Cost/Schedule Control Criteria for Selected Government Contracts

1974

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COST/SCHEDULE CONTROL CRITERIA
FOR SELECTED GOVERNMENT CONTRACTS

BY

ROBERT McDOWELL HAMMOND
B.S.M.E., Auburn University, 1959

RESEARCH REPORT
Submitted in partial fulfillment of the requirements for the degree of Master of Science in Engineering in the Graduate Studies Program of Florida Technological University

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ABSTRACT
COST/SCHEDULE CONTROL CRITERIA
FOR SELECTED GOVERNMENT CONTRACTS
BY
ROBERT McDOWELL HAMMOND

This report presents and interprets the Cost/Schedule Control System Criteria, management techniques which have been determined by the Department of Defense to represent appropriate methods for adequately controlling program costs and schedules. Applied to selected contracts of significantly large dollar value, these standards provide for a system which affords the contractor the ability for effective program management and the customer sufficient output visibility for proper program progress evaluation.

These criteria differ from typical management methods in that they include a means for assessing the value of completed work in terms of its planned cost. Comparing this with the planned cost of work scheduled for the same period, and actual costs, results in a quantitative development of cost and schedule variances.

Approved: M.F. [Signature]
Director of Research Report
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>II. ORGANIZATION</td>
<td>7</td>
</tr>
<tr>
<td>III. PLANNING AND BUDGETING</td>
<td>13</td>
</tr>
<tr>
<td>IV. ACCOUNTING</td>
<td>23</td>
</tr>
<tr>
<td>V. ANALYSIS</td>
<td>26</td>
</tr>
<tr>
<td>VI. REVISIONS AND ACCESS TO DATA</td>
<td>37</td>
</tr>
<tr>
<td>VII. SUBCONTRACTORS</td>
<td>42</td>
</tr>
<tr>
<td>VIII. SUMMARY AND CONCLUSIONS</td>
<td>44</td>
</tr>
<tr>
<td>APPENDIXES</td>
<td>50</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>61</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

"This regulation ... requires the application of the Cost/Schedule Control System Criteria (C/SCSC) ... to selected acquisitions. The purpose of this application is to insure that the contractor's internal management control systems have the capability to plan and control contract performance."\(^1\)

Until recent years, both the military and industry were so caught up in pushing the frontiers of technology performance that they neglected to focus adequately on program cost and schedule objectives and constraints. Frequently overruns surfaced too late in the program to allow any alternatives beyond pouring in more funds. Many programs had to be cancelled.

Government regulations specify that the success of a program is a function not only of the ability of acquiring a system that meets desired technical performance objectives within a reasonable acquisition time, but also of acquiring the system within planned budgets. Extreme care must be exercised to ensure that meaningful cost

control over the acquisition process is maintained.

DOD Directive 3200.9, dated July 1, 1965, established broad Department of Defense policies governing concept formulation and contract definition in the initiation of engineering development and operational systems development of major projects. These projects were defined to include all new (or major modifications of existing) engineering developments and operational systems developments estimated to require RDT & E financing in excess of 25 million dollars or estimated to require a total production investment in excess of 100 million dollars, unless specifically excluded, in writing by the Director of Defense Research and Engineering. These policies included the establishment of schedules and cost estimates for project performance.

The Department of the Air Force issued Air Force Regulation (AFR) 80-20 July 24, 1967, in which they defined the applicability, scope and policy as regards the implementation of DOD Directive 3200.9. While primarily oriented towards the initiation of major projects in engineering and operational systems development, the provisions of the regulation could also be used in selected advanced development projects.

DOD Instruction 7000.2 was published by the government on December 22, 1967 to provide more specific ground rules for performance measurement for selected acquisi-
tions. It set forth objectives and criteria and authorized the publication of a guide for application of uniform DOD requirements for contractor's management control systems to selected defense contracts. The provisions of this instruction require the use of Cost/Schedule Control System Criteria (C/SCSC) in selected acquisitions and apply to all military departments and defense agencies which are responsible for acquisitions during engineering development, operational systems development, and production.

DOD Directive 5000.1 states that, to the maximum extent feasible, contractor management control systems will be the source of management information for both contractor and DOD management of major acquisition contracts and that the DOD will require contractors to make changes in their internal control systems only to the extent necessary to comply with standard DOD requirements.

The Department of the Air Force published AFSCM 70-5 on February 1, 1968. It consisted of the task definition of what was then called the Cost/Schedule Planning and Control System (C/SPCS) which included cost/schedule relationship requirements which satisfied the requirements of AFR 80-20 (DOD Directive 3200.9). It required the contractor to define the work required to meet the contract objectives, assign work to specifically
identified organizational elements, establish internal schedules and budgets, and periodically compare actual cost/schedule performance against the planned budgets and schedules.

On June 22, 1969 the Department of the Air Force published AF Regulation 375-7 entitled "Performance Management for Selected Acquisitions" by which they formally implemented DOD Instruction 7000.2 and formally established the guidelines for complying with it as the Cost/Schedule Control System Criteria (C/SCSC).

On July 7, 1969, the Department of the Air Force published the cost analysis portion of the Cost/Schedule Control Systems Criteria (Implementation Guide) to provide the guidance necessary to assure uniform application of the C/SCSC as contained in AFR 375-7. It reflected experience gained through field testing of systems designed to meet previously existing criteria.

The Departments of the Air Force, the Army, and the Navy jointly published, on March 31, 1972, the "Cost/Schedule Control Systems Criteria Joint Implementation Guide" (AFSCP/AFLCP 173-5, AMCP 37-5, NAVMAT P5 240) which provided procedures which have been approved by AFSC/AFCC/AMC/NMC, commanders for use during planning and implementation of Cost/Schedule Control Systems Criteria and for surveillance of contractor compliances.
In the years since the initial C/SPCS criteria were being applied to project cost and schedule control, the Air Force has led the way in system development and refinement. Increasing numbers of contractor internal management systems are being modified to comply with the existing criteria. As of mid-1973, the Department of the Air Force, alone or jointly with other military agencies, had validated over forty contractor/project management systems.

This report will present and explain the resulting C/SCS criteria as they relate to the following areas of contract performance:

- Organization of the contractor's management/functional area responsibilities with respect to the Work Breakdown Structure developed for the contract.

- Effective planning and scheduling of the contract task requirements and the proper distribution of budgets to the identified tasks.

- Requirements of the contractor's system for accounting for contract costs incurred.

- Analysis of management information system output data necessary for proper cost and schedule evaluation.

- Contract changes, replanning, output data adjustments and proper access to contract performance.
information.

- Subcontractor effort planning and control. In addition to being explained in the body of the text, the major criteria have been summarized, along with a listing of appropriate terminology definitions, in the appendix of the report.

It is felt that establishing a viable C/SC system will require a well structured system organization to provide the foundation for program planning and budgeting, accounting, analysis and all other activities which are necessary for proper program control.
CHAPTER II

ORGANIZATION

The Cost/Schedule Control Systems Criteria do not represent a management system nor do they present specific methods of organization or operation. The criteria are intended to serve as standards for measuring the adequacy of management control systems. Contractors are free to organize in the best manner suited to their individual environments and management philosophies and may select the internal methods and procedures of their choice. However, these methods and procedures must result in a system which provides the data and capabilities specified in the criteria in order to be considered acceptable to the Department of Defense.

These criteria require that the contractor's system provide for clear definition of the overall contractual effort with a work breakdown structure serving as a framework for displaying subdivisions of effort. Integration of the work breakdown structure with the functional organization structure is required in order to provide for assignment of responsibility for identified work tasks.
A WBS is a family-tree subdivision of products, components, work tasks and services rendered to achieve a desired goal or produce an end product. For performance measurement purposes, it is desirable that the WBS be structured in accordance with the way work is actually going to be performed. MIL-STD-881, "Work Breakdown Structure for Defense Materiel Items", is the document which provides guidance for the WBS development.

The top three (summary) levels of the WBS are included in the contract and provide a useful structure for contract reporting. The contractor extends the WBS in any manner he chooses in an effort to divide the contractual work into managable pieces of effort for which internal responsibility can be assigned. Figure 1 depicts a partial WBS of an aircraft system contract, showing the three levels of the contract WBS and a part of the contractor's extension of the task requirements.

The WBS provides a formal method for identifying and defining the contractual effort breakdown. It is required that any significant participation by a subcontractor be also included in the overall WBS development. The contractor's organizational structure is also a formal structure but reflects the manner in which the contractor has organized the people who will be doing the work. Integration of the organizational structure with the WBS is necessary in order to assign functional responsibility for the tasks to be performed. The
Figure 1 -- TYPICAL WORK BREAKDOWN STRUCTURE

(A continuation as desired by contractor)
effort identified by the integration of the two structures can be a valuable management control point in the contractor's system.

The contractor's organizational structure can be both program and functionally oriented. The program organization structure reflects the assignment of people who are responsible for program tasks. The tasks are as defined by the WBS organization. A fully-staffed program organization provides for responsibility assignments at all levels, as necessary, throughout the WBS. As indicated, the program organization is principally concerned with the detailed definition and management of contract work as planned within the framework of the WBS.

Expansion of the detail WBS into functional department responsibilities further defines the tasks to be accomplished by the performing organizations. The functional organization is further subdivided to the level where specific tasks are managed and work performed. The assignment of the functional disciplines to work at each lower level WBS element provides the key intersection of work and responsibility for management control.

In addition to providing the basis for contract task subdivisions and identifying contractor responsibility assignments, the WBS provides the framework for contract cost and schedule subdivisions. Target costs
and schedules are made up of design/development and deliverable hardware, as well as software elements of work needed to achieve contract objectives. The work requirements and limits identified in the WBS must be apportioned down to the lower levels exactly in the same manner as any other engineering performance parameter. This is to say that each major design group and other contributing organizations should be assigned both a cost and schedule target for their particular elements of the tasks, and that performance be measured against these targets. The stipulation made by the Cost/Schedule Control System Criteria is that there must be a formally structured cost and schedule technique to control dollar and time resources and that the technique must be directly relatable to the basic engineering effort.

In addition to tying all direct contract requirements and the contractor's organizational structure together by means of the Work Breakdown Structure, an acceptably structured contractor C/SCS organization identifies the managerial positions responsible for controlling overhead (indirect costs). Additionally, those items comprising the contractor's overhead and the methods by which it is to be allocated to the contracts must be clearly identified. While it will be shown the C/SCSC specify some general requirements related to overhead control and accountability, they leave the task of
indirect cost monitoring as a separate function for some other authority (the DCAA, for instance).
CHAPTER III

PLANNING AND BUDGETING

Planning is the identification, in successively more detailed stages, of the program task and schedule requirements for successful accomplishment of contract objectives. The establishment and maintenance of a meaningful plan against which to measure actual performance is fundamental to the effectiveness of any management control system. Such a plan must be established at a low enough level within the contractor's management structure to provide effective control over the effort, yet not so low as to deprive managers of the flexibility needed to apply and use available resources in an effective manner. In C/SCSC vernacular, this plan is often referred to as the "performance measurement baseline", or simply "baseline".

The organization criteria established the basic framework for defining and organizing the work to be performed. This was implemented through the use of the WBS. The assignment of budgets to scheduled segments of work produces a time-phased plan against which actual performance can be compared. The establishment, maintenance and use of this plan are extremely important aspects of
performance measurement. The thoroughness and discipline inherent in good planning do not mean that the system must be totally inflexible. Changes, however, must be rigorously controlled.

The scheduling system should provide for all specified work to the lowest level element defined in the WBS in a way compatible with contract milestones and meaningful in terms of technical requirements of the contract. The schedules should identify key milestones and activities which recognize significant constraints and relationships. The scheduling system should contain summary or master schedules which provide for all the contractually specified milestones. The summary schedules should be clearly supported by lower level schedules which link the summary to the detailed tasks.

Once the detailed elements comprising the contract sub-definition are established, the overall program scheduling can be accomplished. The C/SCSC do not require contractors to use any specific scheduling technique. PERT, Line-of-balance, Gantt, milestone charts are all good techniques which are effective when properly employed. C/SCSC scheduling requirements basically seek formality, consistency and discipline throughout the scheduling system regardless of the technique used. All authorized work must be scheduled in a manner which will permit the evaluation of actual progress against the
control milestones and which will identify interdependencies of individual tasks.

Work packages are the basic building blocks used for detailed planning, assignment and control of contract performance. A work package is simply a type of lower level job which must be performed. It comprises the work to be performed by a specified organizational element responsible for its accomplishment and serves as a vehicle for monitoring and reporting progress of work. "Work Package" is the generic term used in the criteria to identify discrete tasks which have definable end results. In order to be effective for planning and controlling work, work packages should have the following characteristics:

- It represents units of work at levels where work is performed.
- It is clearly distinguished from all other work packages.
- It is assignable to a single organizational element.
- It has scheduled start and completion dates which are representative of physical accomplishment.
- It has a budget or assigned value expressed in terms of dollars, man-hours, or other measurable units.
- Its size and duration are limited to relatively short spans of time to minimize the work-in-process effort.
- It is integrated with detailed engineering, manufacturing or other schedules.
All work packages are not planned at the beginning of the program. This is because the complete WBS, particularly at the most detailed levels, does not automatically emerge at the beginning of the program. However, the criteria indicates that work packages, to the extent possible, should be planned at least six months in advance. Consequently, the contractor is constructing an on-going plan against which to measure accomplishment. A "rolling wave" concept may be used to overcome this problem. Under this concept, the criteria permits work to be planned in finite but sizeable increments at the outset of a contract. These planning increments, or planning packages, form the basis for work authorization, budgeting, and master scheduling. As the contract work is defined and planned in more detail, work packages suitable for job assignment evolve naturally.

All efforts at the lowest level of WBS task identification are not adaptable to the work package requirement characteristics. These other types of activity are called Level-of-Effort (LOE) and apportioned tasks.\(^2\) While work packages are discrete and accomplishment can be measured based on the completed pieces of work, LOE tasks are normally measured through the passage of time. An example of an LOE task could be that effort necessary

\(^2\)For ease of discussion, unless specifically indicated, the term "work package" will conform to general usage and be applied to include both LOE and apportioned tasks.
to process drawing changes required to improve producibility, recognized at the time of parts manufacture. This type of work, which is basically undefinable in terms of stop and start events, will vary in amount between functional organizations, but should be held to the lowest practical minimum. The criteria do not establish guidelines as to how much effort is acceptable, but require that only work which cannot be work packaged or apportioned be designated as LOE.

Apportioned effort may be discrete or similar to LOE but differs in that the activity is dependent on, or related in direct proportion, to the performance of other effort. An example of apportioned effort could be the inspection associated with the assembly of a turbine stage. As the assembly progresses, the inspection can be presumed to progress in direct relation to the degree of assembly completed. Apportioned effort may be included as a part of the work package to which it relates or may be established separately but associated with the basic work package. Apportioned effort should be held to a minimum since it, like LOE, is more subjective than measured effort.

The cost account is a categorization and combination of tasks ordinarily established at the lowest level in the WBS at which costs are recorded and compared with budgeted costs (i.e., the work package level). It is a
natural control point for cost and schedule planning and control, formed by the intersection of the organizational structure and the WBS. These should include all direct costs for the authorized contract with separate identification of cost elements (labor and material). The performance of the established work packages falling within the scope of the tasks related to the cost account are summarized to provide the cost account performance data. Figure 2 depicts a typical matrix resulting from the combination of the contractor's WBS and his functional organization. For each intersection on this organizational structure/WBS matrix, separate cost accounts are established, as necessary, to relate the work packaged, the apportioned, and the level-of-effort (LOE) tasks. Figure 2 also shows how, for a work package cost account, further increases in detailed task definition leads to the specific work packages established for the work. While not shown in Figure 2, as indicated before, level-of-effort and apportioned cost accounts may also exist at the same WBS/discipline intersection as the indicated work package cost account. The criteria indicates that while cost accounts should not be allowed to exceed a year in length, this limit should not be arbitrarily applied and should reflect a natural grouping of sub-tasks.

Figure 2 also indicates three major organization/
Figure 2 -- WORK PACKAGE/COST ACCOUNT RELATIONSHIP
definition systems associated with program planning. These are:

- The WBS organization extended to the lowest necessary task definition.
- The functional organization to the lowest level at which control will be maintained, and
- The detailed work definition, as it relates to both the WBS and the functional organization, identified to the work package level.

Once the contractual effort is planned and scheduled to the greatest possible extent, budget distribution can be made to responsible organizations for specific tasks. Since budgets will be used to measure cost performance, it is necessary to assign a budget to each increment of work. The integration of the WBS and the organizational structure should permit the assignment of budget to cost accounts regardless of whether budgets are distributed functionally or by WBS element.

The C/SCSC recognize the constructive use of management reserves for control purposes, but require the contractor to clearly identify all reserves regardless of the level at which they are maintained.

Budgets distributed to cost accounts, planning packages, WBS elements, and management reserves should add up to the contract target cost on incentive contracts, or to the estimated cost on fixed fee contracts. Budgets
assigned to authorized work in this fashion provide the basis for measuring cost performance. In other words, each increment of work will have a budget which represents its planned costs or planned value in terms of the total contract. As the work is accomplished, the actual costs incurred can be compared to the budget.

Cost element delineation is required to provide the capability to analyze performance in terms of labor, material or other direct cost. Indirect costs, however, need not be controlled at the cost account or work package levels, but must be budgeted at the level identified by management for control of such costs. In addition, overhead budgets must be established for the total costs of each significant organizational component whose expenses will become indirect costs.

Budgets for planned work may be stated in either dollars, man-hours or other measurable units, although budgets for cost accounts and higher levels are normally expressed in dollars. Regardless of the budgeting technique or units used, all work eventually receives a budget.

The original budgets established for those elements of the WBS identified as priced line items in the contract, and for those elements at the lowest level of the DOD project summary WBS should constitute a traceable basis against which contract growth can be measured.
These budgets will normally be modified only by contractual change or formal reprogramming actions done with the cognizance of the DOD procuring activity. This target cost baseline budget, more than any other amount, represents to the contractor and to the DOD by bilateral agreement, a reasonable cost objective for contract performance.

As the contract effort is defined within the WBS, the basis for baseline budget sub-allocation to detailed tasks is provided. Further budget assignments to work packages are made as detailed planning proceeds.

Before work actually begins, the work authorization system should define and identify the work to be done and the organizational elements responsible. Schedules and budgets should be established for all work at appropriate levels within the framework of the WBS. The contractor's existing system, employing task authorizations, work orders, or other appropriate operational sheets, may be used for this purpose.
CHAPTER IV

ACCOUNTING

The accounting criteria of the C/SCSC primarily require that the contractor be able to accumulate all direct costs in cost accounts and summarize them as directly as possible to the contract level. Cost accumulation by WBS elements or by organizational elements is facilitated by the WBS/organization structure integration which exists at the cost account level. As with the budgeting criteria, indirect costs do not have to be collected at the cost account level, but may be accumulated at the level selected for management control of such costs. Summarization of both direct and indirect costs from the level at which they are initially recorded to the contract level should be possible without the need for allocations between higher level WBS elements.

Contractor's accounting systems are subject to continual scrutiny by the Defense Contract Audit Agency. A DCAA auditor also serves as a principal member of the demonstration review team. Accounting procedures which are acceptable to DCAA will generally satisfy the requirements of C/SCSC and no attempt is made to evaluate DCAA's audit procedures or reaudit significant portions
of the accounting system during system demonstrations. Simple reconciliations are made to verify that summary level reports are properly supported by detail level data and that cost reports used for different purposes are reconcilable and support each other.

An objective of the criteria is to compare the cost of completed work with the planned cost for that work and analyze variances. Cost of completed work should include the cost of all resources consumed in the performance of the work, but should not include costs applicable to outstanding commitments or expenditures for resources acquired, but not consumed.

The criteria require the contractor's system to record applied direct costs which are defined as the costs of labor and materials (1) consumed, (2) issued from stores, (3) scheduled for use within sixty days, (4) specifically identified to a single serially numbered end item of the contract.

For all practical purposes, the time of issuance from stores and the point of actual consumption of material are considered one and the same. The cost of material resources which are received and used within two accounting periods (approximately sixty days) may be recorded as applied at the time they are received, since it may not be cost effective to account for the same material twice in such short a period, and relatively little distortion
would result in the determination of cost of work. Major components and assemblies, purchased on a one-for-one basis where no excess usage or attrition factor applies, may also be recorded as applied costs at the time the materials are received. Other reasonable deviations from the strict interpretation of the applied direct cost requirements are permissable when it can be shown that full compliance would result in a situation that is not the most cost effective possible for the specific situation of concern.

Regardless of the methods used for material accounting, the contractor's system must be able to provide material price variations, cost variances attributable to material usage, accurate cost accumulation for materials on a basis consistent with the budget, and full accountability for all materials ordered, received and used in the performance of the contract.
CHAPTER V

ANALYSIS

The analysis of the contract performance status is based on the development of specific information by the accounting system. The C/SCSC require that the contractor's systems be capable of providing this information. The Budgeted Cost for Work Scheduled (BCWS) is the time-phased budget plan (baseline) which represents the contract work plan. The Budgeted Cost for Work Performed (BCWP), sometimes referred to as the earned value or the planned value of work accomplished, represents the value of completed work. A comparison of BCWS and BCWP indicates whether more or less work was done than was scheduled to be done with the difference depicted as a schedule variance in terms of dollars. Comparing BCWP with actual costs indicates whether the work that was actually performed cost more or less than it was planned to cost. Analysis of cost and schedule variances should enable contractors to pinpoint problems and determine reasons for deviations from plans.

The Budgeted Cost for Work Scheduled is the budget applicable to the work scheduled to be accomplished
within a given time frame. Because the planned work is budgeted to the work package level, BCWS is assigned to the work package and they serve as the foundation for all contract cost and schedule data to be developed. Cumulative levels of BCWS are determined by adding up the budgets applicable to work packages for each of the cost accounts.

Work packages, as they are planned, must be detailed in time and dollars to obtain a time-phased work package plan. Several different methods of spreading the work package BCWS in time are available to the planner. These methods, although they do not reflect precisely the way work package actual charges will be incurred, provide a simplified method for planning and for the subsequent accomplishment of the work package. Any of these methods, singly or in combination - but with only one method per work package - may be employed over the whole contract effort.

- Percentage Technique -- This technique assigns a percentage accomplishment allowance at both the start and completion of the work package. The two percentages assigned must equal 100%. The standard techniques are 50/50, 0/100, and 100/0. Other percentages can be established during the BCWS planning cycle where they provide a legitimate method of measuring accomplishment.

- Milestone Technique -- The work package is fur-
ther subdivided into internal milestones and a percentage of the total work package value assigned to each internal milestone based upon its work content. The sum of the sub-milestone percentages (and the resultant BCWS) must equal 100%.

- Average Value Technique (material only) -- When a work package consists of more than one of a material item, it can be planned by specifying the average BCWS value per unit planned and the number of units scheduled as to time. A BCWS value is then assigned for each month by multiplying the per-unit BCWS by the number of units planned in that month.

- Time Elapsed Technique -- A planned start and stop date is assigned to the work package. BCWS is assigned uniformly between the start and stop dates based on the number of the planned days for the effort. This time elapsed technique should only be used when no other technique is available.

These procedures described should not be construed as being prescribed by the criteria or the DOD. The contractor is free to choose the work-in-process measurement technique he wishes; however, the procedures must be rational, formal, and applied in a consistent fashion.

BCWS is "credited" for apportioned work in the same manner as the work packaged effort it relates to. Level-Of-Effort work is assigned BCWS based on the Time Elapsed
It is obvious that an effective C/SC system must, of necessity, be computer-based in order to appropriately handle all of the many pieces of data required by the system.

As indicated by its name, BCWS is developed for each work package in relation to the manner the work was scheduled to be accomplished. The determination of the incremental work package values, based on the assigned budgets, is a dynamic operation which, typically, is not influenced by actual performance.

The Budgeted Cost for Work Performed is the budget applicable to the work actually accomplished. BCWP is determined by adding up the budgets of those work packages which have been completed, along with an estimated amount of budget for the completed work in open work packages.

The method used for assigning BCWP to a work package should be the same as was used in assigning BCWS to the work package. For the Percentage Technique, the appropriate percentages of work package budgets are assigned when the work actually does begin and actually is completed. For the Milestone Technique, as the sub-work package milestones are reached, BCWP is assigned. For the Average Value Technique, monthly BCWP credit is taken for the number of units actually completed in that
month. With the Time Elapsed Technique, BCWP is assigned with the passage of time after the job has begun. In no case, however, is BCWP assigned per the Time Elapsed Technique to exceed 80% of the original work package total budget. The remaining 20% may be taken only when the work package is designated as being complete.

Distortion of resultant data dictates that BCWS and BCWP should be derived in the same manner, although the criteria is not explicit in this respect.

At the work package level, BCWS and BCWP data associated with labor usage may be expressed in labor-based units, such as man-hours. At the cost account levels, and above, these are converted to dollars so that a total value may be expressed. Actual labor costs must be available in dollars, also.

Schedule status at any summary level desired is evaluated by comparing the BCWS, the budget expressed in terms of planned performance, with BCWP, the budget expressed in terms of actual performance. This relegates the often subjective job of determining schedule status to an objective one. If BCWP is greater than BCWS at a point in time, then more work has been accomplished than was planned to have been accomplished as of that date. If BCWP equals BCWS, the work is on schedule. If BCWP is less than BCWS, less work is being accomplished than was planned.
Cost status is determined in a similar manner as schedule status, except in this case, BCWP is compared to the actual applied costs incurred. The difference thus obtained reflects how much more, or less, the work being accomplished is costing relative to the budget provided.

Table 1 shows, with example values, all of the various combinations of BCWS, BCWP and actual charges, and the appropriate cost and schedule variance interpretation for each.

Overall cost and schedule variances, at the summary level in question, may be investigated on a cumulative basis by comparing cumulative BCWS, BCWP and actual costs up to any present point in time. Figure 3 shows how a typical cost account can be statused, using the applicable work package data. The total budget assigned to each work package is shown adjacent to the work package planned period of performance. The Percentage Technique is used, with 50% for start and 50% for completion. The assumed time of evaluation is indicated. At that time, BCWS is determined by summing 50% of each of the work package total budgets for each of the starts and stops scheduled to have happened to date. For the example given, this value is equal to 38 units. BCWP is determined similarly, for each stop and start actually indicated to have happened. For the example, BCWP is equal to 49 units. The accounting system indicates
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Table 1 --- INTERPRETATION OF COST AND SCHEDULE VARIANCES FROM OUTPUT DATA
Actuals to date = 57
*BCWS = 38
*BCWP = 49
Schedule Variance = +11
Cost Variance = -8

Figure 3 -- DETERMINATION OF COST ACCOUNT COST AND SCHEDULE VARIANCES
actual charges to date are 57 units. Table 1 would indicate that the cost account is ahead of schedule by 11 units (or 29%) and over cost by 8 units (or 16.3%). In C/SCS terminology, a negative variance indicates behind schedule or over cost. Similar status comparisons could be made at any summary level simply by summarizing the appropriate BCWS, BCWP, and actual charges to that level. When cost and schedule variances are developed, the percent variance (variance divided by budget) gives an actual quantitative measure of overall contract performance. In addition, the cost and schedule variance trends may be evaluated by investigating the monthly BCWS, BCWP and actual cost contributions.

The C/SCSC require that the cost and schedule variance analyses be performed at any time a variance exists that exceeds a predetermined amount mutually agreed to by the contractor and the responsible government agency in charge. This may be required at any summary level, with tolerances appropriately established for each. Managerial authority and responsibility for corrective action should exist at the cost account level, making it a key management control point in the system.

BCWS, BCWP, actual costs and associated variances should be summarized directly into both the WBS and the organizational structure from the cost account level in
order to provide both project status and organizational performance at all levels of management. The DOD monthly cost performance report provides data to the government at a summary level, normally the third level of the contract WBS or higher. All significant variances should be explained in the problem analysis section of this report. Only problems having significant cost or schedule impact on the contract will appear in this report due to the wash-out effect of lower level favorable and unfavorable variances. If, however, there is a significant upper level variance, it will be definable in terms of the lower level, detailed variance analyses. It should be a relatively simple matter to trace these variances to their sources through either the WBS or the organizational structure. In such situations, a disciplined, formally structured system is required to show the true status on a systematic, routine basis.

Once identified, the causes of the variances must be followed-up by means of corrective action, where possible, or replanning, if the problems are so severe as to affect overall schedules and budgets.

It should be recognized that many potential problems affecting contract performance may not be identifiable by means of the monthly cost performance reports, and that they constitute only one of the management tools available to contractors and DOD project managers.
Although it is monitored often separately from direct costs, budgeted and actual indirect costs must be monitored and their significant variances explained monthly, also.

Although the requirements of C/SCSC are primarily oriented to obtaining accurate reports of program progress there is also a requirement for contractors to periodically make estimates of cost at contract completion. Such estimates should be based on performance to date, but should also consider other factors which may affect future performance. The exact methods for computing estimates at completion (EAC) is left to the contractor, but the procedure used should be rational and applied consistently from period to period. The estimated cost at completion submitted to the government on the cost performance report should be reconcilable with summary level cost information reports or procurement information reports and the contractor’s latest statement of funds requirements reported on the contract funds status report or its equivalent.

In correlating cost, schedule, and technical achievement, it is apparent that unfavorable cost or schedule conditions are usually caused by technical difficulties rather than the reverse.
CHAPTER VI

REVISIONS AND ACCESS TO DATA

Contract changes frequently affect all aspects of a contractor's internal planning and control system. All of the activities associated with the original contract planning effort are affected since budgets, schedules and work authorizing documents at all levels must be revised to accommodate changes. This situation may be further complicated if work on a change must start before the change has been priced. In these situations, contractors must establish budgets based on preliminary estimates which may change several times before negotiations are completed. Unforeseen funding limitations and schedule stretchouts also present difficult replanning problems due to the widespread impact they usually have on the contract effort.

The C/SCSC require that contract changes be incorporated in a timely manner and that authorized, unpriced work be planned and controlled as arduously as defined effort. Maintenance of a meaningful performance measurement baseline is particularly important since it may become more difficult to determine contract performance accurately when schedules and budgets are being
revised to incorporate contract changes. It is important, therefore, that the contractor have a formal procedure for incorporating changes in order to minimize disruptions of the current effort. The availability of detailed cost, schedule and technical status and variance analyses enables all levels of management to assess problems and take corrective action.

As with contractual changes, internal replanning actions must be carefully controlled to avoid distorting the measurement of performance. However, it is recognized that management flexibility is also necessary to many internal operations, particularly in a dynamic environment such as engineering development.

The C/SCSC provide for a certain amount of flexibility at both upper and lower levels of management. A management reserve is recognized as a necessary and useful management control tool used by many project managers. Being able to replan work packages within the framework of cost account budgets and schedules provides lower level managers with a degree of flexibility for reorganizing work and people as conditions dictate. More extensive replanning can also be done provided the DOD procuring activity is notified in accordance with established procedures. During these replanning actions, a good general rule to follow is that work and budget should stay together so that budget established for one
piece of work is not consumed in the performance of another. Undisciplined transfers of work and budgets often cause the performance measurement baseline to lose its effectiveness as a measurement tool.

Retroactive adjustments to records pertaining to budgets or costs of completed work should not be made except for routine accounting adjustments or correction of errors. The criteria also require that the procuring activity be notified whenever a change is made to the performance measurement baseline. Generally, this means that whenever a cost account budget changes for any reason other than a contractual change, notification is required.

In summary, as to internal planning revisions, the contractor may: 1) use management reserves to change cost account budgets, 2) replan unopened work packages within confines of cost account budgets, 3) transfer work and associated budget between cost accounts, and 4) conduct other reprogramming actions with cognizance of the procuring activity. The contractor may not: 1) make retroactive changes to budgets or costs of completed work, 2) transfer work or budget independently of each other, 3) rebudget in-process work packages, and 4) reopen closed work packages.

The contract budget baseline is normally made up of the sum of the budgets distributed to cost accounts plus
management reserves. The contract target cost serves as the point of departure for initial internal budgeting since profit or fee is not normally budgeted to lower level organizations and since profit, incentive and cost-sharing arrangements are all based on deviations from target costs.

The time-phased budget baseline is not static; it changes whenever the contract changes and performance is measured against the current, not the original, baseline. It should be possible, however, to reconcile the current baseline to the original baseline for cost tracking purposes.

The contractor's system will be capable of providing, not less frequently than monthly, such schedule and financial information as:

- status of cutoff date
- projected status at completion
- analysis of problems
- forecast contract end-item delivery schedules
- status of applicable logistic support, including services and spares
- other data from the contractor's internal planning and control system as specified by the contracting officer, particularly when program difficulty or program change is indicated.
Specific reports required from the contractor are identified on DD Form 1423.

The contractor is required to maintain, in addition to the formally required contract data, and make available for inspection upon request of the contracting office: 1) a list of the cost accounts established for the contract correlated with the WBS established for the contract, 2) the budgets assigned each cost account, 3) the undistributed budgets (or management reserves), 4) a description of the formulas used to measure the planned value of work accomplished, and 5) normal contractor detailed work plans and other basic documents comprising a record of work packages and their summarization into cost accounts.
Because of their size and importance, major subcontractors must follow a specific set of C/SCS criteria ground rules. These ground rules are constructed to ensure adequate performance measurement reporting, both to the contractor and to the customer. Major subcontract C/SCS requirements vary depending upon the type of contract (fixed price or cost plus fixed fee) negotiated with the subcontractor because of the difference in cost risk.

- Cost reimbursable major subcontract -- The complete C/SCS criteria is implemented on a cost reimbursed major subcontract and is included as a part of the original purchase order to the vendor. All subsequent reports and analyses from the contractor must be from this approved C/SC system.

- Firm fixed price major subcontracts -- This type of contract, since the cost risk is known at the time of signing of the purchase order, does not require complete C/SCSC compliance but requires sufficient major subcontractor reporting requirements to be spelled out on the
purchase order to ensure that adequate schedule status is available to the primary contractor.
CHAPTER VIII

SUMMARY AND CONCLUSIONS

It has been the intent of this report to present the Cost/Schedule Control System Criteria and to explain how it can be used by the contractor and the contracting agency for providing increased capabilities for interpreting program cost and schedule performance. This is accomplished, using the techniques presented herein, because the C/SCS incorporates unique means for assessing completed work so that effective methods are available for quantifying cost and schedule status. A summarization of these criteria are found in the Appendix to this report.

The Cost/Schedule Control System Criteria establishes certain standards for organizing, planning, budgeting, accounting and analyzing cost and schedule performance for selected government contracts. Developed over the past six to eight years by various governmental military agencies, the criteria specify ground rules whereby, in the opinion of the government, a system can be developed which affords the contractor the ability for effective program management and the customer
sufficient output information for proper evaluation of program cost and schedule performance.

The C/SCS criteria does not impose any specific management system on the contractor. On the contrary, it is hoped that, to the extent that it can satisfy the criteria guidelines, the contractor's existing management systems be utilized.

Typical management systems in the past possessed the capability for measuring time-phased plans to actual accomplishments. Such reporting methods, however, assume that work is always on schedule in order to derive any meaning from plan-actual variances. This method of performance measurement, which has been open to varying degrees of inaccuracies, is now replaced by the concept of measured accomplishments as derived from a system based on C/SCSC.

With the addition of this new accomplishment value, the system is now capable of portraying a more exact performance picture. It's easy to see a cost variance through a comparison of accomplishments to actual costs, and a schedule variance through a comparison of accomplishments to the value of work scheduled. This improved way of determining status gives rise to new terminology: "plan" is now Budgeted Cost for Work Scheduled (BCWS) and "accomplishment" is Budgeted Cost for Work Performed (BCWP).
The use of the elements BCWS, BCWP and actual costs provides a better perspective of current performance than otherwise possible, but does not furnish the complete picture. Effective controls must also encompass anticipated costs. This is done by means of an estimate-at-completion (EAC). Generally, the further a job progresses the better the EAC can be predicted. When the job is finally done, EAC equals actual expenditures. This final value may vary from previously estimated EAC's but it is, nonetheless, the true cost at completion.

Recognition of the EAC and the BCWS as possibly being separate entities is in contrast with the usual policy of the EAC being the new target cost. There is no new target; only a new forecast of potential cost overrun or underrun. Potential overruns may, however, result in contract renegotiations, fund reallocations and/or possible rebaselining with an associated modification to BCWS.

As an aid in interpreting the criteria requirements relative to the evolving contractor management system, a governmental team is assigned to work with the contractor. Typically this team is comprised of members of the cognizant government procuring office, at least one assigned DCAA representative and representatives of other government agencies that are felt to have a justified interest in the performance of the contract. Within
this team are specialists in the various areas of the criteria requirements (e.g., budgeting, planning, etc.). Working with the contractor, they assist in interpreting the criteria for the contractor, make suggestions for criteria implementation within the contractor's system and perform a validation review of the resultant contractor system. This series of activities may take place over a number of days or weeks, as necessary.

The C/SCS criteria are very liberal in that they provide a wide latitude of interpretations by the contractor of methods of implementation, depending on the nature and type of contract effort and management philosophy specifically involved. To this end, the evaluation team has authority for interpreting the manner in which the contractor applies the criteria and, for the most part, have the final authority for its approval. Successful completion of the validation review is necessary in order to comply with that area of the contract which specifies that the C/SCS be developed and applied to the contract effort.

The contractor's system, once validated, does not necessarily remain static. As performance on the contract proceeds, certain modifications, with the approval of the procuring agency, may be required. These may be due to such things as the changing nature of the work effort or the recognition of more efficient methods
for satisfying system goals. The assigned governmental team makes regular return visits to the contractor to maintain surveillance of the system operation. Should the review and surveillance effort show that modifications cause parts of the resultant system to no longer satisfy the criteria, the contractor will be required to make the proper corrections or suffer loss of validation. A summarization of the objectives of this surveillance is shown in Table 2.
I. To ensure that the contractor's management control systems continue to:
   a. Provide valid and timely information.
   b. Comply with C/SCSC.
   c. Provide timely indications of actual or potential problems.
   d. Maintain baseline integrity.

II. To ensure that the contractor's required external cost and schedule reports:
   a. Contain information that is derived from the same base as that used by the contractor's management.
   b. Contain explicit and comprehensive variance analyses including proposed corrective action.
   c. Contain information that reflects actual conditions.

Table 2 -- OBJECTIVES OF C/SCSC SURVEILLANCE
APPENDIX A

CRITERIA SUMMARY

A summarization of some of the more significant of the C/SCSC requirements has been made and is shown below. The criteria are organized in the same format as the textual matter they refer to.

ORGANIZATION

- Define all the authorized work and related resources to meet the requirements of the contract, using the framework of the contract work breakdown structure.

- Identify the internal organizational elements and the major subcontractors responsible for accomplishing the authorized work.

- Provide for the integration of the contractor's planning, scheduling, budgeting, work authorization, and cost accumulation systems with the contract WBS and the organizational structure.

- Provide for reliable performance measurement at the level where work is performed.

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

- Provide for integration of the WBS with the contractor's functional organizational structure in a manner that permits performance measurement for WBS and organizational elements.
PLANNING AND BUDGETING

- Schedule the authorized work in a manner which describes the sequence of work and identifies the interdependencies required to meet the development, production and delivery requirements of the contract.

- Identify the physical products, milestones, technical performance goals, or other indicators that will be used to measure output.

- Establish budgets for all authorized work to the lowest level of contract planning, with separate identification of cost elements (labor, material, etc.).

- 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 (beyond six months) in larger planning packages for budget and scheduling purposes.

- Identify the relationships of budgets or standards in underlying work authorization systems to budgets for work packages.

- Identify the level-of-effort activity in cost accounts which are planned and controlled by time-phased budgets established for this purpose. Only that effort which cannot be identified in discrete short-span work packages will be classified as level-of-effort.

- Establish overhead budgets on a basis consistent with the way resources are to be consumed and accounted for.

- Identify management reserves and undistributed budget.

- Provide that the contract cost, plus the estimated cost of authorized but undefinitized work, is reconciled with the sum of all internal contract budgets and management reserves.
- Establish and maintain a performance measurement baseline consisting of budgets assigned to scheduled cost accounts. For cost accounts that exceed one year in duration, establish smaller budget planning packages for baseline planning and controls.

- Provide that the sum of all work package budgets, plus planning packages within a cost account, equals the cost account budget.

ACCOUNTING

- Record applied direct costs on a basis consistent with the budgets in a formal system that is controlled by the general books of account. Include within the cost accounts the amounts charged to work in process in the time period:

  -- When labor, material, and other direct resources are actually consumed, or

  -- When material resources are received that are uniquely identified to the contract and scheduled for use either within the same accounting period or not later than the next accounting period. For the purpose of applied direct cost, the accounting period should not exceed approximately one month.

  -- When major components are received that are specifically and uniquely identified to a single serially numbered item.

- Summarize applied direct costs from the cost accounts into the WBS without allocation of a single cost account to two or more WBS elements.

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

- Record all indirect costs which will be allocated to the contract.
- Identify the bases for allocating the cost of apportioned effort to the discrete work packages to which it pertains.

- Identify unit and equivalent unit costs and/or usable lot costs.

- Reconcile original budgets for those elements of the work breakdown structure identified in the contract for reporting to the government with current budgets in terms of changes to the authorized work.

ANALYSIS

- Identify at the cost account level on a monthly basis, using data from or reconcilable with the accounting system:

  -- Budgeted cost for work scheduled and budgeted cost for work performed.

  -- Budgeted cost for work performed and applied direct costs for the same work.

  -- Variances resulting from the above comparisons classified in terms of labor, material, or other appropriate elements, together with the reasons for significant variances.

- 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 therefore.

- Summarize BCWS, BCWP, applied costs, and the associated variances through the contractor organization and WBS to the reporting level specified in the contract.

- Identify managerial action taken as a result of the above.

- Monitor the effectiveness of actions taken to resolve problems or correct deficiencies.
- Based on performance to date and on estimates of future requirements, develop revised estimates of cost at completion for WBS elements identified in the contract and compare these with the contract baseline budgets, current budgets, the contract price, and the latest statement of funds requirements reported to the government.

**REVISIONS AND ACCESS TO DATA**

- Incorporate contractual changes in a timely manner recording the effects of such changes in budgets and schedules. In the directed, prenegotiated effort, base such revisions on the amount estimated and budgeted to the functional organizations.

- Prohibit retroactive changes to records pertaining to work performed that will change previously reported amounts for applied direct costs, or indirect costs, except for correction of errors and routine accounting adjustments.

- Prevent revisions to the contract budget baseline except for government-directed changes to contractual effort; that is, scope, work, and schedule.

- At the time changes occur, advise the procurement activity of any changes to baseline budgets or schedules.

- Work packages that have been opened will not be changed. Work packages that have been closed will not be reopened. Any changes in unopened work packages will be accompanied by a documented explanation of budget and effort moved.

- Provide the contracting officer and his duly authorized representatives with access to all the foregoing information and records in support thereof, including a listing of the cost accounts correlated with the WBS, established for the contract; the budgets assigned thereto; the formulas used to measure the budgeted cost of work accomplished; and normal, detailed work plans and other basic documents comprising a record of work packages and their summarization into cost accounts.
SUBCONTRACTORS

- The contractor will require that his major subcontractors' systems have the capability for monitoring control of schedules and costs in accordance with this specification.
APPENDIX B

DEFINITIONS

Certain terminology is used in describing the Cost/Schedule Control System Criteria. Definitions are provided for many of these based on the context in which they are herein used.

Applied Cost

Applied costs are actual costs, including any burden, that are charged at the point of usage. For direct labor, applied costs equal actual expenses as collected by the formal accounting system. For direct material and services, applied direct costs are recorded: (1) when raw material is issued from stores, (2) upon receipt of other material, and (3) upon payment for services.

Apportioned Cost Account

A cost account that consists of effort that, by itself, is not readily divisible into short-span work packages, but which is directly related to an existing work package cost account and can be apportioned to the accomplishment of that cost account.

Budget

The portion of the program planned cost assigned to a particular task, group of tasks, material item, or group of material items. Budgets are assigned by program management to individual cost accounts for the work to be done or material to be procured. Budget time-phasing must be consistent with the timing of planned applied costs.
Budgeted Cost for Work Performed (BCWP)

The value of completed work and in-process work accomplished based upon the budget assigned to that work.

Budgeted Cost for Work Scheduled (BCWS)

The value of work scheduled to be accomplished based upon the budget assigned to that work. BCWS is equal to the cumulative budget to date.

Contract Target Cost

The estimated cost negotiated in a cost-plus-fee contract or the negotiated cost portion of a fixed-price contract.

Contract Target Cost Budget (CTCB)

CTCB is the contract dollar budget allocated by program management to all levels of program and functional management. The CTCB (including management reserve) equals the Contract Target Cost plus the target cost for government-authorized changes.

Cost Account

The focal point within the contract WBS at which applied direct costs are accumulated and the lowest required level at which BCWP is compared with BCWS and applied direct costs. The cost account, when established, will contain separate identification by organization for cost elements (labor, material and burden).

Estimate At Completion (EAC)

The value developed to represent a realistic appraisal of the final cost of accomplishing a task. It is equal to the actual costs for completed work plus the latest estimate of costs for all in-process and future work.
**Level of Effort (LOE)**

LOE is planned and controlled by time-phased budgets rather than by milestone accomplishments. LOE cost accounts used for that activity cannot be economically associated with definable milestones, products or results.

**Major Subcontract**

A contractor who has a subcontract that involves substantial resources, is technically complex, requires integration and control over functional interfaces and special management attention. Major subcontracts are selected by agreement between the prime contractor and the government procuring agency.

**Management Reserve**

A portion of the budget held in abeyance for contingency purposes, representing the difference between CTCB and the sum of all cost account budgets and undistributed budgets. It is established in special accounts and is controlled by program management.

**Performance Measurement Baseline**

The budget plan consisting of budgets assigned to defined tasks against which the contract performance is measured plus management reserve and/or undistributed budget. This equals the negotiated contract target cost plus the estimated cost for customer approved nonnegotiated changes (includes contract change work and added work). The performance measurement baseline budgets can exceed contract target cost by the value of added work upon approval of the government project manager.

**Rebaselining**

Under conditions when the performance baseline is no longer realistic for measurement purposes, the Contracting Officer may permit the program to be rebaselined to new budget targets (different than currently planned). Rebaselining, then, is the setting of new and more current budget targets and/or revising work content for the contract in accord with the terms and conditions agreed upon by the Contracting Officer.
Tolerance Band (Limits)

A tolerance band is a range of acceptable deviation from established target values for performance measurement purposes. Variances from goals that exceed these limits require analysis.

Undistributed Budget

Budget that has been identified for a general task or a set of tasks in support of the contract but which has not yet been assigned to specific tasks or distributed to a specific operating organization or major subcontract.

Variance, Cost

Cost variance is a term used to describe the current overrun/underrun position. Cost variance is the difference between BCWP and actual applied costs.

Variance, Projected

A variance that indicates potential overrun/underrun position, if no management action is taken. It is calculated as the difference between CTCB and total EAC.

Variance, Schedule

Schedule variance is a term used to describe the current ahead/behind schedule position. It is the difference between BCWP and BCWS.

Variance, Significant

A variance that has exceeded its tolerance band or whose value, time of occurrence, associated task, and interrelated variances warrant its detailed analysis.

Work Breakdown Structure (WBS)

The WBS is a continuously evolving product task pyramid that organizes, defines, and graphically displays the work to be performed to achieve program objectives.
Work Package

A work package is defined as a specified short-span task within a work-package-type cost account and is the responsibility of only one specific performing organization. A work package's budgeted value is expressed in labor hours and dollars and/or material dollars and is the basis for developing both BCWS and BCWP.
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