10 PROJECT CONTROL
(EVMS, PERFORMANCE MEASUREMENT AND REPORTING)

10.1 OVERVIEW

The simplest definition of a successful project would be a project that is completed within the scope, schedule, and cost baselines, and delivers the required technical performance, thus fulfilling the mission needs specified in the justification for the project. The primary elements involved in ensuring success include planning, budgeting, scope execution, performance measurement (analysis, forecasting, and reporting), and developing and implementing corrective actions as needed. In principle, these elements are addressed by all organizations for all work (including non-project work) under the umbrella of management control systems and practices. While DOE is not prescriptive in specifying and/or imposing a single system, the project management system is expected and required to comply with the criteria established in this manual.

The DOE has adopted the industry standard ANSI/EIA-748 "Earned Value Management Systems" (EVMS), supplemented with additional DOE requirements and practices as needed, as the core basis for its program and project management systems requirements.

The EVMS criteria are similar to the cost schedule control system criteria (CSCSC) and DOE Order 4700 required by DOE in the past. Contractor systems that were formally recognized by DOE as meeting the 35 Cost Schedule Control System Criteria will be considered compliant with the 32 EVMS criteria.

In contrast to earlier CSCSC and O 4700 implementations, EVMS implementation should be tailored (degree of rigor, detail) to the needs of the program/project depending upon its size, complexity, importance, and cost.

This section summarizes the overall requirements of the project/program management system including EVMS and performance measurement and reporting.

The EVMS concept is designed to provide insight into how a project progresses from a management (federal and contractor) point of view. The EVMS implementation is directed at providing cost and schedule performance data which

- relate time-phased budgets to specific contract tasks and/or statements of work.
- indicate work progress.
- properly relate cost, schedule, and technical accomplishment.
- are valid, timely, and auditable.
- supply managers with information at a practical level of summarization.
- are derived from the same internal Earned Value Management System (EVMS) used by the contractor to manage the contract.

10.2 PERFORMANCE MEASUREMENT

Formalized methodology for cost-effective implementation of performance measurement (PM) on a project should achieve the following objectives:

- Enable the contractor to depict the work plan for subsequent monthly assessments
- Analyze the current performance status and forecast impacts to work scope, schedule, or cost baselines
- Provide data needed for required DOE reporting and internal (contractor) progress reports.

An effective performance measurement process exhibits the following characteristics:

- The process is accepted and documented (formalized)
- Implementation adequately addresses the needs for measuring and reporting performance against the work scope, cost, and schedule baselines
- Implementation is integrated with and reflects the cost and scheduling system baselines, budgeting and cost estimating, separation of funding sources, and types of funding (capital versus operating)
- Baseline change control systems and procedures are in place
- The separation (identities) of projects are maintained and are consistent with organizational and work breakdown structures
- A risk-based tailored approach is used in establishing performance measurement and control requirements in consultation with DOE

10.3 PERFORMANCE MEASUREMENT TAILORED TO PROJECT

Cost effective application of the performance measurement process requires using a risk-based tailored approach to establish requirements for performance measurement application. A risk analysis is performed on programs/projects or scopes, considering factors such as complexity, dollar value, technology, regulatory requirements, and federal-state agreements, to assess the likelihood and consequences of impacting the workscope's scope, cost, and schedule baselines. This risk analysis forms the basis for establishing the level of detail and the rigor and degree of control exercised in the application of performance measurement. The primary objective of this approach is to maximize program/project control effectiveness at the least cost.

10.4 PERFORMANCE MEASUREMENT PARAMETERS

One or more of the following parameters may be used for performance measurement depending on the nature and importance of the scope.

- Earned Value. A quantified (in dollars) methodology where the "percent of work scope completed" is applied to the total budget for that scope (budget-at-completion, [BAC]) to determine the "earned value" or budgeted cost of work performed (BCWP).

The budgeted cost of work scheduled (BCWS) is a quantified (in dollars) representation of the schedule, being the time-phased (e.g., by month) budget for that scope. A comparison of the BCWP and BCWS may then be used as a schedule performance indicator, while a comparison of the BCWP with the actual cost of work performed (ACWP) serves as a cost performance indicator.

- *Level-of-Effort (LOE).* The time-phased budgets for LOE activities are planned so that at the end of each reporting period, the BCWP is set equal to BCWS. The advantage is that when combined with the discretely planned earned value scopes, all of the budget-scopes for a project are included. This application requires that schedule performance be measured by other parameters (milestones or performance indicators). However, comparison of BCWP (BCWS) with ACWP provides budget versus spending trends and may be used for preparing estimates-at-completion (EAC).

- *Milestone Reports.* The scopes of work to be executed are organized at appropriate levels of detail, milestones are identified, and planned completion dates are established. Monthly (periodic) statusing of the milestones consists of depicting: (a) completed milestones, and (b) forecast completion based on current progress/performance.

- *Technical Progress Indicators.* A product or production-oriented parameter is one where the quantified progress-to-date is compared to the time-phased plan for execution of work scopes for measuring schedule performance. Examples of technical performance indicators include gallons processed, drums produced, tons of soil removed, or cubic yards of concrete placed. Whereas technical performance indicators are an accurate measurement of schedule performance, they do not provide any direct cost performance measurement. However, progress-to-date and forecast schedule completion dates can be used to assess cost impacts.

- *DOE Required Performance Indicators*. Required performance indicators are quantified parameters (similar to technical performance indicators) for which reporting to DOE is a requirement. These indicators may be time-phased or have a single-valued goal against which performance-to-date is measured, Examples include health and safety (collective radiation dose, number of skin contaminations, number of OSHA-reportable incidents); environmental releases (airborne or liquid, radionuclide, hazardous or regulated pollutant effluent releases); hazardous waste inventory; or volume of (solid)/hazardous waste generated at each DOE site.

- *Supplemental Performance Indicators*. Parameters developed by the contractor at each site that are similar to technical performance indicators and DOE-required performance indicators, but are either for contractor use or pertinent to a specific project.

The performance measurement process serves as the foundation for effective project control for both the DOE and the contractor.

From a site integration perspective, the performance measurement methodology for the various projects at a site must have commonality, flexibility, and versatility to enable sitewide integration of performance data as the site management needs evolve.

10.5 PERFORMANCE ANALYSIS AND REPORTING

Several different parameters and methods are applicable in reviewing project progress and performance; analyzing the differences (variance) between actual and planned accomplishments; assessing impacts to work scope, schedule, and cost baselines; and reporting progress to DOE.

The performance and progress review must be a periodic, formalized, documented process with three primary objectives:

- Determine current performance status by comparing actual versus planned accomplishments as represented in the performance measurement baseline.
- Forecast expected completion dates and costs; analyze the potential impacts to work scope, schedule, and cost baselines; and, develop and present corrective action plans when needed to minimize adverse impacts to these baselines.
- Periodically review project performance with cognizant DOE personnel and document project status through formal progress reports.

10.6 RESPONSIBILITIES

Project Managers. Develop performance and progress reporting requirements in consultation with DOE consistent with a tailored approach. The performing organizations and the cognizant managers have the primary responsibility for ownership and integrity of the performance and forecast estimates-at-completion data. The administrative responsibility for integrating and reporting progress and performance analysis lies with the planning and budgeting function.

A tailored approach aims at a cost-effective implementation of the performance analysis and reporting effort by analyzing the project or scope; by developing milestones, indicators, and estimates; by identifying the critical path; and by forecasting schedule and cost, taking into account the size, complexity, cost, and criticality of the project:

- *Analyzing Program, Project, or Scope.* Jointly with DOE, analyze the relative importance of programs and projects and/or scopes within individual programs and projects based on mission importance, complexity, risk, degree of uncertainty, size (dollar value), and number and state of technologies needed. This analysis is a basis for developing a multi-level hierarchy of variance thresholds and reporting requirements appropriate for individual projects, and the contractor's internal lower-level performance analyses. Thus, the lowest

thresholds may be appropriate for the contractor's internal performance and variance analysis at the work-package or cost-account level. However, the highest or broadest thresholds may be more appropriate to justify site-wide exception reporting.

- *Developing Milestones, Indicators, and Estimates*. Milestone, performance indicators, and cost estimates are developed jointly with DOE. These milestones, indicators, and estimates are either DOE-controlled baselines or representative of commitments to state or local agreements or to regulatory requirements. These baselines or commitments establish the site-level equivalents of the L0-L3 multilevel baseline concepts.

- *Identifying Critical Path.* Scopes and variances that are on the critical path or that are otherwise judged to be important and that have the potential for significantly impacting work scope, schedule, and cost baselines are identified.

- *Forecasting Schedule and Cost*. Applicable techniques for forecasting schedule completion (for milestones) and cost estimates-at-completion (for scopes) range from expert opinion or judgement for lower risk, less important scopes, to detailed bottom-up resource-loaded critical-path scheduling for the higher risk, more important scopes.

10.7 PERFORMANCE ANALYSIS

10.7.1 Earned Value Analysis

- *Schedule Variance.* Based on earned value performance measurement, schedule variance (calculated as BCWP–BCWS), is a dollarized depiction of the schedule status as compared to the plan. Schedule variance analysis is used in combination with the applicable milestone completion forecasts for assessing potential impacts to baselines or to controlled, reportable milestones, and to establish whether any corrective actions are needed. Lower thresholds may apply to critical path or near-critical path activities, higher thresholds to non-critical activities.

- *Cost Variance.* The cost variance, calculated as BCWP–ACWP, is an indicator of expenditures measured against completion of corresponding work scopes. While individual cost variances that exceed predetermined thresholds are analyzed for potential impacts to cost baselines, the aggregate cost variance for a particular project is of greater importance for ensuring that authorized funding ceilings are not exceeded by the sum of both expenditures and commitments (encumbrances).

Note: EVMS implementation does not require that earned value be used for fixed price contracts, time and materials contracts, or level-of-effort support contracts.

10.7.2 Level-of-Effort (LOE) Analysis

The LOE work scopes, by definition, do not exhibit any schedule variance. Work scopes that have important schedule milestones should either be planned or be appropriately reflected in the milestones for tracking progress.. Analysis of the cost variance for LOE work scopes is an important factor in preparing an estimate-at-completion forecast and staying within the funding ceiling for expenditures and commitments.

10.7.3 Milestone Analysis

The milestone baseline commitment date, along with the forecast completion date, is the most direct and effective parameter for schedule performance measurement and analysis. The difference between planned and forecast completion dates is referred to as a schedule-time variance. Schedule variance analysis thresholds are generally set at 30 days. Cost impacts due to predicted late completions and/or corrective actions for schedule recovery should be reflected in the cost estimate-at-completion for the corresponding work scope.

10.7.4 Technical Progress and Performance Indicators Analysis

Technical progress and performance indicators are safety-, environmental-, and production-oriented parameters. In some cases there may be associated milestone commitments. Forecast completion dates for milestones should be consistent with current performance. If corrective actions are needed to meet production milestone commitments, this should be reflected in the forecast estimates-at-completion for corresponding work scopes.

10.8 PERFORMANCE/PROGRESS REPORTING

- Progress Review Meetings
  The consolidated site monthly progress and performance review meeting represents a disciplined, formalized, and documented approach to the analysis and presentation to the DOE of performance and progress. This presentation includes an overview of the project; a breakdown by funding categories, such as capital and operating ; and project status, progress, and needs. Consistent

with a tailored approach, selected major projects may be reviewed monthly, with smaller projects being reviewed quarterly or semiannually.

The presentation to DOE may be preceded by an internal contractor review at which the contractor project manager reports progress to senior management and staff.

- *Progress Reports.* A formal project progress report is issued monthly and includes safety performance, status of DOE controlled and reportable milestones, budget and costs, progress status, and variance reporting.

  The Federal program manager's report should be issued quarterly (monthly if required by DOE-HQ).

- *External Factors*. Several external factors not related to performance could significantly impact the project scope, schedule, or cost baselines. These factors include changes in funding, budget reductions, new regulatory requirements, or new agreements with state or regulatory agencies. Potential impacts from such external factors are analyzed and reported as needed in consultation with the DOE.

DEFINITIONS, METHODOLOGY AND PERFORMANCE ASSESSMENT

Earned Value

Earned Value reflects the integration of cost, schedule, and technical work into one common view to establish a project plan. It uses progress against previously defined work plans to forecast such important concerns as estimated completion costs, finish dates, and the effectiveness of corrective action plans. Earned Value is the measurement of what you physically got for what you actually spent, or the value of work accomplished. "Earned Value" is a term that is often referred to as Budgeted Cost of Work Performed. Simply put, it is a program management technique that uses "work in progress" to indicate what will happen to work in the future.

In a graphical representation of the Earned Value approach, the cumulative Budgeted Cost of Work Scheduled or planned accomplishment is the baseline for the project. The Actual Cost of Work Performed is just the cost as a function of time. The Budgeted Cost of Work Performed or actual accomplishment known as Earned Value is a dollar representation of what it should have cost to do the work already accomplished. From this information, it is easy to calculate the cost variance and the schedule variance of the project at any point in time. It allows us to use cost and schedule to determine where we are instead of using them separately and missing the total picture. Figures A-1 and A-2 show the graphical representation of the data collected using this process.

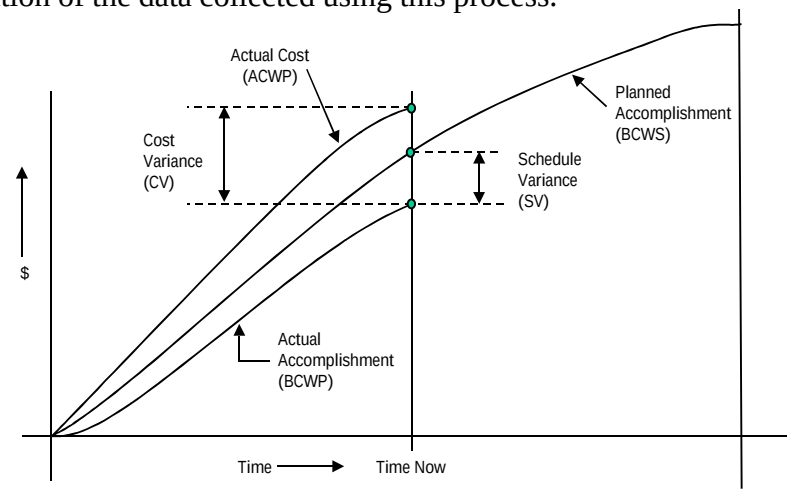

Figure A-1. Data Needed for Earned Value Determination

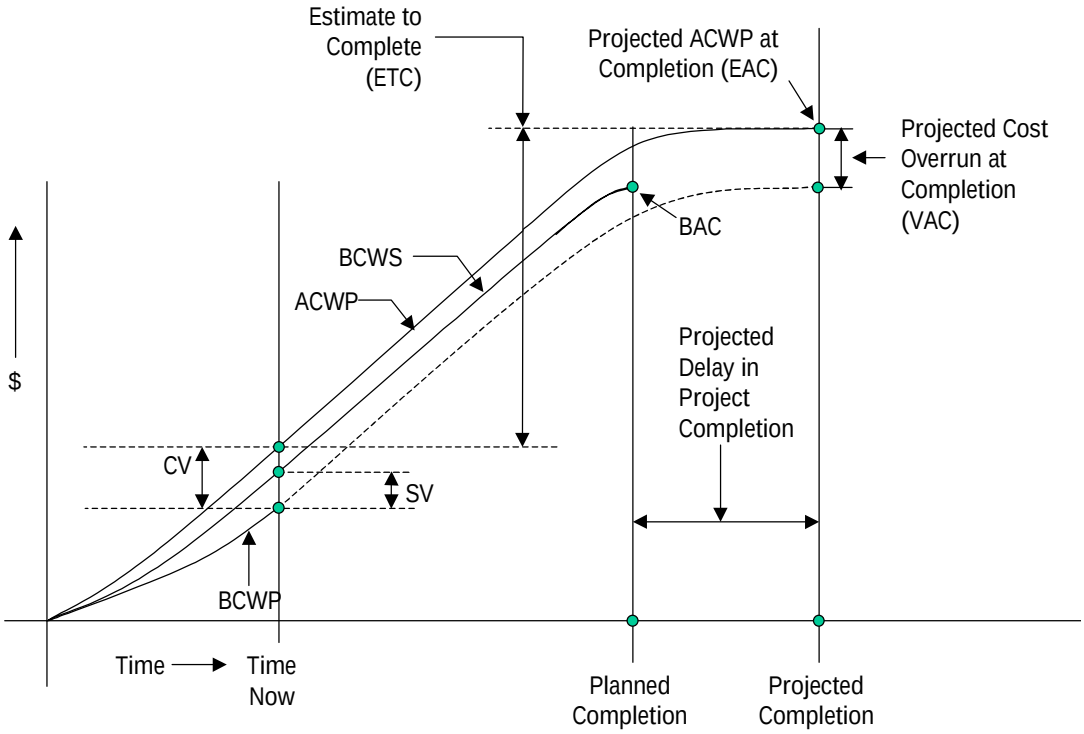

Figure A-2. Earned Value System Parameters

Performance Assessment

The primary performance measures for the Earned Value method are the Cost Performance Index and the Schedule Performance Index. The Cost Performance Index is the ratio between Earned Value and actual costs while the Scheduled Performance Index is the ratio between Earned Value and planned work (budgeted costs). The formulas are shown below:

Cost Performance Index (CPI) =

Earned Value/Actual Cost = BCWP / ACWP

Schedule Performance Index (SPI) =

Earned Value/Planned Value = BCWP/BCWS

If CPI = 1.0, then performance is on target.

If CPI > 1.0, then performance is exceptional.

If CPI < 1.0, then performance is substandard.

The same is true for Schedule Performance Index. Note that a Cost Performance Index of 0.85 means that for every dollar that was spent, only $0.85 in physical work was accomplished. A Schedule Performance Index of 0.90 means that for every dollar of physical work the project had planned to accomplish, only $0.90 was completed.

Other factors that can be used to assess the performance of projects include Cost Variance, Schedule Variance, Percent Variance, Variance at Completion, and To Complete Performance Index.

Estimating Future Cost and Completion Dates

The cost and schedule indices can be used to estimate the approximate cost at completion of the project and the time that it will take to complete it. For cost, we can calculate the Estimate at Completion within a given range of values. The calculations are as follows:

$$\text{Estimate at Completion } (EAC)_{min} =$$

$$(BAC - BCWP) + ACWP$$

$$\text{Estimate at Completion } (EAC)_{max} =$$

$$((BAC - BCWP) / (CPI \times SPI)) + ACWP$$

(Note that there are a number of different Estimates at Completion equations that can be used. See definitions and formulas.

The estimated time to complete the project can also be calculated by taking the projects planned completion in months and dividing it by the Scheduled Performance Index. Therefore:

$$\text{Estimated Time to Complete (ETC)} = \text{Planned Completion} / SPI$$

Note that a straightforward extrapolation of the CPI, SPI for estimating project completion assumes no intervention or corrective action (i.e., future performance is similar to past performance).

Performance Measure Definitions and Formulas (See Figures A-1 andA2)

Actual Cost of Work Performed (ACWP). The cost actually incurred during the accomplishment of work performed.

ACWP. See Actual Cost of Work Performed.

BAC. See Budget at Completion.

BCWP. See Budgeted Cost of Work Performed.

BCWS. See Budgeted Cost of Work Scheduled.

Budget at Completion (BAC). The sum of all budgets allocated to a project excluding contingency.

Budgeted Cost of Work Performed (BCWP). Also known as "Earned Value." The sum of all budgets for completed work and the completed portions of open work. (What was budgeted for the work that actually took place?)

Budgeted Cost of Work Scheduled (BCWS). Also known as "planned value." The sum of all budgets for all planned work scheduled to be completed within a given time period. (The cumulative Budgeted Cost of Work Scheduled gives us the performance measure baseline.)

Cost Performance Index (CPI). Represents the relationship between the actual cost expended and the value of the physical work performed. CPI = BCWP / ACWP.

Cost Variance (CV). The difference between Earned Value and the actual costs (ACWP). CV = BCWP - ACWP.

Cost Variance Percent (CV%). The cost variance as a percent of the Earned Value. CV% = (CV / BCWP) x 100.

CPI . See Cost Performance Index.

EAC. See Estimate at Completion.

Earned Value. What you physically get for what you actually spent; the value of work accomplished; the measured performance; the Budgeted Cost for Work Performed.

Estimate at Completion. The projected final cost of work when completed.

EAC = (BAC - BCWP) + ACWP

(assumes 100% productivity for remaining work)

OR

EAC = [(BAC - BCWP) / CPI] + ACWP = BAC/CPI

(assumes same productivity for remaining work as experienced to date)

OR

EAC = [(BAC - BCWP) / (Performance Factor)] + ACWP

Note: A performance factor can actually be weighted to account for the fact that schedule performance is more relevant at the beginning of the project and cost performance is more relevant toward the end of a project. Factors can be based on performance to date or the last several reporting periods.

Performance Factors for Estimate at Completion Equation.

Cost Performance Index: Assumes cost productivity rate experienced to date.

CPI x SPI: Combination of cost and schedule productivity rates experienced to date. This produces the worst case Estimate at Completion. (Example: EAC_{max} = [(BAC - BCWP) / (CPI x SPI)] + ACWP).

0.8 SPI + 0.2 CPI: Weighted combination of cost and schedule productivity rates experienced to date. Used at the beginning of an effort.

0.5 SPI + 0.5 CPI: Weighted combination of cost and schedule productivity rates experienced to date.

0.2 SPI + 0.8 CPI: Weighted combination of cost and schedule productivity rates experienced to date Used toward the end of the project.

Estimated Time to Complete (ETC). The time required to finish the project based upon the relationship between the value of the initial planned schedule and the value of the physical work performed, or SPI. ETC = Planned Completion / SPI.

Percent Complete. The ratio of the Earned Value to the budget at completion. % Complete = (BCWP / BAC) x 100.

Percent Planned. The ratio of the current plan to the budget at completion. % Planned = (BCWS / BAC) x 100.

Percent Spent. The ratio of the actual costs to the budget at completion. % Spent = (ACWP / BAC) x 100.

SPI. See Scheduled Performance Index.

Scheduled Performance Index (SPI). Represents the relationship between the value of the initial planned schedule and the value of the physical work performed, or Earned Value. SPI = BCWP / BCWS.

Schedule Variance (SV). The difference between Earned Value and the budget plan (BCWS). SV = BCWP - BCWS. Schedule variance in units of time is the difference between the BCP and BCWS on the time axis.

Schedule Variance Percent (SV%). The schedule variance as a percent of the performance baseline. SV% = (SV / BCWS) x 100.

To Complete Performance Index (TCPI). The ratio of the remaining Earned Value to the remaining costs expected. TCPI = (BAC - BCWP) / (BAC-ACWP).

Total Estimated Cost (TEC). The total estimated capital cost of the project. The TEC represents the total capital funds authorized for the project including contingency funds.

Variance at Completion (VAC). The budget at completion minus the estimate at completion. VAC = BAC - EAC.