**Requirement / Check:** DCMA letter showing billings rates, government compliance letter showing current forecasted OH rates.
- 1.5 Provide for integration of the program work breakdown structure and the program organizational structure in a manner that permits cost and schedule performance measurement by elements of either or both structures as needed.  
**Requirement / Check:** RAM

## 2. PLANNING, SCHEDULING, AND BUDGETING

- 2.1 Schedule the authorized work in a manner which describes the sequence of work and identifies significant task interdependencies required to meet the requirements of the program.  
**Requirement / Check:** schedule, cost loading of project schedule, CAWA, CAP
- 2.2 Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure progress.  
**Requirement / Check:** CAP, cost loading of project schedule.
- 2.3 Establish and maintain a time-phased budget baseline, at the control account level, against which program performance can be measured. Initial budgets established for performance measurement will be based on either internal management goals or the external customer negotiated target cost including estimates for authorized but undefined work. Budget for far-term efforts may be held in higher level accounts until an appropriate time for allocation at the control account level. On government contracts, if an over-target baseline is used for performance measurement reporting purposes prior notification must be provided to the customer.  
**Requirement / Check:** CAP (detail and summary)
- 2.4 Establish budget for authorized work with identification of significant cost elements (labor, material, subcontracts, other directs, etc.) as needed for internal management and for control of subcontractors.  
**Requirement / Check:** CAP, CAWA
- 2.5 To the extent it is practical to identify the authorized work in discrete work packages, establish budgets for this work in terms of dollars, hours, or other measurable units and where the entire control account is not subdivided into work packages, identify the far-term effort in larger planning packages for budget and scheduling purposes.  
**Requirement / Check:** CAP
- 2.6 Provide that the sum of all work package budgets plus planning package budgets within a control account equals the control account budget.  
**Requirement / Check:** CAP
- 2.7 Identify and control level of effort (LOE) activity by time-phased budgets established for this purpose. Only that effort which is immeasurable or for which measurement is impractical may be classified as LOE.  
**Requirement / Check:** CAP

- 2.8 Establish overhead budgets for each significant organizational component of the company for expenses which will become indirect cost. Reflect in the program budgets, at the appropriate level, the amounts in overhead pools that are planned to be allocated to the program as indirect costs.

**Requirement / Check:** government compliance letter showing current forecasted OH rates, DCMA letter showing billing rates

- 2.9 Identify management reserves and undistributed budget.

**Requirement / Check:** *Contract Budget Base (CBB) log, CPR Format #1, CPR Format #3*

- 2.10 Provide that the program target cost is reconciled with the sum of all internal program budgets and management reserves.

**Requirement / Check:** *CPR Format #1 and by Control Account, CBB log*

### 3. **ACCOUNTING CONSIDERATIONS**

- 3.1 Record direct cost in a manner consistent with the budgets in a formal system controlled by the general books of account.

**Requirement / Check:** CAP

- 3.2 When a work breakdown structure is used, summarize direct costs from control accounts into the work breakdown structure without allocation of a single control account to two or more work breakdown structure elements.

**Requirement / Check:** WBS – looking for pure integration, no low level cost should roll-up to multiple higher level accounts and no cost duplication should be present.

- 3.3 Summarize direct costs from the *Control Accounts* into the contractor's organizational elements without allocation of a single control account to two or more organizational elements.

**Requirement / Check:** RAM, organizational chart

- 3.4 Record all indirect costs which will be allocated to the contract.

**Requirement / Check:** WBS structure and dictionary

- 3.5 Identify unit costs, equivalent unit costs, or lot costs when needed.

**Requirement / Check:** *Estimate, Cost Estimating and Control System*

- 3.6 For *Earned Value Management System (EVMS)*, the material accounting system will provide for:

- 3.6.1 Accurate cost accumulation and assignment of costs to control accounts in a manner consistent with the budgets using recognized, acceptable, costing techniques.

**Requirement / Check:** material status report (MSR), *Project Schedule, Cost Control System*

- 3.6.2 Cost performance measurement at the point in time most suitable for the category of material involved, but no earlier than the time of progress payments or actual receipt of material.

**Requirement / Check:** *Material Status Report (MSR), Project Schedule, Cost Control System*

- 3.7 Full accountability of all material purchased for the program including the residual inventory.  
**Requirement / Check:** material status report (MSR), Project Schedule, Cost Control System

#### 4. ANALYSIS AND MANAGEMENT REPORTS

- 4.1 At least on a monthly basis, generated the following information at the control account and other levels as necessary for management control using actual cost data from, or reconcilable with, the accounting system.
- 4.1.1 Comparison of the amount of planned budget and the amount of budget earned for work accomplished. This comparison provides the *Schedule Variance (SV)*.  
**Requirement / Check:** *CPR Format #1, CPR Format #2, CPR Format #5-VAR*
  - 4.1.2 Comparison of the amount of the budget earned and the actual (applied where appropriated) direct costs for the same work. This comparison provides the *Cost Variance (CV)*.  
**Requirement / Check:** *CPR Format #1, CPR Format #2, CPR Format #5-VAR*
- 4.2 Identify, at least monthly, the significant differences between both planned and actual schedule performance and planned and actual cost performance and provide the reasons for the variance in the detail needed by program management.  
**Requirement / Check:** *CPR Format #5-VAR*
- 4.3 Identify budgeted and applied (or actual) indirect costs at the level and frequency needed by management for effective control, along with the reasons for any significant variances.  
**Requirement / Check:** government compliance letter showing current forecasted O/H rates, DCMA letter showing billing rates; *CPR Format #5-VAR*.
- 4.4 Summarize the data elements and associated variances through the program organization and/or work breakdown structure to support management needs and any customer reporting specified in the contract.  
**Requirement / Check:** WBS, OBS, CAP, *CPR Format #5-VAR*
- 4.5 Implement managerial actions taken as the result of earned value information.  
**Requirement / Check:** *CPR Format #1, VAR corrective action log*
- 4.6 Develop revised estimates of cost at completion based on performance to date, commitment values for material, and estimates of future conditions. Compare this information with the performance measurement baseline to identify variances at completion important to company management and any applicable customer reporting requirements including statements of funding requirements.  
**Requirement / Check:** *CPR Format #1, CPR Format #3 and Contract Funds Status Report (CFSR)*

**5. REVISIONS AND DATA MAINTENANCE**

5.1 Incorporate authorized changes in a timely manner, recording the effects of such changes in budgets and schedules. In the directed effort prior to negotiation of a change, base such revision on the amount estimated and budgeted to the program organizations.

**Requirement / Check:** CBB log, *Contract* and/or *Modification(s)*

5.2 Reconcile current budgets to prior budgets in terms of changes to the authorized work and internal replanning in the detail needed by management for effective control.

**Requirement / Check:** CBB log, *Contract* and/or *Modification(s)*

5.3 Control retroactive changes to records pertaining to work performed that would change previously reported amounts for actual cost, earned value, or budgets. Adjustments should be made only for correction of errors, routine accounting adjustments, effects of customer or management directed changes, or to improve the baseline integrity and accuracy of performance measurement data.

**Requirement / Check:** *CBB log*

5.4 Prevent revisions to the program budget except for authorized changes.

**Requirement / Check:** CBB log, *Project Work Authorization (PWA)*, *CPR Format #1*

5.5 Document changes to the performance measurement baseline.

**Requirement / Check:** CBB log, PWA

*See the references in the Introduction to this **EVP Certification Study Guide***

Please see **Appendix B: EVP Matrix** on page 191

## Appendix B: EVP Matrix

The EVP Matrix is a comparison of the Commercial, International and US Government Earned Value Management Systems.

EVMS Standard	Cost	Advantages	Disadvantages	Comments
ANSI/EIA 748	high	Recognized standard for cost plus contracts	Expertise required to implement  Tells what to do but not how to do it Schedule performance focused on effects of schedule variances on cost	5 Sections 1. Broad EVMS Guidance, 2. Basic Guidelines (32), 3. Process Discussion, 4. Documentation, 5. Evaluation
AS 4817  (Australian)	low	Simple EVMS for Fix Price & Agile Projects  clear links to CPM schedule  Easily understood by Sr Management	Not suitable for large complex projects or Cost Plus Contracts  Actually 2 standards Large projects must obtain supplemental standard  Not suitable for large complex projects	11 Basic Sections Determine Scope, Assign Responsibility, Schedule Work, Develop TP Budget, Assign Performance Objectives, Set Performance Baseline, Authorize & Perform Work, Accumulate Data & Report Performance, Analyze Performance, Take Management Action, Maintain Baseline

			Common for construction industry fixed price projects	
PMI's EVM SP	medium	Most common EVMS Standard  Uses Earned Schedule Variance Techniques Easily tailored	Not suitable for Cost Plus Contracts or large, complex projects	8 Sections Organize Project, Assign Responsibility, Develop Schedule, Establish Budget, Determine Measurement Methods, Establish Performance Baseline, Analyze Project Performance, Maintain Baseline
Combined GAO	medium	Combined Australian Workflow with US Guidance  Good linkage to Resource loaded schedules, risk management systems and Probability of Project Success	Newer & not widely recognized	Free; 13 Sections Define Scope & WBS, Assign Work, Schedule, Estimate Resources & Budgets, Determine Measurement Methods, Develop Performance Baseline, Execute Work Plan & Record Costs, Analyze Perf. Data & Record Variances, Forecast EACs using EVM, Perform Integrated Cost-Schedule Risk Analysis, Compare EVM EACS with Risk EACs, Mitigate Risks, Update PMB as Changes Occur

## Appendix C: EVP Exam Written Memorandum

Part IV of the EVP Exam requires the candidate to demonstrate writing skills and general knowledge around Earned Value Management competency. The candidate is required to write a memorandum demonstrating their ability to communicate effectively their knowledge on a selected Earned Value Management subject.

The exam consists of a sample question:

**Question:**

The question will identify your position, description of the project and general scope of the question. You should review the documentation required in the listing and prepare the memo as required.

**MEMO**

**To:** John Doe, Project Manager

**From:** John Smith, Risk Manager

**Date:** August 31, 2013

**Subject:** Appropriate Subject Based on the Question

- Paragraph One: Should describe the scope of the question.
- Paragraph Two: Should identify the purpose and the relevant procedures or process.
- Paragraph Three: Should identify the application of the decision and risk management process.
- Paragraph Four: Should be a detailed conclusion of the process based upon paragraphs one to three.

Name

Title

CC:

File

Names based on appropriate context

## List of Versions / Revisions / Changes

The revisions and changes to the 3rd Edition **Earned Value Professional™ (EVP™) Certification Study Guide** are:

Version Number	Date	Description of Changes
EVP-1.0	Aug. 1, 2014	Initial on-line posting



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