

JS-96-002

**AUDIT  
REPORT**

**RAPID ACTION**

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**SPACE STATION PRIME CONTRACTOR  
PERFORMANCE MANAGEMENT**

**JOHNSON SPACE CENTER**

**JUNE 11, 1996**

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National Aeronautics and  
Space Administration

**OFFICE OF INSPECTOR GENERAL**



National Aeronautics and  
Space Administration

Headquarters  
Washington, DC 20546-0001



JUN 11 1996

Reply to Attn of: W

**TO:** Johnson Space Center  
ATTN: OA/Program Manager

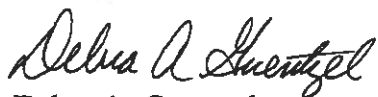
**FROM:** W/Assistant Inspector General for Auditing

**SUBJECT:** Final Rapid Action Report  
Space Station Prime Contractor Performance Management  
Assignment No. A-JS-95-011  
Report No. JS-96-002

The NASA Office of Inspector General has completed an audit of the Space Station Prime Contractor Performance Management (A-JS-95-011). The purpose of this audit was to determine whether NASA is effectively managing the space station contract to control cost, schedule, and performance. Specific audit objectives were to: (1) evaluate procedures established to ensure accurate and timely reporting of cost, schedule, and performance data; (2) determine if Boeing consistently estimates, accumulates, and reports contract cost; and (3) determine whether Boeing's cost and performance data reports comply with applicable NASA procedures and the space station contract. Our audit revealed that the Boeing Defense & Space Group is not revising its monthly performance measurement reports to reflect a reasonable estimate of cost to complete the space station. The disparity between what Boeing reported as a variance at completion and what we calculated for Work Breakdown Structure 1.0, International Space Station, is \$127 million [\$140 million - \$13 million]. If not corrected, NASA will not have a good estimate at completion to manage future funding requirements. Due to the significance and time sensitivity of this issue, we have provided this rapid action report for your immediate attention.

We issued a draft of this report to the Space Station Program Manager on April 24, 1996, and received a written response on May 20, 1996. The response is summarized in the recommendation section of this report and is included in its entirety as Appendix 3. Management concurred with the recommendation in the report, and is implementing actions that are responsive to the recommendation. Because the actions are not complete, please include our office in the concurrence cycle for closing recommendation 1 in accordance with NMI 9910.1B.

The NASA Office of Inspector General staff members associated with this audit express their appreciation to the NASA and contractor personnel for their courtesy, assistance, and cooperation. If you have any questions or need additional information, please call Robert Wesolowski, Director, Division A, or me at 202-358-1232.



Debra A. Guentzel

Enclosure

cc:

HQs-JMC/P. Chait

M/W. Trafton

W/J. Goodnight

JSC-AA/G. Abbey

BU/P. Ritterhouse

OA/W. Bates

OG/D. Tam

# SPACE STATION PRIME CONTRACTOR PERFORMANCE MANAGEMENT

## JOHNSON SPACE CENTER

### INTRODUCTION

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The NASA Office of Inspector General has completed an audit of the Space Station Prime Contractor Performance Management. During the audit, we identified a condition related to the Boeing Defense & Space Group's noncompliance with its performance management policy and procedures, which required immediate management attention. Due to the significance and time sensitivity of this issue, we have provided this rapid action report containing a recommendation for your immediate attention.

#### *PERFORMANCE MANAGEMENT*

NASA has developed drafts of one policy document and one process document that establishes performance management as a way of doing business with NASA on significant contracts:

- NASA Policy Directive (NPD) 9501.3, Earned Value Performance Measurement; and
- NASA Procedure (NP) 9501.4, Earned Value Performance Management Implementation on Significant Contracts.

#### *NASA POLICY DIRECTIVE*

NPD 9501.3 establishes:

- A set of criteria that contractor management information systems must meet; and
- A basis for applying the performance management systems criteria to NASA contracts.

The criteria assure that contractor management systems provide the contractor, and the government project managers, with accurate data to make responsible decisions. This directive applies to contracts awarded after April 1, 1995.

**NASA PROCEDURE**

NP 9501.4 establishes guidelines for the implementation of the performance management systems criteria on significant contracts as defined in NPD 9501.3. The procedure incorporates the Cost/Schedule Management Guide.

**COST/SCHEDULE  
MANAGEMENT GUIDE**

The Cost/Schedule Management Guide, Version G, requires the contractor to periodically develop a comprehensive estimate of cost at contract completion. In developing the estimate at completion (EAC), the contractor should use all available information to arrive at the best estimate of costs. The contractor should:

- Evaluate the efficiency achieved for completed work;
- Establish a schedule forecast;
- Consider risk versus cost avoidance;
- Consider inflation, economic escalation, and projected process improvements; and
- Apply this analysis to future efforts.

A comprehensive EAC is expected annually, but more frequent EACs should be generated when past performance indicates that the current estimate is not reasonable. The EAC should be examined for accuracy as a monthly cost management function and should be updated, as needed. Adequate consideration should be given to performance to date.

Monthly updates to the estimate are necessary for the Program Manager (PM) to effectively manage a program. The guide states:

*"Both the comprehensive EACs and the monthly updates are essential as a basis for management decision-making by both the contractor and government managers. Contractor PMs are encouraged to provide the most accurate cost estimate possible through program level assessments.... The impact of these assessments should be reflected in the EAC reported to the Government PM in the external report. This assessment may include a range of estimates to include best case, worst case and most likely outcome. ...EACs should be established without regard for contract ceilings."*

**SPACE STATION  
CONTRACT**

The Space Station Contract NAS15-10000 was signed January 13, 1995, with Boeing (The Boeing Company, Defense & Space Group) for \$5.638 billion. The contract requires Boeing to fully implement a performance measurement system and assess cost and schedule performance.

***BOEING REPORTS***

Boeing has been delivering monthly performance measurement reports to NASA. Each report incorporates data from product groups in order to get a complete picture of where the project is. The product groups are McDonnell Douglas, Rocketdyne, and Boeing-Huntsville.

***NASA REVIEWS***

Review of Boeing and product groups' performance management systems are in progress. NASA performed the review of Boeing's systems in Houston and Huntsville. Boeing performed reviews at McDonnell Douglas and at Rocketdyne. These system reviews have all resulted in corrective actions. After corrective actions are complete, follow-up reviews will be performed.

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## **OBJECTIVES, SCOPE, AND METHODOLOGY**

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### ***OBJECTIVES***

The purpose of this audit was to determine whether NASA is effectively managing the space station contract to control cost, schedule, and performance.

The overall objectives were to:

- Evaluate procedures established to ensure accurate and timely reporting of cost, schedule, and performance data;
- Determine if Boeing consistently estimates, accumulates, and reports contract cost; and
- Determine whether Boeing's cost and performance data reports comply with applicable NASA procedures and the space station contract.

Specific sub-objectives were to:

- Evaluate applicable management controls;
- Evaluate earned value techniques;
- Assess the reasonableness of the estimates at completion;
- Evaluate prime contractor's use of management reserves;
- Assess whether the space station contract has a stable baseline;
- Determine whether the contractor will perform an annual comprehensive EAC review; and
- Determine whether all changes to the contract baseline were properly authorized.

### ***SCOPE AND METHODOLOGY***

The scope of the audit included review of Boeing's Performance Management Plan, Performance Management Reports, participation in NASA's baseline surveillance reviews, and interviews of NASA and Boeing personnel.

### ***INTERNAL CONTROLS REVIEWED***

Our review was limited to NASA's efforts to fully implement performance measurement on the space station contract. Accordingly, we express no opinion on NASA's system of internal controls.

### ***AUDIT FIELD WORK***

Audit field work was performed during the period of September 1995 through April 1996. Field work was performed at the Boeing Company in Houston, Texas, and Huntsville, Alabama, and the Johnson Space Center. The audit was performed in accordance with generally accepted government auditing standards.

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## OBSERVATION AND RECOMMENDATION

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### **OVERALL EVALUATION**

Boeing is not revising its monthly performance measurement reports to reflect a reasonable estimate of cost to complete the space station. Boeing's performance management system description requires that Boeing review its estimate at completion monthly and update at least annually unless statistical analysis indicates a need for more frequent updates. The disparity between what Boeing reported as a variance at completion and what we calculated for Work Breakdown Structure (WBS) 1.0, International Space Station, is \$127 million [\$140 million - \$13 million]. However, Boeing is reluctant to recognize overruns since it will be penalized in fee and receive additional management oversight. Consequently, NASA does not have Boeing's best estimate of future funding requirements.

### **BOEING'S INTEGRATED MANAGEMENT SYSTEM**

Boeing's performance management system description requires Boeing to update its estimate at completion whenever statistical analysis indicates a need to do so. The General System Description, Volume 1, Revision B, describes the process used by Boeing for operation of its performance management system. The process applies to all Defense & Space Group (D&SG) divisions or segments engaged in performing Government contract work. All programs and functions within D&SG that administer contract cost and schedules are required to implement business principles consistent with the system description. The principles include baseline integrity and cost and schedule visibility.

Boeing's system description describes an estimate at completion as the actual cost to date plus the estimate to complete the authorized remaining work. The estimate at completion projects the total costs that are expected to be incurred on the contract or a specific portion of the contract. Managers should develop estimates at completion by reviewing:

- Performance to date;
- Current and future conditions; and
- Tasks to be accomplished.

Boeing's system description states:

*"EAC data is analyzed on a monthly basis. Individual cost account EAC data updates may be accomplished as frequently as monthly. A detail comprehensive EAC update is done at a minimum annually unless the monthly reviews or statistical analysis reveal a need for*

*more frequent update. ... The procedure for the development of the to-go amount will be systematic and consistent, with any subjective evaluation and judgment based on knowledgeable projections."*

***EAC IS NOT  
REASONABLE***

Boeing is not revising its monthly performance measurement reports to reflect a reasonable estimate of cost to complete the space station. However, cost and schedule variances indicate a need for a revised estimate at completion.

***COST AND SCHEDULE  
VARIANCES***

Analysis of data reported by Boeing in its December 1995 Performance Measurement System Report indicates a need for a revised estimate at completion. Each month, Boeing is required to analyze the ten largest dollar value cost variances, schedule variances, and variances at completion. We selected the four tasks with the largest dollar value cost and schedule variances to calculate:

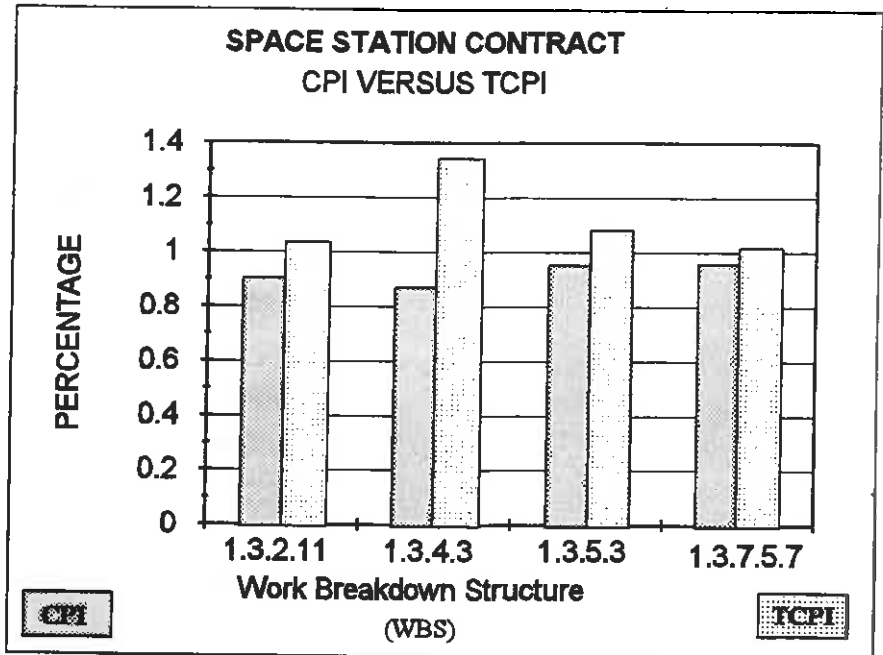
- Cost variance (CV);
- Schedule variance (SV);
- Cost performance index (CPI);
- Schedule performance index (SPI);
- To complete performance index (TCPI);
- Independent estimate at completion (IEAC); and
- Variance at completion (VAC) based on a comparison of the budget at completion to the IEAC.

The following tasks were selected for further review:

<b>Work Breakdown Structure (WBS)</b>	<b>Description</b>
1.3.2.11	Structures and Mechanisms
1.3.4.3	Node 1
1.3.5.3	U.S. Laboratory
1.3.7.5.7	Photovoltaic Electronics

The calculations are included as Appendix 1 of this report.

The following graph illustrates the disparity between what Boeing has performed to date and what it will need to perform to achieve its current estimate at completion:



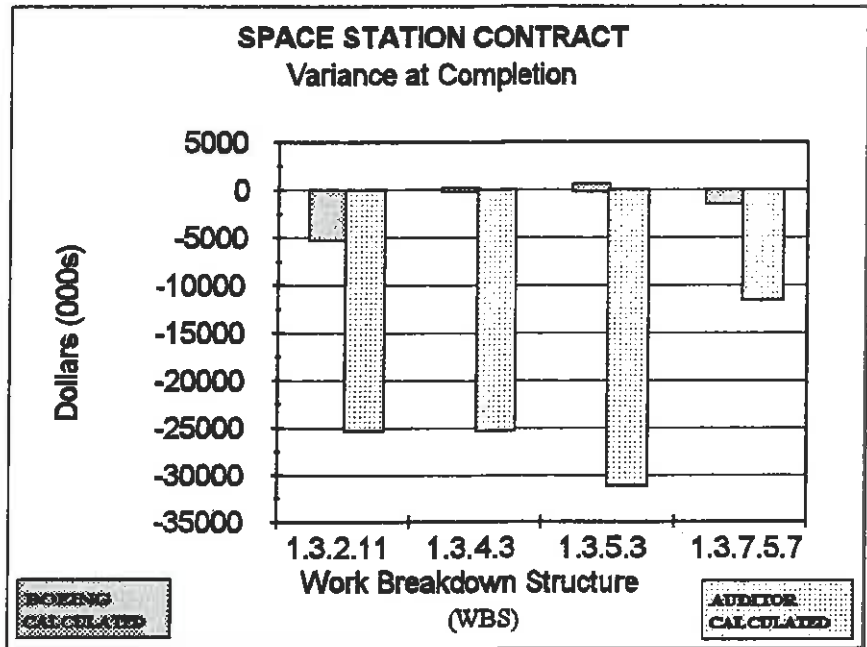
The TCPI represents what the contractor will have to achieve for the remaining work to stay within its current estimate at completion. In each of the WBSs selected, Boeing is projecting better performance for the remaining work than previously achieved.

For example, Boeing has concluded that for Node 1, WBS 1.3.4.3, it will achieve a TCPI of 134 percent. However, to date, Boeing has only achieved a CPI of 87 percent for Node 1. This may be an impossible task when you take into consideration that Node 1 is 63 percent complete.

As the percentage of completion on each task increases, it becomes more difficult to recover from a poor CPI. The top four WBSs with cost and schedule variances are from one-third to two-thirds complete as shown in the following chart:

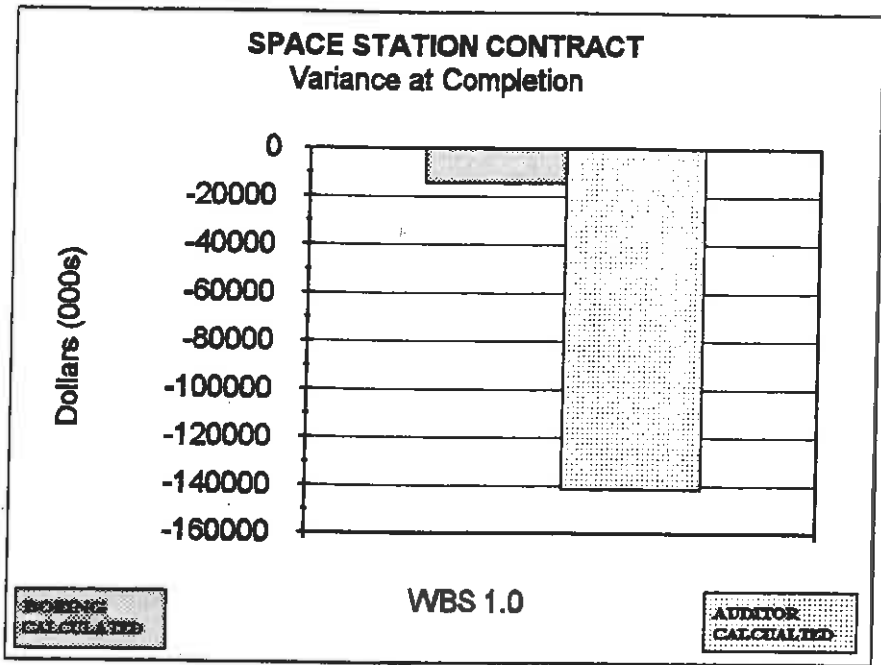
Work Breakdown Structure (WBS)	Percent Complete
1.3.2.11	38 %
1.3.4.3	63 %
1.3.5.3	59 %
1.3.7.5.7	36 %

A disparity also exists between the Boeing reported variance at completion and our calculations as the following graph illustrates:



Boeing's variance at completion represents the difference between the distributed budget for that task and what Boeing is reporting as its current estimate at completion. The auditor-calculated variance at completion represents the difference between the distributed budget for that task and the estimate at completion calculated using the formula presented in Appendix 1. This formula considers the performance to date on both cost and schedule with more weight given to cost performance.

The disparity between what Boeing reports as a variance at completion and what we have calculated is even more apparent for WBS 1.0, which includes Boeing's entire distributed budget of \$5,452,155,000 for the International Space Station. Boeing has reported a variance at completion of \$13,018,000 for WBS 1.0. Based on past performance, we calculated a variance at completion of \$140,435,000. This results in a difference of \$127,417,000 between what Boeing is reporting as a variance at completion and what we calculated as shown in the following graph:



The calculations are included as Appendix 2 of this report.

***BOEING IS RELUCTANT  
TO RECOGNIZE  
OVERRUNS***

Boeing is reluctant to recognize overruns since it will be penalized in fee and receive additional management oversight. According to the Space Station Business Management Office, "Increasing an EAC means admitting that the budget you negotiated is not sufficient, going before the project manager and explaining why you can't get the job done with the established budget, and declaring an overrun on an incentivized contract."

***FUNDING  
REQUIREMENTS ARE  
NOT FULLY KNOWN***

The Space Station Program Office (SSPO) will not have a reliable estimate at completion to manage future funding requirements. The cost to complete the International Space Station will not be known on a month-to-month basis.

Based on our calculations, there is a potential overrun on WBS 1.0 of \$140 million; however, Boeing is only recognizing \$13 million. Accordingly, the Space Station Program may have to fund overruns in FY 1996 through FY 2003 (scheduled contract completion) in order to build a space station.

Current funding shortfalls exist in Fiscal Year (FY) 1996 when cost threats and Boeing's year-to-date expenditure rate are taken into account. The current SSPO spending plan for FY 1996 is as follows:

Development (000s)	\$1,791
Utilization	65
Operations	156
Reserves	<u>181</u>
Total	<u>\$2,193</u>

Current cost threats carried by the Business Management Office (BMO) for FY 1996 are \$155 million. This leaves only \$26 million [\$181-\$155] of reserves to cover any expenditures over plan. At present, the BMO has identified a trend in Boeing's FY 1996 spending that would result in \$148 million over plan for the year. This results in a deficit of \$122 million [\$26-\$148] for FY 1996.

***RECOMMENDATION***

We recommend the Contracting Officer require Boeing to:

- Analyze the estimate at completion data on a monthly basis; and
- Report the revised estimate at completion to reflect performance to date, current and future conditions, and tasks to be performed.

***MANAGEMENT'S  
RESPONSE***

The Space Station Program Office concurred with the finding that the Boeing Defense & Space Group has not revised its monthly performance measurement report to reflect a reasonable estimate of the cost to complete the space station. In response to direction from the contracting officer, Boeing has established a corrective action plan for updated estimates at completion for the entire contract. The current commitment is to have this completed and incorporated into the July 1996 performance measurement report.

***EVALUATION OF  
MANAGEMENT'S  
RESPONSE***

Actions taken or planned by NASA management are responsive to the recommendation.



## **MAJOR CONTRIBUTORS TO THIS REPORT**

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**JOHNSON SPACE  
CENTER**

Janice Goodnight, Audit Field Office Manager  
Doug Orton, Program Manager  
Dennis Clay, Auditor-in-Charge

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**SPACE STATION CONTRACT**  
**Selected December 1995 WBSs - Top Four Cost And Schedule Variances**

**WBS 1.3.2.11 Structures and Mechanisms**  
**Cumulative to Date (000s)**

**Contractor Provided Data:**

BCWS	\$101,303
BCWP	\$95,532
ACWP	\$105,689
BAC	\$248,831
EAC/LRE (Contractor)	\$253,812
VAC	(\$4,981)

**Calculated Data:**

SV (1)	(\$5,771)
CV (2)	(\$10,157)
CPI (3)	90.39%
SPI (4)	94.30%
% complete (5)	38.39%
TCPI based on BAC (6)	107.10%
TCPI based on contractor's EAC/LRE (7)	103.49%
Auditor-calculated EAC/LRE (8)	\$273,831
VAC (9)	(\$25,000)

**Formulas:**

- (1) Schedule variance = BCWP - BCWS
- (2) Cost variance = ACWP - BCWP
- (3) Cost performance index = BCWP/ACWP
- (4) Schedule performance index = BCWP/BCWS
- (5) Percent complete = BCWP/BAC
- (6) To complete performance index = BAC - BCWP/BAC - ACWP
- (7) To complete performance index = BAC - BCWP/EAC - ACWP
- (8) Estimate at completion = A-cum + ((BAC - BCWP)/.8CPI + .2SPI)
- (9) Variance at completion = BAC - Auditor-calculated EAC/LRE

**Acronyms:**

ACWP = Actual cost of work performed  
A-cum = Cumulative cost to date  
BAC = Budget at completion  
BCWP = Budgeted cost of work performed  
BCWS = Budgeted cost of work scheduled  
CPI = Cost performance index  
CV = Cost variance  
EAC = Estimate at completion  
LRE = Latest revised estimate  
SPI = Schedule performance index  
SV = Schedule variance  
TCPI = To complete performance index  
VAC = Variance at completion

**SPACE STATION CONTRACT**  
**Selected December 1995 WBSs - Top Four Cost And Schedule Variances**

**WBS 1.3.4.3 Node 1**  
**Cumulative to Date (000s)**

**Contractor Provided Data:**

BCWS	\$119,265
BCWP	\$113,395
ACWP	\$130,134
BAC	\$179,856
EAC/LRE (Contractor)	\$179,602
VAC	\$254

**Calculated Data:**

SV (1)	(\$5,870)
CV (2)	(\$16,739)
CPI (3)	87.14%
SPI (4)	95.08%
% complete (5)	63.05%
TCPI based on BAC (6)	133.67%
TCPI based on contractor's EAC/LRE (7)	134.35%
Auditor-calculated EAC/LRE (8)	\$205,040
VAC (9)	(\$25,184)

**Formulas:**

- (1) Schedule variance = BCWP - BCWS
- (2) Cost variance = ACWP - BCWP
- (3) Cost performance index = BCWP/ACWP
- (4) Schedule performance index = BCWP/BCWS
- (5) Percent complete = BCWP/BAC
- (6) To complete performance index = BAC - BCWP/BAC - ACWP
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- (9) Variance at completion = BAC - Auditor-calculated EAC/LRE

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EAC = Estimate at completion  
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SPI = Schedule performance index  
SV = Schedule variance  
TCPI = To complete performance index  
VAC = Variance at completion

**SPACE STATION CONTRACT**  
**Selected December 1995 WBSs - Top Four Cost And Schedule Variances**

**WBS 1.3.5.3 US Laboratory**  
**Cumulative to Date (000s)**

**Contractor Provided Data:**

BCWS	\$385,934
BCWP	\$368,278
ACWP	\$386,675
BAC	\$620,664
EAC/LRE (Contractor)	\$620,030
VAC	\$634

**Calculated Data:**

SV (1)	(\$17,656)
CV (2)	(\$18,397)
CPI (3)	95.24%
SPI (4)	95.43%
% complete (5)	59.34%
TCPI based on BAC (6)	107.86%
TCPI based on contractor's EAC/LRE (7)	108.16%
Auditor-calculated EAC/LRE (8)	\$651,567
VAC (9)	(\$30,903)

**Formulas:**

- (1) Schedule variance = BCWP - BCWS
- (2) Cost variance = ACWP - BCWP
- (3) Cost performance index = BCWP/ACWP
- (4) Schedule performance index = BCWP/BCWS
- (5) Percent complete = BCWP/BAC
- (6) To complete performance index = BAC - BCWP/BAC - ACWP
- (7) To complete performance index = BAC - BCWP/EAC - ACWP
- (8) Estimate at completion = A-cum + ((BAC - BCWP)/.8CPI + .2SPI)
- (9) Variance at completion = BAC - Auditor-calculated EAC/LRE

**Acronyms:**

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EAC = Estimate at completion  
LRE = Latest revised estimate  
SPI = Schedule performance index  
SV = Schedule variance  
TCPI = To complete performance index  
VAC = Variance at completion

**SPACE STATION CONTRACT**  
**Selected December 1995 WBSs - Top Four Cost And Schedule Variances**

**WBS 1.3.7.5.7 Photovoltaic Electronics**  
**Cumulative to Date (000s)**

**Contractor Provided Data:**

BCWS	\$85,227
BCWP	\$76,225
ACWP	\$79,694
BAC	\$209,132
EAC/LRE (Contractor)	\$210,382
VAC	(\$1,250)

**Calculated Data:**

SV (1)	(\$9,002)
CV (2)	(\$3,469)
CPI (3)	95.65%
SPI (4)	89.44%
% complete (5)	36.45%
TCPI based on BAC (6)	102.68%
TCPI based on contractor's EAC/LRE (7)	101.70%
Auditor-calculated EAC/LRE (8)	\$220,478
VAC (9)	(\$11,346)

**Formulas:**

- (1) Schedule variance = BCWP - BCWS
- (2) Cost variance = ACWP - BCWP
- (3) Cost performance index = BCWP/ACWP
- (4) Schedule performance index = BCWP/BCWS
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TCPI = To complete performance index  
VAC = Variance at completion

## SPACE STATION CONTRACT

WBS 1.0 International Space Station  
Cumulative to Date (000s)**Contractor Provided Data:**

BCWS	\$2,337,425
BCWP	\$2,274,609
ACWP	\$2,332,641
BAC	\$5,452,155
EAC/LRE (Contractor)	\$5,465,173
VAC	(\$13,018)

**Calculated Data:**

SV (1)	(\$62,816)
CV (2)	(\$58,032)
CPI (3)	97.51%
SPI (4)	97.31%
Percent complete (5)	41.72%
TCPI based on BAC (6)	101.86%
TCPI based on contractor's EAC/LRE (7)	101.44%
Auditor-calculated EAC/LRE (8)	\$5,592,590
VAC (9)	(\$140,435)

**Formulas:**

- (1) Schedule variance = BCWP - BCWS
- (2) Cost variance = ACWP - BCWP
- (3) Cost performance index = BCWP/ACWP
- (4) Schedule performance index = BCWP/BCWS
- (5) Percent complete = BCWP/BAC
- (6) To complete performance index = BAC - BCWP/BAC - ACWP
- (7) To complete performance index = BAC - BCWP/EAC - ACWP
- (8) Estimate at completion = A-cum + ((BAC - BCWP)/.8CPI + .2SPI)
- (9) Variance at completion = BAC - Auditor-calculated EAC/LRE

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SV = Schedule variance  
TCPI = To complete performance index  
VAC = Variance at completion





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APPENDIX 3

Reply to Attn of OG2-96-053

MAY 20 1996

TO: NASA Headquarters  
Attn: W/Assistant Inspector General for Auditing  
THRU: AA/Director  
FROM: OA/Manager, Space Station Program  
SUBJECT: Response to Rapid Action Report on Prime Contractor  
Performance Management, Assignment No. A-JS-95-011

The Space Station Program Office has reviewed the subject draft Rapid Action Report and concurs in the finding that the Boeing Defense and Space Group is not revising its monthly Performance Measurement System Report (PMSR) to reflect a reasonable estimate of the cost to complete the Space Station. A contracting officer's letter was sent to Boeing on April 15, 1996, directing them to establish a corrective action plan for updated Estimates At Completion (EAC's) for the Product Groups (PG's) and the entire contract. Boeing has responded with a plan to have this completed by the July PMSR. The specifics of the plan are as follows:

PG-1: Tier II subcontractors will be completed by the April PMSR with an inhouse EAC to be completed by June and incorporated into the July PMSR.

PG-2: A quarterly EAC was completed in March and will be reflected in the April PMSR. The next quarterly update is scheduled for June and will be reflected in the July PMSR.

PG-3: Tier II EAC's will be completed by the May PMSR with the exception of Allied Signal. A cost cap is being negotiated with Allied to limit the impact on the overall EAC. The Allied Signal and inhouse EAC will be completed in June for incorporation into the July PMSR.

Program Engineering & Integration: The May PMSR will have updated EAC's for Safety and Mission Assurance, Configuration Management, Program Planning and Control, and Quality Assurance. Due to the recent Boeing reorganization, all other teams had new budgets by May 10, 1996, and EAC's will be prepared for inclusion into the June PMSR.

NASA has met with Boeing and gone over this plan. We have asked for a more detailed milestone schedule so that we can measure progress against these plans. We also will request Boeing to provide monthly updates to these EAC's. NASA is performing its own EAC analysis each month based on statistical measures obtained from the monthly PMSR's.



Randy H. Brinkley

Concurrence by:



George W. S. Abbey

cc:

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HQ/JMC/P. Ghait  
HQ/M/W. C. Trafton  
HQ/ML/G. W. McClain  
HQ/W/J. Goodnight



