DCMA

Earned Value Management System (EVMS)

Program Analysis Pamphlet (PAP)

DCMA-EA PAM 200.1

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THE DCMA ENGINEERING AND ANALYSIS EXECUTIVE DIRECTOR IS RESPONSIBLE

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DEPARTMENT OF DEFENSE
Defense Contract Management Agency

PAMPHLET

Earned Value Management System (EVMS) Program Analysis Pamphlet (PAP)

Engineering and Analysis   **DCMA-EA PAM 200.1**
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1. PURPOSE. This EVMS Program Analysis Pamphlet (EVMSPAP) will serve as a primary reference for EVMS Specialists to properly generate EVM metrics, graphs, tables, and presentations supporting the creation of the Program Assessment Report (PAR). It outlines EVM key components spanning the integrated business management systems and the Integrated Master Schedule (IMS).

2. APPLICABILITY. This Pamphlet applies to all DCMA activities.

3. RELEASABILITY – UNLIMITED. This Pamphlet is approved for public release.

4. EFFECTIVE DATE. This Pamphlet is effective immediately.

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FOREWORD

The Defense Contract Management Agency (DCMA) performs three types of Earned Value Management System (EVMS) functions: Compliance Reviews, System Surveillance, and Program Analysis. The Agency has developed a suite of instructions to define and standardize these functions. In addition, the EVMS Specialist Certification Program (ESCP) standardizes the training and experience requirements for DCMA EVMS Specialists. The Major Program Support (MPS) instruction (http://guidebook.dcma.mil/56/index.cfm) provides a framework for Contract Management Office (CMO) multifunctional Programs Support Teams (PST) and requires a Program Assessment Report (PAR). This EVMS Program Analysis Pamphlet (EVMSPAP) shall be used as a reference to generate EVM metrics, graphs, tables, and presentations.

1.0 INTRODUCTION

The intent of the EVMSPAP is to outline the key components of EVM analysis. An EVMS is an integrated business management system consisting of the following five areas: Organization; Planning, Scheduling & Budgeting; Accounting; Analysis & Management Reports; and Revisions & Data Maintenance. Scheduling is a critical EVMS function. Therefore, this Pamphlet also contains information regarding Integrated Master Schedule (IMS) analysis.

The purpose of the EVMSPAP is to provide a standard for conducting analysis and to ensure all EVMS Specialists have the information required to approach EVM and the IMS analysis consistently. An integral part of successful program management is reliable and accurate information. Program managers and their teams perform best when they are well informed. The goal of EVM program analysis is to provide consistent and timely insight to program status in order to enable timely, effective management decision making.

2.0 PROGRAM ASSESSMENT REPORT (PAR) EVM REQUIREMENTS

The PAR is a product for DCMA customers containing functional input from all members of a program support team (PST). One of those PST functions is EVMS. EVMS information is contained in Section 4 and Annex A: Earned Value Report Template. The information requested in Section 4 can be entirely derived from the Earned Value (EV) Report Template. If a program has more than one contract, an EV Report will be generated for each contract and summarized into a single Section 4 summary.

The following sections contain guidance for EVMS Specialists in the production of EV Reports intended for Annex A of the PAR.

2.1 EXECUTIVE SUMMARY

The executive summary is intended to provide a brief synopsis for management that may not necessarily have the time to read the entire report. Try to avoid providing too many details. Instead, focus on broad trends or major issues that require DCMA or otherwise governmental PM attention. Major programmatic issues related to cost, schedule, or Estimated at Completion (EAC) growth should be included. For example, an Over Target Baseline (OTB) or Nunn McCurdy breach would be a significant issue to be addressed in the executive summary. A summary of metrics such as the Cost Performance Index (CPI) and the Schedule Performance Index (SPI), and the top cost and schedule drivers provides a useful assessment of overall contractor performance. Lastly, provide the latest EVM System Status as this indicates the higher reliability of contractor reports generated by their EVMS.

2.2 INDEPENDENT ESTIMATE AT COMPLETION (IEAC)

An IEAC is DCMA's forecast of the final total cost of the program. The process begins with determining the upper and lower statistical bounds with the following equations:

$$\text{EAC}_{\text{cpi}} = \text{ACWP}_{\text{cum}} + \frac{(\text{BAC} - \text{BCWP}_{\text{cum}})}{\text{CPI}_{\text{cum}}}$$

$$\text{EAC}_{\text{composite}} = \text{ACWP}_{\text{cum}} + \frac{(\text{BAC} - \text{BCWP}_{\text{cum}})}{(\text{CPI}_{\text{cum}} * \text{SPI}_{\text{cum}})}$$

Typically the EAC_{cpi} formula provides a lower bound, or the most optimistic IEAC. The $EAC_{composite}$ formula provides an upper bound, or the most pessimistic IEAC. This assumption is based on CPI_{cum} and SPI_{cum} being less than 1. If both of these metrics are greater than 1 then the reverse will be true; meaning EAC_{cpi} will become the most pessimistic IEAC. These formulas are most accurate when the program is between 15% complete and 95% complete. Outside of these ranges the formulas may not provide accurate bounds.

The next step performs a detailed analysis of the contractor EAC by Work Breakdown Structure (WBS) element at the lowest level available. This analysis involves determining the reasonableness of the WBS level estimates with information gained from program surveillance and other functional PST member input. This is the perfect place to make adjustments if the contractor's value does not appear reasonable. For a detailed discussion regarding analysis of a contractor's EAC please refer to "Examining the Comprehensive Estimate-at-Completion" found in the references section of this Pamphlet.

A contractor's most likely EAC is required to include some program risk factors. Review the program risk registry and determine if the risks included by the contractor in their most likely EAC are reasonable. These risks may present a consequence in terms of either cost or schedule. However, even schedule risks end up presenting a cost risk in the end. However, it should be noted that risks themselves might never result in a cost or schedule increase until the risk manifests itself. Risk mitigation (abatement) on the other hand would need effort expended and result in some cost and possible schedule impact. Any differences between the contractor's estimate of likely risks and DCMA's assessment should be documented in terms of dollars.

Finally, roll up any adjustments made to individual WBS element EACs and any changes made to risks to determine the value of the DCMA IEAC. Check the rolled-up value against the two formula values discussed earlier in this section. The rolled-up value may fall outside of the statistical formula bounds, but this should be considered a flag. If this occurs, double check your adjustments and ensure they are properly documented.

The EAC is an important number used by program stakeholders. A program office relies on the EAC for securing sufficient funding for the program. The DCMA IEAC is an independent second opinion of the final costs of the program. This provides the program office with important information to aid in funding decisions.

Some programs may have a Contract Funds Status Report (CFSR) requirement. CFSRs are typically submitted to the program office on a quarterly basis. The CFSR provides a forecast of the total program price at completion, to include any applicable fee. The contractor's most likely EAC reported on the monthly Contract Performance Report (CPR) should reconcile with the forecast in the CFSR after taking into account the timing differences of the reports.

2.3 SUMMARY TABLE

This section of the PAR contains a summary table of metrics for the contract WBS (CWBS) watch items identified in Section 2 of the PAR as well as other CWBS elements that require management visibility. Appendix B of the PAR defines the assessment criteria for metrics in terms of Green, Yellow, and Red. The following metrics are already defined in this Pamphlet and can be found in the following sections:

2.2	INDEPENDENT ESTIMATE AT COMPLETION (IEAC)
3.1.1.1	COST PERFORMANCE INDEX (CPI)
3.1.1.3	THE RATIO: "PERCENT COMPLETE" TO "PERCENT SPENT"
3.1.2.1	SCHEDULE PERFORMANCE INDEX (SPI)

The remaining metrics are

- Schedule Variance (SV)
- Schedule Variance (SV) Trend
- Cost Variance (CV)
- Cost Variance (CV) Trend

Schedule Variance (SV) is the difference between the dollars of budget earned {the budgeted cost of work performed (BCWP)} and the dollars planned to be earned to date {the budgeted cost of work scheduled (BCWS)}. BCWP and BCWS can be found on the CPR Format 1. Due to

the various techniques available for calculating the amount of budget earned (BCWP), the SV metric should not be confused with a behind schedule or ahead of schedule condition. It should be used as a general indicator of schedule performance, but must be used in conjunction with IMS analysis to determine the true schedule status of the program. The formula for calculating SV is as follows:

$$\text{Schedule Variance (SV)} = \text{Earned} - \text{Budgeted}$$
$$\text{or}$$
$$SV = BCWP - BCWS$$

SV less than 0 indicates negative schedule variance and perhaps unfavorable performance. Conversely, SV values greater than 0 indicate positive schedule variance.

The SV Trend compares the metric for a specific reporting period (usually monthly) to the same metric in prior reporting periods. An SV trend is favorable if the SV increases in value over the course of multiple reporting periods (i.e., three months). Conversely, the SV trend is unfavorable if it decreases in value. The following tables provide examples of both trends. Note in the second table that although the trend decreases, the SV itself remains favorable.

Table 1. Favorable SV Trend

Reporting Period	Schedule Variance (SV)
January	-$8K
February	-$7K
March	-$6K

Table 2. Unfavorable SV Trend

Reporting Period	Schedule Variance (SV)
January	$8K
February	$7K
March	$6K

Cost Variance (CV) is the difference of the value of budget earned, or budgeted cost of work performed (BCWP), and the amount of costs incurred, or actual cost of work performed (ACWP). BCWP and ACWP can be found on the CPR Format 1. The formula for calculating CV is as follows:

$$\text{Cost Variance (CV)} = \text{Earned} - \text{Actual}$$
$$\text{or}$$
$$CV = BCWP - ACWP$$

A Cost Variance less than 0 indicates a negative cost variance or more has been spent to accomplish work to date than was originally planned and that the project may be currently over budget. Conversely, a CV greater than 0 indicates a positive cost variance.

Similar to the SV Trend, the CV Trend is a comparison of the metric for a specific reporting period (usually monthly) to the same metric in prior reporting periods. A CV trend is favorable if the CV increases in value over the course of multiple reporting periods. Conversely, the CV trend is unfavorable if it decreases in value. Examples are similar to those provided in the SV Trend tables above.

2.4 CONTRACT VARIANCE AND PERFORMANCE CHARTS

This section of the PAR is a graphical view of various metrics depicting program performance from program inception to date. These charts are presented as part of the Defense Acquisition Executive Summary (DAES) review; which is routinely conducted at Office of the Secretary of Defense for programs determined to be high risk or high visibility.

The first chart, Figure 1 Contract Variance Chart, depicts the following:

- Cost Variance
- Schedule Variance
- Management Reserve Usage,
- Contractor Variance at Completion
- Program Manager Variance at Completion
- 10% BCWP Thresholds

The Program Manager Variance at Completion (VAC) is calculated by subtracting the Program Office EAC from the Budget at Completion (BAC) of the contract. The BAC can be found on the CPR Format 1. VAC in general is calculated with the following formula:

$$\text{Variance at Completion (VAC)} = \text{Budgeted} - \text{Estimated}$$

$$\text{or}$$

$$\text{VAC} = \text{BAC} - \text{EAC}$$

The Variance at Completion identifies either a projected over-run (negative *VAC*) or an under-run (positive *VAC*). If a contract is projected to overrun, it means the total cost at completion will be greater than the budget.

The second chart, Figure 2 Contract Performance Chart, depicts

- ACWP
- BCWS
- BCWP
- Total Allocated Budget (TAB)
- Contract Budget Base (CBB)
- Contractor EAC
- The program manager's EAC over the period of performance of the contract.

Both Figure 1 and Figure 2 can be generated from wlnsight or by using Microsoft Excel file found in the Resource Page Tab to this Pamphlet (http://guidebook.dcma.mil/).

2.5 VARIANCE ANALYSIS

Variance Analysis is the identification and explanation of the top cost and schedule drivers and typically involves cumulative information. Variance analysis employing current data may also be useful in identifying emerging trends that may signal concern. The WBS elements that significantly contribute to the program cost and schedule variance should be discussed in this section of the PAR. The CPR Format 1 contains the cost and schedule variance by WBS element. When available, a wlnsight export file from the contractor's EVMS may contain more detailed WBS level information. If using a CPR Format 1, ensure you have a Microsoft Excel

electronic copy. If one is not available then populate a blank spreadsheet with the CPR information.

The first step in identifying top drivers is to calculate cost variance percent (CV%) and schedule variance percent (SV%). The CV% metric quantifies the magnitude of the cost variance (CV) by dividing CV by BCWP and multiplying by 100. The formula for calculating CV% is as follows:

$$CV\% = \frac{CV}{BCWP} \times 100$$

A high CV% indicates significant variance magnitude. Both positive and negative CV, and likewise CV%, are considered drivers.

SV% is similar in that the metric quantifies the magnitude of the schedule variance (SV). The formula for calculating SV% is as follows:

$$SV\% = \frac{SV}{BCWS} \times 100$$

A high SV% indicates significant variance magnitude. Both positive and negative SV, and likewise SV%, are considered drivers.

If using wlnsight, the CV% and SV% fields are already calculated and available by inserting a new column and selecting these elements. If using a CPR Format 1, ensure you either have the MS Excel copy or have populated a MS Excel spreadsheet. Then use the formulas above to calculate the metric by WBS element.

Once the CV% and SV% metrics have been calculated, sort the WBS elements by CV% from smallest to largest. If there are WBS elements with negative (unfavorable) CV% they will be displayed at the top of the list. If there are WBS elements with positive (favorable) CV% they will be displayed at the bottom of the list. Select the largest favorable and unfavorable cost

drivers and include them in the variance analysis section of the PAR. Likewise, sort the list by SV% and select the largest favorable and unfavorable schedule drivers.

Once the top schedule drivers have been identified, identify any resulting impacts to the key milestones in the IMS. In order to do this the WBS elements in the CPR must be correlated to activities in the IMS. Typically, contractors include a WBS reference column in the IMS for this purpose. Obtain a copy of the IMS for the same month as the CPR being analyzed. Microsoft Project is a common software tool used for creating an IMS. Filter for the WBS elements identified as top schedule drivers. A list of activities will be displayed with logic links. Follow the successors of these tasks until you find the first major milestone in the logic chain. A few examples of major milestones are the Preliminary Design Review (PDR) or the Critical Design Review (CDR). This will be the key milestone impacted by the schedule variance.

2.6 SCHEDULE ANALYSIS

The area of schedule analysis is broad and diverse. For the purpose of the PAR, two metrics will be calculated: Critical Path Length Index (CPLI) and Baseline Execution Index (BEI). See section 3.1.2.3 of this Pamphlet for a detailed discussion regarding CPLI or section 3.1.2.4 for BEI.

2.7 BASELINE REVISIONS

The Baseline Revisions metric highlights changes made to the time-phased PMB (or budget) over the past 6 -12 month period using the CPR Format 3. If the Format 3 has been tailored out, request a wlnsight data file. A change of five or more percent is used as an early warning indicator that the program's time-phasing and control of budget is volatile in the near term and that a significant departure from the original plan has occurred. This metric indicates how the volatile near term baseline changes over time. Substantial changes to the baseline time phasing may indicate the supplier has inadequate plans in place and the performance metrics may be unreliable. Change is inevitable but the near term plan should be firm and change control should be exercised.

The Baseline Revisions metric is measured using "end of period" data from the CPR Format 3. The Format 3 of the CPR (end of period) projects the PMB for future periods, and it's important to ensure that only the End of Month (EOM) data is being used for this calculation. An example of the calculation is provided in the Baseline Revisions Spreadsheet found in the Resource Page Tab to this Pamphlet (http://guidebook.dcma.mil/) and is calculated using the following steps:

1. Format a spreadsheet with the report dates of the six CPRs being analyzed in Column A, Rows 2-7.

2. Format the spreadsheet with the forecast months beginning with the date from Block 6, Column 4 of the oldest of the six CPR's Format 3 and ending with the date from Block 6, Column 9 of the most recent of the six CPR's Format 3.

3. Input the values from "Six Month Forecast" in Block 6, Columns 4-9 of the oldest CPR Format 3 into Row 2, Columns B-G.

4. Continue inputting values from subsequent months CPR's, aligning the dates from Block 6, Columns 4-9 of CPR Format 3 to the dates in Row 1 of the spreadsheet.

5. For the past 6 periods identified in row 1, identify the min and max values.

6. Calculate the Baseline Revision Percentage for each of the last 6 months using the following calculation:

$$\text{Baseline Revision (\%)} = \frac{\text{Maximum} - \text{Minimum}}{\text{Minimum}} \times 100$$

If this metric exceeds 5% there is high volatility in the near term plan, and it should be documented in the PAR as an issue. This metric can be generated/reported through wInsight.

2.8 EVM SYSTEM STATUS

The EVM System Status is important for stakeholders that depend on EVMS data. The System Status indicates if the data generated by the contractor EVMS is reliable for management decision making. The DCMA Standard Surveillance Instruction (SSI) used by CMOs, and the Compliance Review Instruction (CRI) used by the EVM Center outline what steps are necessary to ensure a contractor EVMS is in compliance with ANSI/EIA-748 Guidelines.

This section of the PAR requires the following information:

- The status of system acceptance by DCMA.

- EVM system surveillance results

- Status of open Corrective Action Requests (CAR) and ongoing Corrective Action Plans (CAP)

The first bullet is a product of the CRI process and is represented by either a Letter of Acceptance (LOA) or Advance Agreement (AA). The remaining bullets are products of the SSI process. Take all of these items into consideration to determine the overall health of the contractor's EVMS.

2.9 EV ASSESSMENT POINT OF CONTACT (POC)

The official EV point of contact for each contractor site is maintained on a spreadsheet by the EVM Center. Those POCs conduct system surveillance and produce the applicable documents per the SSI. If there is a separate POC for program analysis, list both names and contact information in this section of the PAR.

3.0 INTEGRATED DATA ANALYSIS PERFORMANCE INDICATORS

The integrated data analysis performance indicators (PIs) will be used by DCMA to quickly determine program and overall supplier status with respect to EVMS and other functional areas. The PIs will be located and maintained in Metrics Studio. Figure 1 below outlines the PIs related to EVM. For ease of reference, the numbering scheme in section 3.0 of this Pamphlet reflects the numbering scheme in Figure 1.
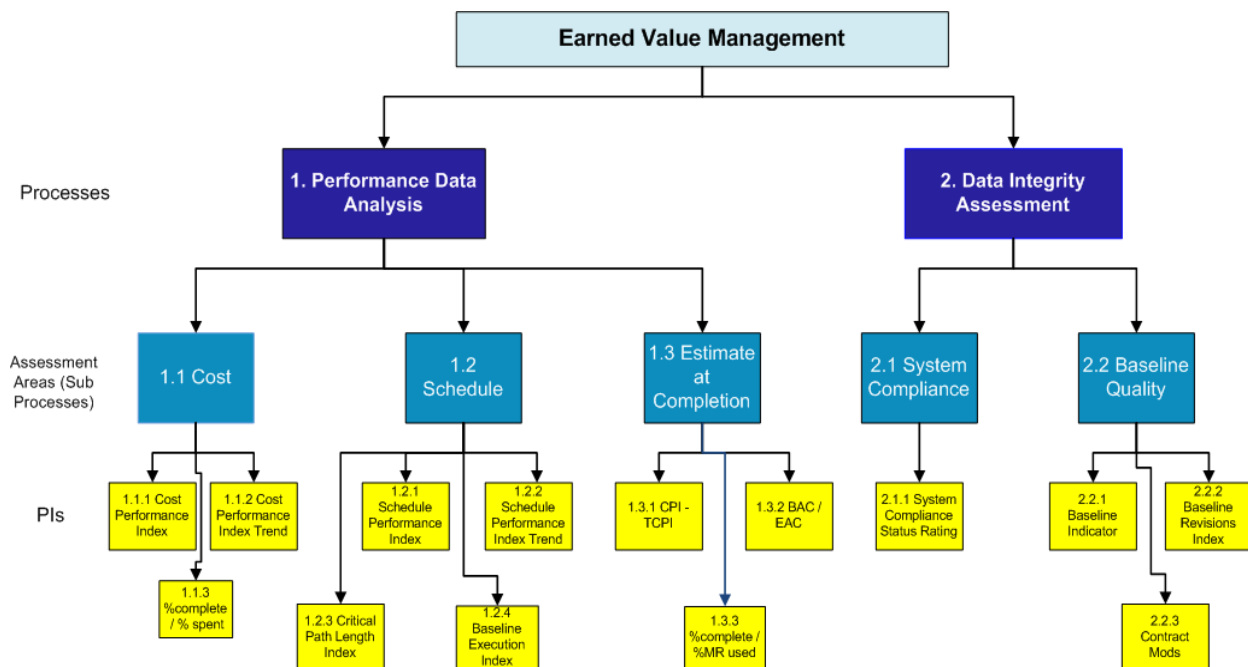
Figure 1: EVM Performance Indicators

3.1 PERFORMANCE DATA ANALYSIS

The performance indicators are grouped into two main categories: Performance Data Analysis and Data Integrity Assessment. This section discusses Performance Data Analysis. As the names suggest, these metrics relate to how well the program is performing with respect to cost, schedule, and EAC management. These metrics reflect program execution with respect to the performance measurement baseline (PMB).

3.1.1 COST

The first subgroup of performance metrics is cost. The cost performance metrics selected for performance indicators are Cost Performance Index (CPI), CPI Trend, and the ratio "% complete" to "% spent."

3.1.1.1 COST PERFORMANCE INDEX (CPI)

The Cost Performance Index (CPI) is an efficiency factor representing the relationship between the performance accomplished (BCWP) and the actual cost expended (ACWP). The CPI for programs without an OTB is calculated as follows:

$$\text{Cost Performance Index}_{\text{cumulative}} = \frac{\text{Earned}}{\text{Actual}}$$

or

$$CPI_{\text{cum}} = \frac{BCWP_{\text{cum}}}{ACWP_{\text{cum}}}$$

An index of 1.00 or greater indicates that work is being accomplished at a cost equal to or below what was planned. An index of less than 1.00 suggests work is accomplished at a cost greater than planned. A cumulative index of less than 0.95 is used as an early warning indicator of cost increase and should be investigated.

$BCWP_{\text{cum}}$ is found in block 8.g. column 8 of CPR Format 1 and $ACWP_{\text{cum}}$ in block 8.g. column 9. The CPI for programs with an OTB is calculated as follows:

$$CPI_{\text{adj}} = \frac{BCWP_{\text{cum}} - BCWP_{\text{prior to OTB}}}{ACWP_{\text{cum}} - ACWP_{\text{prior to OTB}}}$$

3.1.1.2 COST PERFORMANCE INDEX TREND

The CPI Trend is a comparison of the metric this reporting period (usually monthly) to the same metric in prior reporting periods. A CPI trend is favorable if the CPI increases in value over the course of multiple reporting periods. Conversely, the CPI trend is unfavorable if it decreases.

3.1.1.3 THE RATIO: "PERCENT COMPLETE" TO "PERCENT SPENT"

This metric is a ratio of two other metrics for the purpose of gauging the amount of budget spent in relation to the amount of work completed. The first part of this metric, the numerator, is Percent Complete (%comp). The formula to calculate %comp is as follows:

$$\text{Percent Complete } (\%) = \%\text{comp} = \frac{\text{BCWP}_{cum}}{\text{BAC}} \times 100$$

The value range of %comp is from 0% to 100%. It provides a measure of how far along the program is toward project completion. The second part of the metric, the denominator, is Percent Spent (%spent). The formula to calculate % spent is as follows:

$$\text{Percent Spent } (\%) = \%\text{spent} = \frac{\text{ACWP}_{cum}}{\text{BAC}} \times 100$$

The value range of %spent starts at 0% and since it tracks actual cost, theoretically has no limit. It provides a measure of how far along the program is toward completion. If %spent is over 100%, it indicates a cost over-run condition has been realized. The combination of these two metrics results in the following formula:

$$\frac{\%\text{comp}}{\%\text{spent}} = \frac{\text{BCWP}_{cum}/\text{BAC}}{\text{ACWP}_{cum}/\text{BAC}} = \frac{\text{BCWP}_{cum}}{\text{ACWP}_{cum}} = \text{Cost Performance Index (CPI)}$$

When measured independently, %comp and %spent provide additional insight into program performance. As shown above, the ratio of these two metrics results in the CPI.

3.1.2 SCHEDULE

The second subgroup of performance metrics is schedule. The schedule performance metrics selected for performance indicators are the Schedule Performance Index (SPI), the SPI Trend, the Critical Path Length Index (CPLI), and the Baseline Execution Index (BEI).

3.1.2.1 SCHEDULE PERFORMANCE INDEX (SPI)

The Schedule Performance Index (SPI) is an efficiency factor representing the relationship between the performance achieved and the initial planned schedule. The SPI for programs without an OTB is calculated as follows:

$$\text{Schedule Performance Index}_{\text{cumulative}} = \frac{\text{Earned}}{\text{Budgeted}}$$

or

$$\text{SPI}_{\text{cum}} = \frac{\text{BCWP}_{\text{cum}}}{\text{BCWS}_{\text{cum}}}$$

An index of 1.00 or greater indicates that work is being accomplished at a rate on or ahead of what was planned. An index of less than 1.00 suggests work is being accomplished at a rate below the planned schedule. An index of less than 0.95 is used as an early warning indication of execution and should be investigated.

BCWP_{cum} is found in block 8.g. column 8 of CPR Format 1 and BCWS_{cum} in block 8.g. column 7. The SPI for programs with an OTB is calculated as:

$$\text{SPI}_{\text{cum}} = \frac{\text{BCWP}_{\text{cum}} - \text{BCWP}_{\text{cum @ time of OTB}}}{\text{BCWS}_{\text{cum}} - \text{BCWS}_{\text{cum @ time of OTB}}}$$

3.1.2.2 SCHEDULE PERFORMANCE INDEX (SPI) TREND

Similar to the CPI Trend, the SPI Trend is a comparison of the metric for this reporting period (usually monthly) to the same metric in prior reporting periods. An SPI trend is favorable if the SPI increases in value over the course of multiple reporting periods. Conversely, the SPI trend is unfavorable if it decreases in value.

3.1.2.3 CRITICAL PATH LENGTH INDEX (CPLI)

The Critical Path Length Index (CPLI) is a measure of the efficiency required to complete a milestone on-time. It measures critical path "realism" relative to the baselined finish date, when

constrained. A CPLI of 1.00 means that the program must accomplish one day's worth of work for every day that passes. A CPLI less than 1.00 means that the program schedule is inefficient with regard to meeting the baseline date of the milestone (i.e. going to finish late). A CPLI greater than 1.00 means the program is running efficiently with regard to meeting the baseline date of the milestone (i.e. going to finish early). The CPLI is an indicator of efficiency relating to tasks on a milestone's critical path (not to other tasks within the schedule). The CPLI is a measure of the relative achievability of the critical path. A CPLI less than 0.95 should be considered a flag and requires further investigation.

The CPLI requires determining the program schedule's Critical Path Length (CPL) and the Total Float (TF). The CPL is the length in work days from time now until the next program milestone that is being measured. TF is the amount of days a project can be delayed before delaying the project completion date. TF can be negative, which reflects that the program is behind schedule. The mathematical calculation of total float is generally accepted to be the difference between the "late finish" date and the "early finish" date (late finish minus early finish equals total float). The formula for CPLI is as follows:

$$\text{Critical Path Length Index (CPLI)} = \frac{\text{CPL} + \text{TF}}{\text{CPL}}$$

For programs that provide the IMS in a native schedule format, use the "Critical Path guide" to determine the program's critical path. Once the critical path has been identified, the CPL is calculated by inserting a new task into the IMS, with an actual start date of the IMS status date. The CPL is determined by inserting a number value in the duration of this new task until the finish date equals the finish date of the completion milestone identified by the critical path analysis. This is a trial and error process to get the correct duration for the CPL. Total Float for the completion milestone is recorded for conducting the CPLI calculation.

For programs that provide the IMS in a static format, the CPL is estimated by counting workdays between the start and finish. This can also be done by creating a new project file and entering the dates in the manner described in the Critical Path Guide. Total Float used for this method is

the float for the completion milestone identified on the critical path. If the IMS is not delivered in the native software tool and is not independently verified note the data used, method of verification or that verification could not be independently conducted, and method used to assess the critical path.

In addition to recording the CPLI results, it is important to document any rationale for the completion milestone chosen and the analysis method used to calculate the critical path. It is also important to note if the final milestone or task in the schedule has a baseline finish date beyond the contract period of performance (CPR Format 3, Block 5.k.).

3.1.2.4 BASELINE EXECUTION INDEX (BEI)

The Baseline Execution Index (BEI) metric is an IMS-based metric that calculates the efficiency with which tasks have been accomplished when measured against the baseline tasks. In other words, it is a measure of task throughput. The BEI provides insight into the realism of program cost, resource, and schedule estimates. It compares the cumulative number of tasks completed to the cumulative number of tasks with a baseline finish date on or before the current reporting period. BEI does not provide insight into tasks completed early or late (before or after the baseline finish date), as long as the task was completed prior to time now. See the Hit Task Percentage metric below for further insight into on-time performance. If the contractor completes more tasks than planned, then the BEI will be higher than 1.00 reflecting a higher task throughput than planned. Tasks missing baseline finish dates are included in the denominator. A BEI less than 0.95 should be considered a flag and requires additional investigation. The BEI is calculated as follows:

$$BEI_{cum} = \frac{\text{Total \# of Tasks Complete}}{\text{Total \# of Tasks Completed Before Now} + \text{Total \# of Tasks Missing Baseline Finish Date}}$$

The BEI is always compared against the Hit Task Percentage. The Hit Task Percentage is a metric that measures the number of tasks completed early or on time to the number of tasks with a baseline finish date within a given fiscal month. This metric can never exceed a value of 1,

since the metric assesses the status of tasks with a base finish date within a single fiscal month. The following are definitions to become familiar with when calculating the BEI metric:

- Total Tasks: The total number of tasks with detail level work associated to them
- Baseline Count: The number of tasks with a baseline finish date on or before the reporting period end

Begin by exporting or copying the IMS data to an MS Excel Worksheet. Include the Unique ID, Task Name, EV Method, Duration, Summary, Actual Finish, Baseline Finish and Finish Variance fields from the IMS file. Employ the following steps:

1. Filter out Level of Effort (LOE) tasks, summary tasks, and zero duration tasks (milestones).
2. Filter the Baseline Finish data to include only dates up to the current reporting period of the IMS.
3. Subtotal the number of tasks as the "Baseline Count".
4. Undo the filter on Baseline Finish.
5. Filter the Actual Finish data to include only dates up to the current reporting period of the IMS.
6. Subtotal the number of tasks as the "Total number of tasks completed".
7. Undo the filter on Actual Finish.
8. Divide the "Total number of tasks completed" by the "Baseline Count" to get the BEI value.

The Hit Task Percentage is calculated as follows:

$$\text{Hit Task \%} = \frac{\text{Total \# of tasks complete on or before task baseline date}}{\text{\# of tasks with baseline finish date within current reporting period}}$$

Steps:

1. Using the same spreadsheet used to calculate the BEI, clear all filters and reapply filters to remove all LOE, summary and zero duration (milestone) tasks.

2. Filter the baseline finish less than or equal to current reporting month end.

3. Subtotal these tasks as "Current Period Baseline Count" tasks.

4. Filter (within above filter) the actual finish less than or equal to baseline finish date.

5. Subtotal these tasks as "Actual Hit".

6. Divide the "Actual Hit" number by the "Current Period Baseline" number to get the Current Hit Task Percentage.

3.1.3 ESTIMATE AT COMPLETION (EAC)

The third subgroup of performance metrics is estimate at completion (EAC). The EAC metrics selected for performance indicators are CPI-TCPI and the ratio of BAC to EAC and %comp to %MR used.

3.1.3.1 "COST PERFORMANCE INDEX" – "TO COMPLETE PERFORMANCE INDEX"

This metric compares the Cost Performance Index (CPI_{cum}) to the To Complete Performance Index ($TCPI_{EAC}$). This metric gauges the realism of the contractor's Latest Revised Estimate (LRE) or Estimate at Completion (EAC). A mathematical difference of 0.10 or greater is used as an early warning indication that the contractor's forecasted completion cost could possibly be unrealistic, stale, or not updated recently.

A CPI_{cum} – $TCPI_{EAC}$ difference greater than or equal to 0.10 (Using the absolute value of the difference) should be considered a flag. To begin it is first necessary to calculate the CPI_{cum}. Follow the same method described in section 3.1.1.1 of this Pamphlet. The CPI_{cum}.formula is repeated here for convenience:

$$\text{Cost Performance Index } (CPI_{cum}) = \frac{BCWP_{cum}}{ACWP_{cum}}$$

$TCPI_{EAC}$ reflects the work remaining divided by the cost remaining as follows:

$$\text{To Complete Performance Index } (\text{TCPI}_{\text{EAC}}) = \frac{\text{BAC} - \text{BCWP}_{\text{cum}}}{\text{EAC} - \text{ACWP}_{\text{cum}}}$$

In the case of an OTB, replace Budget at Completion (BAC) with the Total Allocated Budget (TAB). The EAC used in this formula is the contractor's most likely EAC from Block 6.c. of the header information in the CPR Format 1.

The CPI_{cum} and the TCPI_{EAC} are compared to evaluate the realism of the supplier's EAC and to evaluate the reasonableness of using past efficiencies to predict future efficiencies. It is possible that the nature of the work has changed thus making predictions of the future based on past performance unjustified.

3.1.3.2 THE RATIO: "BUDGET AT COMPLETION" TO "ESTIMATE AT COMPLETION"

The budget at completion (BAC) and estimate at completion (EAC) are values that can be found on the CPR Format 1. This metric divides BAC by EAC to determine a ratio. A ratio value above 1.0 indicates the program is estimate to complete under cost. A ratio value of less than 1.0 indicates a projected cost over-run.

3.1.3.3 THE RATIO: "% COMPLETE" TO "% MANAGEMENT RESERVE USED"

This metric divides the program percent complete (%comp) by the percentage of management reserve (%MR) used to date. It provides insight into how quickly the MR is being depleted. If the rate of MR usage is high it may indicate the original performance measurement baseline did not contain the necessary budget for accomplishing the contract statement of work. Since this metric is a ratio of two different metrics, those components must be calculated first. To calculate %comp use the following formula:

$$\text{Percent Complete } = \%\text{comp} = \frac{\text{BCWP}_{\text{cum}}}{\text{BAC}} \times 100$$

To calculate %MR, use the following formula:

$$\text{Percent Management Reserve} = \%\text{MR} = \frac{\text{Total amount of MR used}}{\text{Total amount of MR added to the program}}$$

Keep in mind that MR may be added or removed based on contractual actions. So it is important to account for all the MR debits and credits when calculating this metric. It is not simply the current value of MR divided by the original value of MR. In fact, if significant credits have been made to MR since program inception, the current MR value might actually be greater than the original value, even if some MR was debited.

Now take the ratio of %comp and %MR:

$$\text{Ratio} = \frac{\text{Percent Complete}}{\text{Percent Management Reserve}} = \frac{\%\text{comp}}{\%\text{MR}}$$

3.2 DATA INTEGRITY ASSESSMENT

This section of the EVM performance indicators discusses Data Integrity. As the name suggests, these metrics determine the validity and accuracy of EVM data produced by the contractor for management decision making. These metrics reflect the trustworthiness of EVM reports, such as the CPR.

3.2.1 SYSTEM COMPLIANCE

As the Department of Defense Executive Agent for EVMS, DCMA determines the system compliance of a contractor's EVMS. System Compliance is one type of data integrity assessment as it helps ensure the EVM data is valid.

3.2.1.1 SYSTEM COMPLIANCE STATUS RATING

The system compliance rating can be Approved, Non-Approved, Not Evaluated, or Not Applicable. See section 2.8 for a detailed discussion regarding the EVM system status. Ratings can be found in approved supplier lists.

3.2.2 BASELINE QUALITY

Baseline quality is a type of data integrity assessment that determines the quality of the initial performance measurement baseline (PMB). The metrics indicate the amount of planning and forethought placed into the PMB.

3.2.2.1 BASELINE INDICATOR

The Baseline Indicator assesses the health of the contractor's Performance Measurement Baseline (PMB). It is a qualitative metric that identifies the quality, completeness and adequacy of the contractor's Integrated Baseline Review (IBR) and any follow-on baseline reviews. The following is a list of events that would adversely impact this indicator:

1. Initial IBR not conducted within 180 days from the contract award date.
2. Incomplete IBR conducted; cost, schedule, technical, resource and management risks not addressed in the IBR.
3. Inadequate plan to address the program risks; risks can be assessed as high but the supplier either needs to have a plan to mitigate the risk or account for it with a larger Estimate at Completion (EAC).
4. Follow on IBRs not conducted within 180 days.
5. IBR not conducted after major scope changes, formal reprogramming/restructuring or re-baseline efforts.
6. Baseline does not capture the total scope of work.
7. Supplier does not have an executable, time-phased plan (resourced IMS).
8. Multiple, ineffective Over Target Baselines (OTBs) or incorrectly implemented OTBs over the life of the program.
9. Excessive, ongoing baseline revisions.

Documents to review include the IBR briefs, action item resolution forms, and out-brief risks and risk mitigation plans.

With respect to IBR documentation, ensure that:

1. The date the IBR is conducted falls within the required time limit from contract award.
2. If high risks were identified at IBR:

a. Have the risks been mitigated? or

b. Have mitigation plans been developed? or

c. Have the risks been offset by budgetary and/or schedule considerations?

With respect to the IMS, ensure that:

1. All tasks have baseline start and baseline finish dates

2. Risk and Mitigation plans from IBR or subsequent re-plans have been incorporated into IMS

3. Frank discussions with PI and EVMS Specialists are held to get their opinion of the adequacy/scope of the IBR(s).

3.2.2.2 BASELINE REVISIONS INDEX

See section 2.7 for a detailed discussion regarding the baseline revisions index.

3.2.2.3 CONTRACT MODIFICATIONS

The Contract Modifications metric highlights changes made to the contract dollar value from the time of award to the present. A delta of ten percent is used as an early warning indication that the program's technical requirements were not understood at the time of contract award, poor contracting practices were in place, and the entire scope of the contract may not be entirely understood. This metric helps to identify when new requirements have been added to the contract (requirements creep) or when existing requirements have been modified extensively. A Contract Modifications percentage greater than or equal to 10% should be considered a flag. The Contract Modification Calculation is performed as follows:

$$\text{Contract Mods \%} = \frac{(\text{CPR Format 3 Block 5. e}) - (\text{CPR Format 3 Block 5. a})}{\text{CPR Format 3 Block 5. a}} \times 100$$

4.0 14 POINT SCHEDULE METRICS FOR IMS (PROJECT/OPEN PLAN, ETC.) ANALYSIS

The DCMA 14 Point Schedule Metrics were developed to identify potential problem areas with a contractor's IMS. These metrics provide the analyst with a framework for asking educated questions and performing follow-up research. The identification of a "red" metric is not in and of itself synonymous with failure but rather an indicator or a catalyst to dig deeper in the analysis for understanding the reason for the situation. Consequently, correction of that metric is not necessarily required but it should be understood. A detailed and comprehensive training course has been developed (Reference 3). The training identifies the techniques (14 Point Assessment), tools, and reference materials used by EVMS Specialists to accomplish schedule analysis requirements. After taking the course students will be able to determine whether schedules are realistic and perform schedule analysis using tools such as MS Project and MS Excel. The Agency's automated MS Project macro for performing the 14 Point Assessment is demonstrated and provided within the course presentation; which is available online at http://guidebook.dcma.mil/51/index.cfm#tools.

4.1 LOGIC

This metric identifies incomplete tasks with missing logic links. It helps identify how well or poorly the schedule is linked together. Even if links exist, the logic still needs to be verified by the technical leads to ensure that the links make sense. Any incomplete task that is missing a predecessor and/or a successor is included in this metric. The number of tasks without predecessors and/or successors should not exceed 5%. An excess of 5% should be considered a flag. The formula for calculating this metric is as follows:

$$\text{Missing Logic \%} = \frac{\text{\# of tasks missing logic}}{\text{\# of incomplete tasks}} \times 100$$

4.2 LEADS

This metric identifies the number of logic links with a lead (negative lag) in predecessor relationships for incomplete tasks. The critical path and any subsequent analysis can be adversely affected by using leads. The use of leads distorts the total float in the schedule and

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may cause resource conflicts. Per the IMS Data Item Description (DID), negative time is not demonstrable and should not be encouraged. Using MS Excel, count the number of "Leads" that are found. Leads should not be used; therefore, the goal for this metric is 0.

$$\text{Leads \%} = \frac{\text{\# of logic links with leads}}{\text{\# of logic links}} \times 100$$

4.3 LAGS

This represents the number of lag in predecessor logic relationships for incomplete tasks. The critical path and any subsequent analysis can be adversely affected by using lags. Per the IMS DID, lag should not be used to manipulate float/slack or to restrain the schedule. Using MS Excel, count the number of "Lags" that are found. The number relationships with lags should not exceed 5%.

$$\text{Lags \%} = \frac{\text{\# of logic links with lags}}{\text{\# of logic links}} \times 100$$

4.4 RELATIONSHIP TYPES

The metric provides a count of incomplete tasks containing each type of logic link. The Finish-to-Start (FS) relationship type ("once the predecessor is finished, the successor can start") provides a logical path through the program and should account for at least 90% of the relationship types being used. The Start-to-Finish (SF) relationship type is counter-intuitive ("the successor can't finish until the predecessor starts") and should only be used very rarely and with detailed justification. By counting the number of Start- to-Start (SS), Finish-to-Finish (FF), and Start-to-Finish (SF) relationship types, the % of Finish-to-Start (FS) relationship types can be calculated.

4.5 HARD CONSTRAINTS

This is a count of incomplete tasks with hard constraints in use. Using hard constraints [Must-Finish-On (MFO), Must-Start-On (MSO), Start-No-Later-Than (SNLT), & Finish- No-Later-Than (FNLT)] will prevent tasks from being moved by their dependencies and, therefore,

prevent the schedule from being logic-driven. Soft constraints such as As- Soon-As-Possible (ASAP), Start-No-Earlier-Than (SNET), and Finish-No-Earlier-Than (FNET) enable the schedule to be logic-driven. Divide the total number of hard constraints by the number of incomplete tasks. The number of tasks with hard constraints should not exceed 5%.

$$\text{Hard Constraint \%} = \frac{\text{Total \# of incompelte tasks with hard constraints}}{\text{Total \# of incomplete tasks}} \times 100$$

4.6 HIGH FLOAT

An incomplete task with total float greater than 44 working days (2 months) is counted in this metric. A task with total float over 44 working days may be a result of missing predecessors and/or successors. If the percentage of tasks with excessive total float exceeds 5%, the network may be unstable and may not be logic-driven.

$$\text{High Float \%} = \frac{\text{Total \# of incompelte tasks with high float}}{\text{Total \# of incomplete tasks}} \times 100$$

4.7 NEGATIVE FLOAT

An incomplete task with total float less than 0 working days is included in this metric. It helps identify tasks that are delaying completion of one or more milestones. Tasks with negative float should have an explanation and a corrective action plan to mitigate the negative float. Divide the total number of tasks with negative float by the number of incomplete tasks. Ideally, there should not be any negative float in the schedule.

$$\text{Negative Float \%} = \frac{\text{Total \# of incompelte tasks with negative float}}{\text{Total \# of incomplete tasks}} \times 100$$

4.8 HIGH DURATION

An incomplete task with a baseline duration greater than 44 working days (2 months), and has a baseline start date within the detail planning period or rolling wave is included in this metric. It helps to determine whether or not a task can be broken into two or more discrete tasks rather than one. In addition, it helps to make tasks more manageable; which provides better insight into

cost and schedule performance. Divide the number of incomplete tasks with high duration tasks by the total number of incomplete tasks. The number of tasks with high duration should not exceed 5%.

$$\text{High Duration \%} = \frac{\text{Total \# of incompelte tasks with high duration}}{\text{Total \# of incomplete tasks}} \times 100$$

4.9 INVALID DATES

Incomplete tasks that have a forecast start/finish date prior to the IMS status date, or has an actual start/finish date beyond the IMS status date are included in this metric. A task should have forecast start and forecast finish dates in the future relative to the status date of the IMS (i.e. if the IMS status date is 8/1/09, the forecast date should be on or after 8/1/09). A task should not have an actual start or actual finish date that is in the future relative to the status date of the IMS (i.e. if the IMS status date is 8/1/09, the actual start or finish date should be on or before 8/1/09, not after 8/1/09). There should not be any invalid dates in the schedule.

4.10 RESOURCES

This metric provides verification that all tasks with durations greater than zero have dollars or hours assigned. Some contractors may not load their resources into the IMS. The IMS DID (DI-MGMT-81650) does not require the contractor to load resources directly into the schedule. If the contractor does resource load their schedule, calculate the metric by dividing the number of incomplete tasks without dollars/hours assigned by the total number of incomplete tasks.

$$\text{Missing Resource \%} = \frac{\text{Total \# of incomplete tasks with missing resource}}{\text{Total \# of incomplete tasks}} \times 100$$

4.11 MISSED TASKS

A task is included in this metric if it is supposed to be completed already (baseline finish date on or before the status date) and the actual finish date or forecast finish date (early finish date) is after the baseline finish date or the Finish Variance (Early Finish minus Baseline Finish) is greater than zero. This metric helps identify how well or poorly the schedule is meeting the

baseline plan. To calculate this metric, divide the number of missed tasks by the baseline count which does not include the number of tasks missing baseline start or finish dates. The number of missed tasks should not exceed 5%.

$$\text{Missed \%} = \frac{\text{\# of tasks with actual/forecast finish date past baseline date}}{\text{\# of tasks with baseline finish dates on or before status date}} \times 100$$

4.12 CRITICAL PATH TEST

The purpose is to test the integrity of the overall network logic and, in particular, the critical path. If the project completion date (or other milestone) is not delayed in direct proportion (assuming zero float) to the amount of intentional slip that is introduced into the schedule as part of this test, then there is broken logic somewhere in the network. Broken logic is the result of missing predecessors and/or successors on tasks where they are needed. The IMS passes the Critical Path Test if the project completion date (or other task/milestone) show a negative total float number or a revised Early Finish date that is in direct proportion (assuming zero float) to the amount of intentional slip applied.

4.13 CRITICAL PATH LENGTH INDEX (CPLI)

See section 3.1.2.3 for a detailed discussion regarding the critical path length index.

4.14 BASELINE EXECUTION INDEX (BEI)

See section 3.1.2.4 for a detailed discussion regarding the Baseline Execution Index.

5.0 DATA INTEGRITY INDICATORS

Data integrity indicators are metrics designed to provide confidence in the quality of the data being reviewed. Many of the other metrics described in the EVMSPAP are designed to provide insight into the performance of a program. The data integrity metrics are not primarily intended for program performance information. If control accounts or work packages have one of the conditions being tested for by these metrics, then the EVMS Specialist should investigate further.

5.1 $BCWS_{cum} > BAC$

The budgeted cost of work scheduled (BCWS) is the program budget time-phased over the period of performance. The summation of BCWS for all reporting periods should equal the budget at completion (BAC). In other words, $BCWS_{CUM}$ should equal BAC on the month the program is planned to complete. Both of these values can be found on the CPR Format 1. Due to this relationship, the value of $BCWS_{CUM}$ should never exceed BAC. Errors may exist in EVMS data resulting in this condition, thereby making it necessary to perform this metric. The calculation of this metric is simple. Compare the value of $BCWS_{CUM}$ to the value of BAC; if $BCWS_{cum}$ is greater than BAC, consider this an error in the EVMS data and pursue corrective action. There is no plausible explanation. If the value of $BCWS_{cum}$ is less than BAC, there is no issue.

5.2 $BCWP_{cum} > BAC$

The budgeted cost of work performed (BCWP) is the amount of BCWS earned by the completion of work to date. Like the metric in section 5.1, $BCWP_{cum}$ may not exceed the value of BAC. The program is considered complete when $BCWP_{cum}$ equals BAC. The calculation of this metric is simple. Compare the value of $BCWP_{cum}$ to BAC. If $BCWP_{cum}$ is greater, then this is an error requiring corrective action. Otherwise there is no issue.

5.3 ACWP$_{cum}$ WITH NO BAC

The actual cost of work performed (ACWP) is the total dollars spent on labor, material, subcontracts, and other direct costs in the performance of the contract statement of work. These costs are controlled by the accounting general ledger and should reconcile between the accounting system and EVMS. Work should only be performed if there is a clear contractual requirement. The BAC is required to be traceable to work requirements in the contract statement of work. If work is performed and ACWP$_{cum}$ incurred without applicable BAC, there may be a misalignment between this work and the requirements of the contract. To test for this condition, simply review the CPR Format 1 or wInsight data for WBS elements containing ACWP$_{cum}$ but no BAC. If there are elements that meet these criteria, consider this an error that must be investigated. The contractor should provide justification and must take corrective action regardless of the reason.

5.4 ACWP$_{cur}$ WITH NO BAC

Similar to section 5.3 above, this metric differs in that current reporting period actual costs (ACWP$_{cur}$) are being compared to the BAC. The calculation of this metric and the meaning of its results are identical to section 5.3.

5.5 NEGATIVE BAC

BAC is the total budget assigned to complete the work defined within the contract. A negative total budget is not logical. To test for this condition simply examine the CPR Format 1 or wInsight data for a BAC less than zero. This test should be performed at the reported WBS levels as well as the total program level. A BAC less than zero should be considered an error and corrective action must be taken by the contractor.

5.6 ZERO BUDGET WPs

Work packages (WPs) are natural subdivisions of control accounts (CAs). The summation of all WP budgets within a given CA results in the CA budget. If there is a WP with a budget of zero, it should be considered an error because no work can be performed without budget. At a minimum, there is no need for the WP with a BAC of zero. To test for this condition a detailed

EVMS report must be obtained from the contract. The CPR Format 1 will not contain sufficient detail down to the WP level. The contractor can easily export to wlnsight the EVMS data down to the WP level. It is important to understand at which levels of the WBS the contractor established CAs and WPs. Examine this report to determine if any WPs have a BAC of zero. Consider this condition an error requiring corrective action.

5.7 LEVEL OF EFFORT WITH SCHEDULE VARIANCE

Level of effort (LOE) is an earned value technique (EVT) used to calculate BCWP for work that is supportive in nature and produces no definable end product. See ANSI/EIA-748 EVMS Guideline 12 for more information on LOE requirements. The LOE technique automatically earns BCWP equal to the amount of BCWS for the reporting period. Since schedule variance (SV) is defined as the difference between BCWP and BCWS, work measure with the LOE EVT should have an SV of zero. BCWP is earned at the WP level. Therefore a report with WP level detail and indication of EVT used is required to perform this metric. This report can be requested from the contractor as a wlnsight export or other electronic format, such as Microsoft Excel. Simply check all elements with an EVT of LOE for an SV other than zero. If this condition exists consider it an error that requires corrective action.

5.8 BCWP WITH NO ACWP

Since work or materials must be paid for, it is not possible to earn BCWP without incurring ACWP. This condition may occur for elements using the LOE EVT. In this case, it would signify the support work that was planned to occur is not occurring due to some delay. The delay is likely in the work the LOE function would support. Either way, this condition should be flagged and investigated to determine the root cause. This metric can be calculated using the CPR Format 1 or more detailed wlnsight data. Inspect the elements on the report for any instance of $BCWP_{cum}$ with an $ACWP_{cum}$ equal to zero.

5.9 COMPLETED WORK WITH ETC

Work is considered complete when the CA or WP $BCWP_{cum}$ equals BAC. The estimate to complete (ETC) is the to-go portion of the estimate at completion (EAC). The ETC should be

zero if the work is complete, as there should be no projected future cost left to incur. A detailed report from the contractor's EVMS is required to calculate this metric. The report will need to have all the information contained in the CPR Format 1 in addition to providing the ETC by WBS element. Examine this report for completed elements ($BCWP_{cum} = BAC$) with an ETC other than zero. This condition may exist if labor or material invoices are lagging behind and haven't been paid yet. However, this requires investigation to determine the root cause.

5.10 INCOMPLETE WORK WITHOUT ETC

This metric is the converse of section 5.9 of this Pamphlet. If work has yet to be completed, there should be a forecast of the remaining costs to be incurred. Obtain a report similar to the one described in the previous section. Determine if there are any elements that are incomplete ($BCWP_{cum} < BAC$) and contain an ETC of zero. If this condition exists consider it an error that requires corrective action.

5.11 ACWP ON COMPLETED WORK

As discussed in section 5.9 of this Pamphlet, there may be valid reasons to incur cost (ACWP) following the completion of work ($BCWP_{cum} = BAC$). However, this should not be considered the norm. Review the CPR format 1 or a more detailed wlnsight report for the following:

1. $BCWP_{cum} = BAC$, and
2. $BCWP_{cur} = 0$, and
3. $ACWP_{cur} \neq 0$

Keep in mind there may be costs incurred in the month the element of work is complete. That is why it's necessary to check for item 2 above. This insures the work was completed in a prior period and if item 3 returns a value other than zero the metric is flagged. Investigate further and require corrective action if necessary.

5.12 CPI-TCPI > 0.10

This metric differs from others in this section as it does not result in a clear error. A CPI-TCPI > 0.10 may indicate an overly pessimistic EAC; that is, in this case, the EAC implies an expected

drop in cost performance by 0.10 or more for the remainder of the contract. It should be used as a flag for further investigation into the reasonableness of the EAC. This metric can be performed at the control account or total program level. See section 3.1.3.1 for further details on this metric.

5.13 CPI-TCPI < -0.10

This metric differs from others in this section as it does not result in a clear error. A CPI-TCPI < 0.10 may indicate an overly optimistic EAC that implies an expected increase in cost performance by 0.10 or more for the remainder of the contract. It should be used as a flag for further investigation into the reasonableness of the EAC. This metric can be performed at the control account or total program level. See section 3.1.3.1 for further details on this metric.

5.14 $ACWP_{CUM} > EAC$

The Estimate at Completion (EAC) consists of two components, the actual costs incurred to date ($ACWP_{cum}$) and the estimate of future costs to be incurred or the estimate to completion (ETC). The EAC formula is as follows:

$$EAC = ACWP_{cum} + ETC$$

The $ACWP_{cum}$ can only be greater than EAC if the ETC is negative. There may be limited cases that would require a negative ETC. However, this is not the norm. Using the CPR Format 1 or a wlnsight report, examine the elements for any condition of $ACWP_{cum}$ greater than EAC. If this condition exists, further investigation is required.

5.15 NEGATIVE $BCWS_{CUM}$ OR NEGATIVE $BCWS_{CUR}$

The budgeted cost of work scheduled (BCWS) is the time-phased contract budget. The summation of BCWS for all reporting periods equals the total contract budget at completion. When the initial baseline is established there should be no instances of negative BCWS. However, as work progresses there may be legitimate reasons for re- planning of budget. These changes to the baseline may result in a negative value for budget in the current reporting period, or $BCWS_{cur}$. It is not possible to re-plan more budget than has already been time-phased to date.

Therefore, there should not be an instance of negative $BCWS_{cum}$. To test for this condition simply examine the current and cumulative sections of the CPR Format 1 for $BCWS_{cum}$ or $BCWS_{cur}$ less than zero. If there are instances of either value being negative, investigate further to determine the root cause.

5.16 NEGATIVE BCWP$_{cum}$ OR NEGATIVE BCWP$_{cur}$

Similar to section 5.15 of this Pamphlet, there may be instances of negative BCWP due to re-plan actions. However, a re-plan would not result in negative cumulative performance, or $BCWP_{cum}$. To test for this condition simply examine the current and cumulative sections of the CPR Format 1 for $BCWP_{cum}$ or $BCWP_{cur}$ less than zero. If there are instances of either value being negative, investigate further to determine the root cause.

5.17 EVM COST TOOL TO IMS WORK PACKAGE COMPARISON

This metric is the only one in section 5.0 of this Pamphlet that requires an examination of two integrated EVMS subcomponents, the cost and scheduling tools. The intent is to ensure the integrated master schedule (IMS) contains all of the discrete (non-LOE) work packages represented in the cost tool. LOE work is not required to be included in the IMS. The proper integration of these two systems is critical to the accuracy of performance data produced by the EVMS. An electronic copy of the IMS with WP number references and an electronic copy of a cost tool report down to the WP level are required to perform this metric. In the IMS, filter out any WPs with an LOE EVT. Note the number of discrete work packages in the schedule. In the cost tool report (possible wInsight), filter out any WPs with an LOE EVT. Note the number of discrete work packages in the cost tool. The formula to calculate the metric is as follows:

$$\text{Integration \%} = \frac{\text{\# of discrete WPs in IMS}}{\text{\# of discrete WPs in cost tool}} \times 100$$

The numerator was selected because it is often the case that less work packages are included in the IMS than in the cost tool. However, the opposite may be the case. If this percentage is less than 100%, it indicates some discrete work packages are missing from the IMS. If the percentage is greater than 100%, some discrete work packages are missing from the cost tool. A

percentage of 100% indicates perfect integration. If the metric is not 100%, investigate which work packages are missing and document any rationale. Corrective action may be required if supporting rationale is insufficient.

6.0 ADDITIONAL RESOURCES

1. EVMS 104, "Predictive Analysis Training EVMS 104" – This course addresses EVMS Specialist training that supports EVM Program Analysis in the techniques required to produce a standard, uniform product regardless of external demand requirements including Data Integrity Indicators, Performance Indicators, and the DCMA Trip-Wire metrics and thresholds. The combination of these analysis techniques provides unbiased insights into program cost, schedule, and/or performance issues. The instruction requirements supporting this training for EVM Program Analysis are included in the MPS and PAI. The SPA Analysis Workbook is available through DCMA and ESCP courses including EVMS 104.

2. EVMS 203, "Critical Path Analysis" – This course teaches the student how to identify the Program Critical Path and presents four predictive analysis techniques employed in schedule analysis. After error checks are performed and metrics are collected, the analyst commences in-depth schedule analysis. If the analysts come to the conclusion that the schedule is able to calculate a valid critical path based on the results thus far, then the four point final appraisal can begin. The four point Schedule Predictive Analysis consists of two "Achievability Measures" and two "Program Forecast Completion Dates."

3. ENGR 120, "Integrated Master Plan/Schedule" – This training is designed to improve skill levels of the technical workforce(Engineers, PIs, QA, IS, and EVMS Specialists) in the area of the Integrated Master Plan (IMP) and Integrated Master Schedule (IMS) with a view to (1) determining whether the program plans and schedules are realistic and (2) monitoring progress in accordance with the plan and schedule. It identifies techniques, tools, and reference materials necessary to conduct analysis of IMP/IMS in support of DCMA responsibilities. The training includes case studies and is available for local CMO schedule analysis trainings and much more in support of the Agency efforts. The importance of IMP/IMS understanding, analysis, and application in tracking and managing program performance is being emphasized from all sectors of DoD with specific responsibilities increasingly delegated to DCMA. As the acquisition program management plan, IMP and IMS are fundamental management tools that are critical to performing effective planning, scheduling, and execution of work efforts as well as for tracking total program performance,

all aspects of it including risk mitigation efforts, on a day-to-day basis. EV and other diverse ranges of management and control tools are integrated and utilized within IMP/IMS for successful program execution and best solution.

4. "Examining the Comprehensive Estimate-at-Completion" is a document which examines the prudent application of the Comprehensive Estimate-at-Completion (CEAC) and its pragmatic analysis and assessment to support the creation of the final report. The CEAC is to be done at least annually for all contractors and subcontractors wishing to remain compliant to the Federal Acquisition Regulations (FAR) requirement for DOD EVMS. DCMA's CEAC assessment is an opportunity to evaluate the CEAC and include all the available information. The better we perform our evaluation of the contractor/subcontractor's CEAC, the more likely the government Program Management Office (PMO), Program Executive Office (PEO), and the Milestone Decision Authority (MDA) will be able to perform their responsibilities including making Cost AS an Independent Variable (CAIV) decisions while sufficient funds and time are available. This document can be found on the DCMA Website.

5. DAU Gold Card – The DAU Gold Card is a single-sheet reference that defines common Earned Value (EV) terminology, lists EV metric equations, and labels the most common EV graph. The Current Gold Card is usually reviewed and updated annually and can be found at the Acquisition Community Connection web site at https://acc.dau.mil/evm.

7.0 APPENDIX: ACRONYM GLOSSARY

AA	Advance Agreement
ACWP	Actual cost of work performed
ASAP	As-Soon-As-Possible
BAC	Budget at Completion
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted cost of Work Scheduled
BEI	Baseline Execution Index
BRP	Baseline Revision Percentage
CA	Control Accounts
CAP	Corrective Action Plans
CAR	Corrective Action Requests
CBB	Contract Budget Base
CDR	Critical Design Review
CFSR	Contract Funds Status Report
CMO	Contract Management Office
CPI	Cost Performance Index
CPL	Critical Path Length
CPLI	Critical Path Length Index
CPR	Contract Performance Report
CRI	Compliance Review Instruction
CV	Cost Variance
CWBS	Contract Work Breakdown Structure
DAES	Defense Acquisition Executive Summary
DCMA	Defense Contract Management Agency
DID	Data Item Description
EAC	Estimate at Completion
EOM	End of Month
EOY	End of Year
ESCP	EVMS Specialist Certification Program

EV	Earned Value
EVMS	Earned Value Management System
EVMSPAP	EVMS Program Analysis Pamphlet
EVT	Earned Value Technique
FF	Finish-to-Finish
FNET	Finish-No-Earlier-Than
FNLT	Finish-No-Later-Than
FS	Finish-to-Start
IBR	Integrated Baseline Review
IEAC	Independent Estimate at Completion
IMS	Integrated Master Schedule
LOA	Letter of Acceptance
LOE	Level of Effort
LRE	Latest Revised Estimate
MFO	Must-Finish-On
MPS	Major Program Support
MSO	Must-Start-On
OTB	Over Target Baseline
PAR	Program Assessment Report
PDR	Preliminary Design Review
%comp	Percent Complete
%MR	Management Reserve
PI	Performance Indicator
PMB	Performance Measurement Baseline
PST	Programs Support Teams
SF	Start-to-Finish
SNET	Start-No-Earlier-Than
SNLT	Start-No-Later-Than
SPI	Schedule Performance Index
SS	Start-to-Start

SSI	Standard Surveillance Instruction
SV	Schedule Variance
TAB	Total Allocated Budget
TCPI	To Complete Performance Index
TF	Total Float
VAC	Variance at Completion
VR	Validation Reviews
WBS	Work Breakdown Structure
WP	Work Package