MASTER

**COST & SCHEDULE
CONTROL SYSTEMS
CRITERIA FOR
CONTRACT
PERFORMANCE
MEASUREMENT**

**SUMMARY
DESCRIPTION**

**OFFICE OF
THE CONTROLLER
DEPARTMENT OF ENERGY**

AUGUST 1979

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FOREWORD

To accomplish DOE's energy system acquisition objectives in today's environment of limited budgets and tight schedules, we must rigorously pursue our efforts to improve program and project management of our outlay programs. In moving toward an improved DOE management capability, we have instituted a number of policy and procedural changes and will continue to investigate new ways and techniques to further improve the way we do business.

The application of standardized performance measurement requirements on selected contracts is a significant step toward achieving our goal in this area. Contractor compliance with our requirements for work definition, cost and schedule control, and performance reporting will provide increased assurance that a contractor's progress is sufficiently visible to reliably indicate status and to provide the basis for timely and meaningful management decisions. By using the Criteria approach described in this document to evaluate the integration and operation of contractors' management control systems, project status will be presented in terms of established cost and schedule objectives and will provide an accurate measure of project accomplishment.

This document, the first in a series of guides on this subject, provides an overview of the DOE Criteria approach for contract performance measurement. It has been prepared to assist both DOE and industry personnel in understanding and using the Criteria approach properly.

Jack E. Hobbs
Controller

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DOE COST AND SCHEDULE CONTROL SYSTEMS CRITERIA FOR CONTRACT PERFORMANCE MEASUREMENT

SUMMARY DESCRIPTION

This document summarizes the Cost and Schedule Control Systems Criteria (CSCSC) for DOE contract performance measurement. This Criteria approach was developed for use by designated projects on selected contracts. Readers are encouraged to submit recommendations concerning the requirements and this Summary Description to the Office of the Controller, Department of Energy, Washington, D.C., 20585.

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I. INTRODUCTION

A. Purpose

The purpose of this document is to provide an overview of the Cost and Schedule Control Systems Criteria (CSCSC), and their operation and application on selected contracts within DOE projects.

Detailed guidance for the implementation of these Criteria to specific contracts and for the review and acceptance of contractors' cost and schedule control systems for compliance therewith is contained in DOE/CR2250/2. Other guidance will be provided in the following areas:

- The duties and responsibilities of participants in systems review activities and in the continued government surveillance of contractors' systems,
- Contractor reporting of performance data to DOE and DOE analysis of these data, and
- The use of the Work Breakdown Structure technique.

B. The Criteria Approach

The importance and complexity of DOE's outlay programs require the use of project management techniques that promote effective planning, managing, and controlling of contracted work. To the extent to which DOE projects are being accomplished by contractors, DOE needs to ascertain the effectiveness of the cost and schedule control systems applied to this contracted effort. The Criteria approach is used to fill this need. This approach:

- Sets forth the characteristics and capabilities required of a contractor's cost and schedule control system, such as work definition, responsibility assignment, and cost and schedule controls,
- Requires the integration of work organization, planning and budgeting, accounting, analysis, and change incorporation, and
- Requires that a baseline be established and maintained for purposes of performance measurement and that such measurement be on the basis of earned value.

Normally, these requirements are inherent in contractors' management control systems. Under the Criteria approach, the DOE does not impose any specific systems and the contractor is allowed maximum flexibility in determining how internal operations are to be conducted. The result is the use of internal management control systems which satisfy the needs of both the contractor and DOE for contract performance information.

Figure 1 displays how the Criteria approach relates to the program management functions of planning, direction, and evaluation, and their interface with contract performance measurement. As can be seen in the figure, performance measurement is integral to proper direction of contractors. On selected contracts, performance measurement is enhanced by contractually applying the Cost and Schedule Control Systems Criteria. By Cost and Schedule Control Systems is meant the internal management control systems a contractor uses to manage the contract work and from which data is reported to both contractor and DOE management to facilitate review, analysis, projections, and management actions with regard to cost and schedule performance. Criteria refer to the uniform DOE standards that a contractor's management control systems must meet. These Criteria are delineated in Appendix 1. They do not prescribe specific methods or procedures; rather contractors are free to define work, organize, and use procedures best suited to their needs, environment, and management philosophy, subject only to meeting the Criteria. They are intended to ensure that contractors submit valid and uniform performance reports which permit data analysis to be performed by both the contractor and DOE using a common data base and analytical methods.

FIGURE 1
DOE MANAGEMENT FUNCTIONS/CONTRACT PERFORMANCE MEASUREMENT INTERFACE

The Criteria approach may be applied on contract in either a full or a modified version. The primary differences between the two versions is the degree of rigor which accompanies the contractor implementation and the DOE determination of compliance with the requirements. A comparison of important characteristics of full and modified Criteria implementation is provided in Figure 2.

II. CRITERIA APPLICATION

A. Activities Involved in Criteria Application

Successful contract performance measurement resulting from Criteria application requires DOE and contractor top management emphasis for the duration of the contract. Implementation must be based on common sense, which means being practical and keeping the overall need for contract performance measurement in its proper perspective. For example, DOE and the contractor should guard against requiring Work Breakdown Structures, operating procedures, reporting requirements, and thresholds for variance analysis which go beyond the minimum necessary for effective management.

The sequence of activities required for Criteria implementation is shown in Figure 3. The DOE Controller is the focal point for these activities. Since performance measurement spans the life of a contract, various DOE organizations are involved with applying the Criteria approach and with reviewing the contractor's implementation and subsequent system operation. Program Management, Project Management, and Field Offices have responsibilities over the entire contract period. Other DOE offices, such as Procurement and Contract Management, may participate in the various actions shown in Figure 3. Because the Criteria are primarily associated with direction of contractors, DOE Project Management will be the most active organization concerned. In some instances, DOE may request another agency, e.g., the Defense Contracts Audit Agency (DCAA), to perform a surveillance activity such as financial audit, if DOE resources are unavailable.

B. Application of Requirements

The DOE policy requires the Criteria approach (full or modified) to be implemented contractually on all new major system acquisition projects and on other projects as Assistant Secretaries or the Director of Energy Research may elect. The Criteria approach is sufficiently general in nature to permit its use by research, development, demonstration, construction, or production projects.

After a project is designated to use the Criteria approach, project planning and budgeting documentation is reviewed to identify the potential contracts to which the Criteria should be applied. Normally, the full Criteria implementation is used on high dollar contracts within major system acquisition projects and on critical subcontracts. Typically, contracts for major waste treatment facilities, pilot or demonstration plants or facilities, or major test facilities would be candidates for full Criteria implementation. The use of the modified Criteria approach is more appropriate for the one-contract-per-project type endeavor (e.g., component development such as steam generation) or for less risky prime contracts or subcontracts (e.g., definitive facility engineering) within projects. Thus, a major project would have either the full or modified version applied on a prime contract and on selected subcontracts, whereas a small project would have the modified version both on the prime contract and subcontracts. Identification of the contracts for Criteria implementation is made by the DOE Project Manager in coordination with the DOE Program Office. Each contract is individually evaluated, taking into consideration the following guidelines:

- Estimated Cost of the contract (over \$50 million-Full Criteria Implementation, \$2 to \$50 million – Modified Criteria Implementation)
- Contract duration (contracts with a duration of less than one year are normally not considered for Criteria application),

FULL IMPLEMENTATION	MODIFIED IMPLEMENTATION
Contractor develops a detailed work breakdown structure (WBS) (generally, four or more levels)	Contractor may develop a WBS at an aggregated work level with fewer levels of detail (generally, three or more levels)
Contractor maintains cost/schedule/baseline at detailed work level (e.g., WBS level 5)	Contractor may maintain cost/schedule/baseline at an aggregated work level (e.g., WBS level 3)
Contractor maintains integration between the WBS and the responsible organization to detail performing level	Contractor may provide for integration, between the WBS and the responsible organization at an aggregated work level
Contractor budgets work and classifies variances by element of cost	Extent of contractor work budgeting and variance classification by element of cost is negotiable
Contractor reports both WBS and functional information	Contractor may report WBS information only
Contractor measures earned value at detailed work level	Contractor may provide for measuring earned value at an aggregated work level
Formal in-depth review conducted to evaluate contractor's systems	Less formal, more flexible review conducted to evaluate contractor's systems
Contractor's systems evaluated using the DOE Cost and Schedule Control Systems Criteria Checklist	Contractor's systems evaluated using the DOE Cost and Schedule Control Systems Criteria Checklist, but tailored to specific contract circumstances
Contractor's systems awarded DOE Controller validation thereby permitting systems use on other DOE contracts as well	Contractor's systems are accepted for use on the specific contract by the DOE Project Manager
Contractor-proposed changes to validated systems submitted to DOE Project Manager for approval	Contractor notifies DOE Project Manager of changes to systems

FIGURE 2
COMPARISON OF FULL AND MODIFIED CRITERIA IMPLEMENTATION

ACTIVITY	RESPONSIBLE PARTICIPANT	
	DOE	CONTRACTOR
Projects Designated to Apply Criteria Approach on Contract	X	
Preliminary Project Summary Work Breakdown Structure (PSWBS) Developed	X	
Acquisition Strategy for Project Formulated	X	
Appropriate Contracts Selected for Full or Modified Criteria Implementation	X	
Criteria Implementation Requirements (Clauses, Reports, Reviews) Planned	X	
Criteria Requirements Specified in Solicitation	X	
System Description and Contract Work Breakdown Structure (CWBS) Submitted in Proposal		X
Proposals Evaluated	X	
Contract Awarded with Criteria Requirements in Contract including Subcontracts Identified for Criteria Implementation	X	
Implementation Activity Coordinated	X	X
Contractor's Management Control Systems Reviewed for Compliance with Contractual Requirements	X	
Discrepancies Identified During Review Corrected		X
Systems Acceptance Documented	X	
Systems Surveillance Performed	X	X
Systems Operated and Cost/Schedule Performance Reports Submitted		X
Performance Reports Analyzed and Results (Status Assessment, Trend Identification, and Forecasts) Used by Management	X	X

FIGURE 3
TYPICAL CRITERIA IMPLEMENTATION SEQUENCE OF ACTIVITIES

- National urgency of the project,
- Special problem areas or high risk known or expected to exist during the contract period,
- Recommendations by appropriate DOE management (Program Office Director, Assistant Secretaries, or the Director of Energy Research),
- Type of contract (firm-fixed price or fixed priced with escalation contracts are normally not considered for Criteria implementation).

C. Implementation of Requirements

1. General

After selection of contracts on which the Criteria will be implemented, the next phase of activity is initiated by including the appropriate requirements in the designated contracts. This action is accomplished by inclusion of pertinent clauses in the solicitation document and resulting contract. A sample Solicitation Clause is shown in Appendix 2. The clauses appropriate to the contract involved require the contractor to:

- Extend the Project Summary Work Breakdown Structure (PSWBS) to identify and structure the work effort and use the resulting Contract Work Breakdown Structure (CWBS) in performance of the contract,
- Establish and use management control systems in accordance with the stated requirements,
- Describe the management control systems to be used,
- Provide access to internal records and data,
- Apply the Criteria requirement to selected subcontractors, and
- Report performance in accordance with specified formats.

Contractors respond to the solicitation by describing how their internal management control systems meet the Criteria requirements. Implementation on an ongoing contract is by contractual agreement between DOE and the contractor. After contract award, the contractor's management control systems are reviewed by a team of DOE representatives to verify compliance with the contractual requirements. This ensures that the data generated by the contractor's system will depict actual conditions, contain information derived from the same data base as that used by the contractor's management, and contain clear comprehensive problem analyses including proposed corrective action.

2. Full Implementation

In full Criteria implementation, after the contractor demonstrates compliance with the contractual requirements, a formal review report is prepared to document in detail how the contractor's systems comply. This report is the basis for DOE validation of the contractor's management control systems. A certificate of validation is issued by the DOE Controller. The cognizant contracting officer officially notifies the contractor of the validation. After validation, the contractor is required to update systems documentation, as necessary, to maintain an accurate description of the systems. Any changes in the systems are forwarded for review and approval by the DOE Project Manager prior to incorporation. A Memorandum of Understanding, referencing the validated systems, may then be executed relative to application of the systems to other DOE contracts which may require compliance with the Criteria requirements. The contractor may then respond to solicitations for potential contracts with these requirements by citing the Memorandum of Understanding in his proposal.

3. Modified Implementation

In a successful modified Criteria implementation, the contractor is notified by letter through the routine contract administration process. A modified Criteria acceptance is for the specific contract only and the Memorandum of Understanding is not applicable. Any system operational changes require notification to the DOE Project Manager.

D. System Operation and Surveillance

Acceptance of a contractor's management control systems is not intended to inhibit subsequent innovations and improvements. However, contractors are contractually obligated to operate their systems so as to satisfy the Criteria requirements, including the reporting of performance data which can be traced and verified.

To provide assurance of continuing satisfactory operation of the systems, systems surveillance is conducted by both DOE and the contractor. Surveillance may be conducted by DOE project representatives through periodic visits to the contractor's facility or by agreements with appropriate Procurement Offices, Field Operations auditors, or DCAA. Contractor surveillance should be conducted systematically and documented appropriately. Contractors are encouraged to include appropriate references for systems surveillance in their internal audit procedures. Discrepancies identified by either party should be corrected in a timely fashion.

III. WORK BREAKDOWN STRUCTURE (WBS)

A. General Information

The initial step to effective implementation of the Criteria requires the identification and definition of the various tasks associated with the project. These efforts by DOE are then supplemented by the contractors engaged in the project. The WBS is the technique used to accomplish the project/contract objective of work definition. Its preparation plays a central role in successful Criteria implementation and project management.

A WBS is a product-oriented family tree composed of and depicting the hardware, services, and data required to produce the end product, e.g., a heat engine, an accelerator test facility, or a fossil fuel pilot plant. The WBS is structured in accordance with the way the work will be performed and reflects the way in which project costs and data will be summarized and eventually reported to DOE. Preparation of the WBS also considers other areas which require structured data, such as scheduling, configuration management, contract funding, technical performance parameters.

B. Project Summary WBS

The preparation of the Project Summary WBS (PSWBS), i.e., the WBS tailored for the project, begins with the identification of the major end product to be developed, demonstrated, or produced. This identification is normally obtained from the quantified objectives specified for the project effort, as identified from pertinent legislation or DOE documentation (e.g., a Project Plan). The highest level product is designated as PSWBS Level 1 and is generally the entire project. An example of a Level 1 element would be a Nuclear Reactor Plant Project. Level 2 WBS elements are major work segments of the project such as Nuclear Steam Supply System (NSSS) and Site and Buildings. For smaller projects, e.g., acquisition of a steam generator, Level 1 would be the steam generator, and Level 2 elements would be components such as superheater and evaporators.

Generally the project elements will be subdivided to the third level. However, the DOE Project Manager may choose to subdivide further with each successive lower level reducing the scope, complexity, and cost of the work involved.

C. Contract WBS

The preliminary PSWBS serves as the source for selection and application of appropriate WBS elements to various contracts to acquire the necessary product or service (e.g., system components, design engineering, and facility construction). The contractor, in turn, constructs the contract WBS (CWBS) by further dividing the PSWBS elements into manageable pieces of effort for which internal responsibility can be assigned. The CWBS usually is more detailed for a full Criteria implementation than for a modified Criteria implementation.

During proposal activities, contractors may propose alternatives to the selected PSWBS elements for the proposed contract in order to enhance the effectiveness of the CWBS in satisfying the objectives of the project. Changes proposed by the contractor to the selected PSWBS elements of the CWBS require approval of the DOE Project Manager. After necessary adjustments based on contractor's proposals and contract negotiations, the PSWBS elements selected for the contract become the basis for further evolutionary extension by the contractor during the contracted effort.

The contract indicates the CWBS levels at which cost and associated data reporting is made to DOE. Traceability of data is required to the CWBS level used by the contractor for performance measurement, i.e., the cost account level for Criteria purposes. Development of the CWBS, thus, is critical to effective performance measurement and considerable care needs to be exercised in its preparation.

D. CWBS/Organizational Structure Integration

Integration of the CWBS and organizational structure at the cost account level may be visualized as a matrix with the functional organizations listed on one axis and the applicable CWBS elements listed on the other axis. Each organization may then be clearly identified with the work for which it is responsible. Critical products (as determined by the prime contractor and DOE Project Manager) which are assigned to subcontractors must also be identified and should be treated as individual CWBS elements and cost accounts. Figure 4 illustrates this integration and further subdivision of effort, as well as other matters discussed in preceding paragraphs.

IV. COST AND SCHEDULE CONTROL SYSTEMS CRITERIA

The Criteria (Appendix 1) serve as DOE standards in evaluating the adequacy of a contractor's management control systems. The Criteria by themselves do not represent a management system nor do they prescribe specific methods of organization or operation. Contractors may organize in the manner best suited to their individual environments and management philosophies and use the internal methods and procedures of their choice. However, their internal systems must consider the CWBS, have the capabilities specified in the Criteria, and provide management data from a single source for both contractor and DOE use. The Criteria are grouped into five major categories: Organization, Planning and Budgeting, Accounting, Analysis, and Revisions and Access to Data. The content and requirements of these categories are summarized in the following paragraphs.

A. Organization

The Organization Criteria require that the contractor provide for clear definition and subdivision of the overall contractual effort, including major subcontractors, within the CWBS. Integration of the CWBS with the organizational structure is required in order to provide for assignment of responsibility of identified work tasks and to facilitate performance measurement. Additionally, integration of the planning, scheduling, budgeting, estimating, work authorizing, and data accumulating systems is directed to ensure an effective operational system.

B. Planning and Budgeting

All the contractually authorized work must be planned, scheduled, budgeted, and authorized by the contractor. Although no specific scheduling techniques are required by the Criteria, all authorized work must be formally scheduled in a manner which will permit the evaluation of actual progress against contract milestones and the contract master schedule must be clearly supported by lower-level schedules. Establishment of the contract performance measurement baseline is based on scheduled cost accounts and provides the key in properly planning and budgeting the contract effort. Cost accounts, because of their importance, are further discussed in paragraph F of this section.

FIGURE 4.

C. Accounting

The Accounting Criteria require that contract costs and performance measurement data elements be accumulated and summarized from the bottom up as directly as possible, without allocations. The contractor's system must be able to provide material price and usage variances, cost accumulation for materials on a basis consistent with the budgets, and full accountability for all contract materials ordered, received and used. Indirect costs must be controlled and procedures are required for identifying overhead to the incurring organizations.

D. Analysis

Comparisons of actual versus planned performance are required by the Analysis Criteria. Thresholds for variance analyses are established to avoid excessive contractor effort in analyzing every variance. Variances are examined in terms of increments or aggregations of work which are large enough to produce significant information. Estimates of contract final costs, based on performance to date and on estimates of future conditions must be developed.

E. Revisions and Access to Data

Contract changes authorized by DOE and those due to contractor internal replanning and formal reprogramming must be incorporated in a timely manner. Particular emphasis is placed on the need to retain a meaningful performance measurement baseline. Requirements include reconciliation of original budgets to current budgets and prohibition of retroactive changes to records. DOE is allowed access to contractor data for systems evaluations and surveillance.

F. The Cost Account

The cost account is an inherent and essential feature of the Criteria approach. It is the main action point for planning and control of contractual effort. In full Criteria implementations, the cost account is composed of work packages, i.e., detailed short-span jobs. In a modified Criteria implementation, the cost account may represent an aggregation of work, since the planning and controlling of the work may not warrant separate work packages.

To a great extent the effectiveness of system operation will depend on the discipline with which the procedures governing the systems operation are followed at the cost account level. At this level budgets, estimates, schedules, work assignments, costs, progress assessment (i.e., earned value), and problem identification initially come together and corrective actions are initiated. Most management actions taken at higher levels to solve significant problems are on an exception basis, based on problems identified at the cost account level. For these reasons, the CWBS and functional levels selected for establishment of cost accounts should be carefully considered at the outset of either full or modified Criteria implementation to ensure that the work will be defined properly into manageable units and that the functional responsibilities are clearly and reasonably established. The quality and amount of visibility available on contract performance relate directly to the level and makeup of the cost accounts.

V. CONTRACTOR REPORTING

A. DOE Information Requirements

A group of related reports are used in conjunction with contract performance measurement to satisfy DOE information requirements. A selection guide for these reports is shown in Figure 5. The contents of the reports are obtained from the same data base that supports day-to-day contractor management and that provides the means of reporting summary level cost, schedule, and funding data to DOE. For a DOE project these reports also serve as a basis for project status reporting to upper DOE management. The requirements for these reports are placed on contract by clause (separate from the clause requiring application of CSCSC) and in accordance with DOE Uniform Contractor

PLANS AND REPORTS	FORM NO.	RESEARCH SUPPORT OR TECHNICAL DEVELOPMENT		CONSTRUCTION OR DEMONSTRATION	
		\$2M-50M MODIFIED	OVER \$50M FULL	\$2M-50M MODIFIED	OVER \$50M FULL
BASELINE PLANS					
Management Plan	None	XO	XO	XO	XO
a. Management Control System Description	None	XC	XC	XC	XC
b. CWBS Dictionary	142A, 142B	XC	XC	XC	XC
Cost Plan	533P	XOYC	XOYC	XOYC	XOYC
Milestone Schedule and Status Report (Plan)	535	XOYC	XOYC	XOYC	XOYC
Manpower Plan	534P	XOYC	XOYC	XOYC	XOYC
STATUS REPORTS					
Cost Performance Report					
a. Format 1	144	M	M	M	M
b. Format 2	144A	A	M	A	M
c. Format 3	144B	A	M	A	M
Project Status Report	None	M	M	M	M
Cost Management Report	533M	M	M	M	M
Milestone Schedule and Status Report	535	M	M	M	M
Manpower Management Report	534M	M	M	M	M

Legend: A As required
C Contract Change
M Monthly
O Contract Award

Q Quarterly
S Semiannually
X With Proposal/Bid
Y Yearly or Upon Contract Renewal

FIGURE 5
REPORT SELECTION GUIDE

Reporting System Guidelines. These contain instructions regarding the level of detail and the frequency of reporting. Normally, contract reporting is at Level 3 of the CWBS. Although DOE relies on summarized data in these reports for contract management purposes, the detailed data available at the contractors may be requested for tracing a problem area to its source.

B. Performance Measurement Data Elements

For performance measurement purposes, a unique set of data elements is generated that the contractor uses internally for managing and externally for reporting to DOE. Figure 6 lists the data elements for earned value reporting, Figure 7 provides a graphical depiction of their relationship, and Figure 8 interprets their variances as discussed further in the following paragraphs.

Actual Cost of Work Performed (ACWP) consists of the direct and indirect costs applicable to the contract. The Budgeted Cost for Work Schedule (BCWS) is the time-phased budget plan (baseline) which represents the contract work plan. The Budgeted Cost for Work Performed (BCWP), the "earned value" or the "planned value of work accomplished", represents the value of work completed. A comparison of BCWS and BCWP indicates whether more or less work was done than was scheduled to be done. The difference represents the Schedule Variance in terms of dollars. Comparing BCWP with ACWP results in a Cost Variance that indicates whether the work that was actually performed cost more or less than it was planned to cost. Analyses of Cost and Schedule Variances enable the contractors to identify problems, to determine reasons for deviations from plans, to take corrective actions, and to report the results.

Based on performance to date and estimates of future conditions, an estimated cost at completion (EAC) is computed and compared to the total BCWS or budget at completion (BAC). At the contract level, total budget is usually equal to the contract value; therefore, the difference between BAC and EAC (At Completion Variance) may forecast a contract overrun or underrun.

BCWS and BCWP are determined at the cost account level in both full or modified Criteria implementation. In full Criteria implementation, the status of the work package budgets that compose the cost account are determined to obtain BCWS and BCWP. In modified Criteria implementations, the budgets assigned at the cost account level may be used to obtain BCWS and BCWP.

ACWP, under both full and modified Criteria implementations, is collected through the contractor's cost accounting system and accumulated to the cost account level. Thus, all the performance measurement data elements are available at the cost account level. This information can be used directly by the contractor's lower-level managers and summarized for higher levels of contract management and for reporting to DOE.

The reporting system is structured so that traceability is maintained, i.e., summary data can be traced to their detail, variances to their source.

C. Technical Achievement

A key to effective cost/schedule control is correlation of technical achievement with accomplishment of the work effort. If the PSWBS and associated CWBSs properly define the project and contract tasks, correlation of cost, schedule, and technical performance is greatly simplified. Since unfavorable cost or schedule variances are usually caused by technical difficulties, the quantitative information in the contractors' cost and schedule reports should be supplemented by narrative to explain the technical problem and its impact.

As work on a contract progresses, the contractor determines the adequacy and quality of the work performed by inspections, tests, or other types of technical measurements. If the results are satisfactory and no corrective action is required, the work is allowed to proceed further. If, on the other hand, deficiencies are found, the contractor considers various alternatives for corrective action, e.g., redesign or rework. When considering these alternatives,

ELEMENT DESCRIPTION	CRITERIA TERM	ACRONYM
WORK PLANNED	BUDGETED COST FOR WORK SCHEDULED	BCWS
WORK ACCOMPLISHED (EARNED VALUE)	BUDGETED COST FOR WORK PERFORMED	BCWP
COST OF WORK ACCOMPLISHED	ACTUAL COST OF WORK PERFORMED	ACWP
WORK AUTHORIZED	BUDGETED COST AT COMPLETION	BAC
ESTIMATE OF FINAL CONTRACT COST (LATEST REVISED ESTIMATE)	ESTIMATED COST AT COMPLETION	EAC
COST DIFFERENCE	COST VARIANCE (BCWP MINUS ACWP)	CV
SCHEDULE DIFFERENCE	SCHEDULE VARIANCE (BCWP MINUS BCWS)	SV
COST AT COMPLETION DIFFERENCE	AT COMPLETION VARIANCE (BAC MINUS EAC)	ACV

FIGURE 6
EARNED VALUE DATA ELEMENTS

FIGURE 7
EARNED VALUE DATA ELEMENTS RELATIONSHIPS

A. INTERPRETATION OF COST AND SCHEDULE VARIANCES						
BCWS	BCWP	ACWP	COST VARIANCE	SCHEDULE VARIANCE	DESCRIPTION	
\$1	\$1	\$1	\$0	\$0	On Schedule	On Cost
\$2	\$2	\$1	\$1	\$0	On Schedule	Under Cost
\$1	\$1	\$2	(\$1)	\$0	On Schedule	Over Cost
\$1	\$2	\$2	\$0	\$1	Ahead of Schedule	On Cost
\$1	\$2	\$3	(\$1)	\$1	Ahead of Schedule	Over Cost
\$1	\$2	\$1	\$1	\$1	Ahead of Schedule	Under Cost
\$3	\$2	\$1	\$1	(\$1)	Behind Schedule	Under Cost
\$2	\$1	\$3	(\$2)	(\$1)	Behind Schedule	Over Cost
\$2	\$1	\$1	\$0	(\$1)	Behind Schedule	On Cost

Cost Variance = BCWP - ACWP
Schedule Variance = BCWP - BCWS

B. INTERPRETATION OF AT COMPLETION VARIANCES			
BAC	EAC	AT COMPLETION VARIANCE	DESCRIPTION
\$1	\$1	\$0	Forecast On Cost
\$2	\$1	\$1	Forecast Under Cost
\$1	\$2	(\$1)	Forecast Over Cost

At Completion Variance = BAC - EAC

FIGURE 8
EARNED VALUE DATA ELEMENTS INTERPRETATION

the impact on cost and schedule must be weighed in addition to the technical considerations. After one of the alternatives is selected as the desired course of action to correct the deficiencies, it becomes necessary to replan and accomplish the additional work. The contractor may or may not choose to provide more budget for this additional work to the responsible organization. In either case, the performance measurement reports will document the budget change or the increasing variances. Thus, there is a close relationship between technical achievement and its impact on cost and schedule.

D. Data Analysis

Performance measurement data analysis is a dual responsibility of the contractor and DOE. The contractor performs this function for internal management needs and for preparation of the external reports to DOE. Contract data analysis is initiated at the cost account level by the appropriate manager. Cost, schedule, and at completion, variances that exceed previous established thresholds require review and analysis to determine the cause, to evaluate options to resolve the situation, and to report actions to higher-level management. These internal data and their analyses are used by the contractor to:

- Communicate contract status among all levels of internal management through a variety of reports (e.g., status by WBS, function, cost account, etc.) designed to serve individual manager needs,
- Serve as the basis for corrective action,
- Report contract performance to the DOE Project Manager, and
- Provide inputs for formal contract status meetings.

The DOE Project Manager has ready access to various formal and informal sources of information relative to a contract, including regular contact with contractor personnel. Although this assists in timely awareness of individual problems, it does not always contribute toward documenting or quantifying their overall impact. The contractor-furnished performance reports fulfill this need. They present systematically summarized information in a manner designed to assist overall assessment of contract status. These reports require additional processing by DOE project personnel to facilitate their use and understanding and to extract their full benefit. The use of various analytical techniques will assist both the contractor and DOE in:

- Determining the current contract cost and schedule performance status,
- Highlighting areas requiring more detailed data,
- Identifying deviations and trends, and
- Forecasting, verifying, or questioning future work status.

The proper collection, analysis, and use of contract performance data are major ingredients in successful performance measurement. The importance of making effective use of the data by the contractor and DOE cannot be overemphasized.

VI. IMPLEMENTATION CONSIDERATIONS

Certain undesirable practices pose potential problems in the contractor's proper implementation of the DOE Criteria approach to contract performance measurement. The contractor's management control system must be reviewed to ensure that the following do not exist:

- Improper planning,
- Undisciplined budgeting practices,
- Poor forecasting, and
- Inadequate procedures.

Of these potential problem areas, improper planning causes the most difficulty in measuring performance. Where the entire contractual effort has not been identified and defined, and a performance measurement baseline established, the problem of ascertaining total contract status is very difficult. Under such circumstances, it is particularly difficult to determine whether more budget has been consumed than should have been for the work that has been performed.

Internal budgeting practices which permit budgets to be shifted from one piece of work to another or from one organization to another frequently result in performance measurement distortions which may render the system useless. The practice of adding budget to a task whenever it becomes obvious that the actual costs will exceed the existing budget tends to negate the earned value concept. This concept relies on variances from plan to pinpoint problems and to reflect cost and schedule performance. Establishment and maintenance of a valid performance measurement baseline, which is representative of planned contract accomplishment, is the most basic requirement. This also requires that contract changes be incorporated in a timely manner. Authorized, unpriced work must be planned and controlled with the same discipline accorded definitized effort. Any undisciplined changes to internal budgets undermine the measurement process and result in misleading performance reporting within the contractor's organization and to DOE.

Poor development of contract estimates of final cost results in poor contract status reporting. The ground rules, frequency, and individual responsibilities for preparing estimates at completion must be defined to ensure their reliability and timeliness. Otherwise, management decision-making by both the contractor and DOE managers is jeopardized by the unrealistic estimates.

Inadequate procedures will hinder system discipline and aggravate problems associated with overall system operation. Proper system discipline requires operating procedures that describe the system accurately and that are understood and complied with by the contractor's personnel. All concerned participants, particularly contractor management at the performing level, will benefit from clear procedures that define and govern systems operation.

VII. IMPLEMENTATION BENEFITS

A. DOE

A number of benefits are derived by DOE Project Management from contract performance measurement using the Criteria approach. As a result of the contractor review process, DOE representatives gain a good working knowledge of contractor organization, operations, work definition, procedures, and system terminology. Additionally, the reporting leads to better communications with the contractor and greater confidence in contractor-generated contract information.

Reporting of variance analyses highlights contract problem areas. The capability to trace these problems to their source facilitates their early analysis and correction. Additionally, the data available in the performance reports lend themselves readily to forecasting future performance. The extrapolation of past and present performance trends to predict future performance is an important and practical analysis tool.

Analysis of schedule conditions in terms of cost impact is a valuable management control tool. Correlating schedule variances with the outputs of the formal scheduling system permits a cross-check on the validity of the budgeted cost for work performed and the associated cost variance.

Perhaps the most important benefit, from DOE's point of view, is that contract performance is being measured against a formal, contract-related baseline rather than against a contractor's internal operating plan, which may represent something other than the contractual commitment. Finally, contractual implementation of the Criteria approach, integrated by DOE with other management controls in the technical, financial, and procurement areas, will enhance the overall management of the project.

B. Contractor Management

Contractors also benefit from implementing management control systems containing an earned value feature for performance measurement. Major benefits usually experienced by contractors are:

- Improved operational discipline,
- Integration of budget and schedule plans and performance,
- Added dimension of earned value,
- Improved planning,
- Better communication internally and with the customer,
- More detailed and earlier project visibility, and
- Increased cost and schedule awareness at all levels, particularly at the lower management levels.

VIII. CONCLUSION

Implementation of the Criteria approach is a worthy goal for project and contractor management. It provides needed management flexibility to contractors in meeting the requirements and encourages their refinements and innovations to operational systems. Successful and expeditious implementation promotes effective project/contract management and enhances communication among project participants by use of standard terminology to report contract and project performance.

APPENDIX 1

COST AND SCHEDULE CONTROL SYSTEMS CRITERIA

1. General

a. The management control systems used by the contractor in planning and controlling the performance of the contract shall meet the Criteria set forth in paragraph 2 below. Nothing in these Criteria is intended to affect the basis on which costs are reimbursed and progress payments are made, and nothing therein will be construed as requiring the use of any single system, or specific method of management control or evaluation of performance. The contractor's systems need not be changed, provided they satisfy the DOE Criteria.

b. An element in the evaluation of proposals will be the proposer's systems for planning and controlling contract performance. The proposer will fully describe the system to be used. The prospective contractor's cost and schedule control system proposal will be evaluated to determine whether it meets the DOE Criteria. The prospective contractor will agree to operate compliant systems throughout the period of contract performance if awarded the contract. DOE will rely on the contractor's compliant systems and therefore will not impose separate management control systems.

2. The Criteria

The contractor's management control systems will include policies, procedures, and methods which are designed to ensure that they will accomplish the following:

a. Organization

(1) Define all authorized work and related resources to meet the requirements of the contract, using the framework of the Contract Work Breakdown Structure.

(2) Identify the internal organizational elements and the major subcontractors responsible for accomplishing the authorized work.

(3) Provide for integration of the contractor's planning, scheduling, budgeting, estimating, work authorization, and cost accumulation systems with each other, the Contract Work Breakdown Structure and the organizational structure.

(4) Identify the managerial positions responsible for controlling overhead (indirect costs).

(5) Provide for integration of the Contract Work Breakdown Structure with the contractor's functional organizational structure in a manner that permits cost and schedule performance measurement for Contract Work Breakdown Structure and organizational elements.

b. Planning and Budgeting

(1) Schedule the authorized work in a manner which describes the sequence of work and identifies the significant task inter-dependencies required to meet the development, production, construction, installation and delivery requirements of the contract.

(2) Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure output.

(3) Establish and maintain a time-phased budget baseline at the cost account level against which contract performance can be measured. Initial budgets established for this purpose will be based on the negotiated target cost. Any other account used for performance measurement purposes must be formally recognized by both the contractor and the Government.

(4) Establish budgets for all authorized work with separate identification of cost elements (labor, material, etc.).

(5) To the extent the authorized work can be identified in discrete, short-span work packages, establish budgets for this work in terms of dollars, hours, or other measurable units. Where the entire cost account

cannot be subdivided into detailed work packages, identify the far term effort in larger planning packages for budget and scheduling purposes.

(6) Provide that the sum of all work package budgets plus planning package budgets within a cost account equals the cost account budget.

(7) Identify relationships of budgets or standards in underlying work authorization systems to budgets for work packages.

(8) Identify and control level of effort activity by time-phased budgets established for this purpose. Only that effort which cannot be identified as discrete, short-span work packages or as apportioned effort will be classed as level of effort.

(9) Establish overhead budgets for the total costs of each significant organizational component whose expenses will become indirect costs. Reflect in the contract budgets at the appropriate level the amounts in overhead pools that will be allocated to the contract as indirect costs.

(10) Identify management reserve and undistributed budget.

(11) Provide that the contract target cost plus estimated cost of authorized but unpriced work is reconciled with the sum of all internal contract budgets and management reserve.

c. Accounting

(1) Record direct costs on an applied or other acceptable basis in a formal system that is controlled by the general books of account.

(2) Summarize direct costs from cost accounts into the Work Breakdown Structure without allocation of a single cost account to two or more Work Breakdown Structure elements.

(3) Summarize direct costs from the cost accounts into the contractor's functional organizational elements without allocation of a single cost account to two or more organizational elements.

(4) Record all indirect costs which will be allocated to the contract.

(5) Identify the bases for allocating the cost of apportioned effort.

(6) Identify unit costs, equivalent unit costs, or lot costs as applicable.

(7) The contractor's material accounting system will provide for:

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

(b) Determination of price variances by comparing planned versus actual commitments.

(c) Cost performance measurement at the point in time most suitable for the category of material involved, but no earlier than the time of actual receipt of material.

(d) Determination of cost variances attributable to the excess usage of material.

(e) Determination of unit or lot costs when applicable.

(f) Full accountability for all material purchased for the contract, including the residual inventory.

d. Analysis

(1) Identify at the cost account level on a monthly basis using data from, or reconcilable with, the accounting and budgeting systems:

(a) Budgeted cost for work scheduled and budgeted cost for work performed.

(b) Budgeted cost for work performed and applied (actual where appropriate) direct costs for the same work.

(c) Estimates at completion and budgets at completion.

(d) Variances resulting from the above comparisons classified in terms of labor, material, or other appropriate elements together with the reasons for significant variances, including technical problems.

(2) Identify on a monthly basis, in the detail needed by management for effective control, budgeted indirect costs, actual indirect costs, and variances along with the reasons.

(3) Summarize the data elements and associated variances listed in paragraph 2d (1) and (2) above through the contractor organization and Contract Work Breakdown Structure to the reporting level specified in the contract.

- (4) Identify significant differences on a monthly basis between planned and actual schedule accomplishment together with the reasons.
- (5) Identify managerial actions taken as a result of paragraph 2d (1) through (4) above.
- (6) Based on performance to date and on estimates of future conditions, develop revised estimates of cost at completion for Work Breakdown Structure elements identified in the contract and compare these with the contract budget base and the latest statement of funds requirements reported to the Government.

e. Revisions and Access to Data

- (1) Incorporate contractual changes in a timely manner recording the effects of such changes in budgets and schedules. In the directed effort before negotiation of a change, base such revisions on the amount estimated and budgeted to the functional organizations.
- (2) Reconcile original budgets for those elements of the Work Breakdown Structure identified as priced line items in the contract, and for those elements at the lowest level of the Project Summary Work Breakdown Structure, with current performance measurement budgets in terms of changes to the authorized work and internal replanning in the detail needed by management for effective control.
- (3) Prohibit retroactive changes to records pertaining to work performed that will change previously reported amounts for direct costs, indirect costs, or budgets, except for correction of errors and routine accounting adjustments.
- (4) Prevent revisions to the contract budget base except for Government directed changes to contractual effort.
- (5) Document, internally, changes to the performance measurement baseline and, on a timely basis, notify the Government project management through prescribed procedures.
- (6) Provide the Contracting Officer and his duly authorized representatives access to all of the foregoing information and supporting documents.

APPENDIX 2
SAMPLE
CSCSC SOLICITATION CLAUSE

NOTICE OF COST AND SCHEDULE CONTROL SYSTEMS

(a) The offeror shall submit a plan for compliance with the Criteria for the internal cost and schedule control systems (management control systems) which are and/or will be operational for any contract resulting from this solicitation which includes the Cost and Schedule Control Systems Contract Clause. The Criteria for contractors' cost and schedule control systems are set forth in DOE/CR-2250/2, Contract Performance Measurement Implementation Guide. The offeror shall identify his existing management control systems separately from proposed modifications to meet the Criteria. The plan shall:

(i) describe the management control systems and their application in all major functional cost areas such as engineering, manufacturing, construction, etc., including their relationships to the Contract Work Break-down Structure (CWBS);

(ii) describe the procedures for planning, budgeting, scheduling, work authorization, cost accumulation, measurement and reporting of cost and schedule performance, estimating of costs at completion, variance analyses, and baseline control, including their relationships to the major functional cost areas and the CWBS;

(iii) describe compliance with each of the Criteria*, preferably by cross-referencing the description of the management control systems with the items in the Criteria Checklist contained in DOE/CR-2250/2.

(iv) identify the major subcontractors or major subcontracted effort in the event major subcontractors have not been selected, to whose management systems the Criteria will be applied;

(v) describe the proposed procedures for administration of the Criteria when applied to subcontractors.

(b) If the contractor is utilizing management control systems which have been previously accepted by the Department of Energy (DOE) or by the Department of Defense, or is operating such systems under a current Memorandum of Understanding with DOE, or the Department of Defense, evidence of such may be submitted in lieu of the plan mentioned above. In such an event, the Contracting Officer will determine the extent to which such systems shall be reviewed to assure continued compliance with the Criteria.

(c) The offeror shall provide information and assistance as requested by the Contracting Officer for evaluation of compliance with the cited Criteria.

(d) The offeror's plan for compliance with the Criteria for cost and schedule control systems will be evaluated prior to contract award. Upon validation or acceptance of the cost and schedule control systems, a description of these systems will be referenced in the contract. Subsequent changes to validated systems will require prior approval of the Contracting Officer. Subsequent changes to accepted systems will require notification to the Contracting Officer.

(e) Subcontractor selection for application of the Criteria will be by agreement between the prime contractor and the Government. The prime contractor will contractually require the selected subcontractors to comply with the Criteria. However, demonstration and reviews of these selected subcontractors' management systems may be performed by DOE when requested by either the prime or subcontractor.

(f) Changes to contractor management control systems required to meet the cited Criteria shall be made at no direct cost to DOE.

*Note: DOE will identify any Criteria and/or Criteria checklist items which may be waived.