

W

September 24, 1998

TO: AA/Director, Johnson Space Center

FROM: W/Assistant Inspector General for Auditing

SUBJECT: Final Report on the Space Station Configuration Management  
(Assignment Number A-HA-98-024)  
Report No. IG-98-032

The subject final report is provided for your use. We have incorporated into the final report your comments, which included additional information and clarification of items in the draft report. We consider the report closed for reporting purposes.

If you have questions concerning the report, please contact Mr. Dennis Coldren, Program Director for Human Exploration and Development of Space Audits, at (281) 483-4773, or Ms. Karen VanSant, Auditor-in-Charge, at (256) 544-1149. We appreciate the courtesies extended to the audit staff. Appendix D contains the report distribution.

**[original signed by]**

Russell A. Rau

Enclosures

cc:

B/Chief Financial Officer

G/General Counsel

JM/Director, Management Assessment Division

**IG-98-032**

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**AUDIT  
REPORT**

**SPACE STATION CONFIGURATION  
MANAGEMENT**

**September 24, 1998**

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National Aeronautics and  
Space Administration

**OFFICE OF INSPECTOR GENERAL**

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## **ACRONYMS**

FCA	Functional Configuration Audit
ISS	International Space Station
PCA	Physical Configuration Audit
SSCB	Space Station Control Board
SSICB	Space Station Integration Control Board
SSP	Space Station Program

# **Report on the Survey of Space Station Configuration Management Assignment Number A-HA-98-024**

## **Introduction**

The NASA Office of Inspector General completed a survey of the International Space Station (ISS) Configuration Management Program. The overall objective of the survey was to evaluate the adequacy and effectiveness of the Configuration Management Program for the ISS. Specifically, we evaluated the adequacy of the functional and physical configuration audit processes for the ISS Program and assessed whether procedures for reviewing, approving, and obtaining equitable consideration<sup>1</sup> for major waivers and deviations were adequately applied.

We met with NASA and Boeing Company personnel to obtain an overview of the configuration management process. Also, we reviewed ISS Configuration Management Program documentation, dated from April 1992 through June 1998, to identify applicable management controls and to verify that the controls were working as described. The survey was performed in accordance with generally accepted Government auditing standards. We performed field work from February through July 1998.

## **Results in Brief**

The functional and physical configuration audit processes for the ISS Program were effective in meeting program needs. In addition, the procedures the ISS Program managers used for reviewing, approving, and obtaining equitable cost consideration for waivers, deviations, and other changes were adequate.

## **Background**

The ISS effort involves more than 100,000 people in space agencies and at hundreds of contractor and subcontractor companies worldwide. In all, 16 nations have coordinated in one of the largest, nonmilitary, joint efforts in history. NASA has contracted with the Boeing Company to be the integrating prime contractor and to participate in the management of the ISS Program. Boeing is responsible for design, development, test, verification, and delivery of the U.S. On-Orbit Segment, Functional Cargo Block (also known by its Russian acronym FGB), its hardware, software, and associated data. Boeing's responsibility also includes the on-orbit performance of the entire ISS.

The Configuration Management Program is needed for the successful implementation of the ISS Program. Space Station Program (SSP) Document 41170, "Configuration Management Requirements," dated March 23, 1994, requires that configuration management:

- establish a baseline of requirements and implement a disciplined system that serves to control subsequent changes to the baseline,

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<sup>1</sup> Consideration can mean reduced contract price, reimbursement, or other compensation.

- perform reviews to verify that the previously established baseline requirements are included in the design and development of program configuration items,
- establish an accounting system that identifies the baseline and tracks changes and change actions thereto, and
- provide for audits of the configuration management system to ensure that it is functioning properly in accordance with the baseline requirements.

The primary requirements of the ISS Configuration Management Program are identified in SSP Document 41170, "Configuration Management Requirements," dated March 23, 1994, and SSP Document 50123, "Configuration Management Handbook," dated June 30, 1995.

The ISS Program Office has established the Space Station Control Board (SSCB) to oversee the overall configuration baseline. According to the SSCB charter, "The SSCB shall be responsible for controlling the Space Station Program top-level baseline, consisting of technical, management, operations, user, and integration requirements; Program schedules; resources; and the overall Space Station configuration." The SSCB is chaired by the NASA Manager of the Space Station Program and includes representatives from NASA, the prime contractor, and the International Partners.

In addition, the ISS Program has established the Space Station Integration Control Board (SSICB), which reports to the SSCB. According to its Charter, "The SSICB is responsible for approval of changes to the baseline and deviations, waivers, and exceptions to the baseline consisting of technical, management, operations, user, and integration requirements, as well as Program schedules and resources and the overall NASA baseline for the ISSP [ISS Program] configuration." The SSICB is jointly chaired by the NASA and Boeing ISS Program managers. The SSICB also includes representatives from NASA, the prime contractor, and International Partners.

### **Functional Configuration Audits and Physical Configuration Audits**

The ISS Program has adequate functional and physical configuration audit processes. A Functional Configuration Audit (FCA) is a formal audit of the "as-designed" configuration. The purpose is to validate that the development of a configuration item has been completed satisfactorily and that the configuration item will perform as designed. A Physical Configuration Audit (PCA) is an audit that compares the "as-built" configuration item against its technical documentation. The PCA formally establishes the production baseline for the configuration item.

The FCA and PCA are normally combined but may be performed separately. To evaluate the adequacy of the FCA and PCA processes, we reviewed FCA and PCA program documentation. We also selected a sample of six combined FCA/PCAs for review from the universe of 93 completed FCA/PCAs. (See Appendix A for a listing of FCA/PCAs selected for review.) We selected the six FCA/PCAs from various Boeing sites and subcontractors; the configuration items varied in size and complexity. Two of the FCA/PCAs included both hardware and software configuration items or interfaces. The remaining four FCA/PCAs were for hardware

configuration items. The overall FCA and PCA processes for software configuration items are the same as for hardware configuration items.

The FCA and PCA processes were adequately documented. The FCA/PCA team members documented the results of the FCA/PCAs in the minutes of the reviews. The minutes supported the processes as described in the program documentation and included all required certifications and reviews.

Boeing's configuration management staff tracks the action items and program issues from the FCA/PCAs and reports the status at weekly teleconferences with ISS Program managers. Action items and program issues are questions, issues, or actions that must be completed and closed before the formal audit can be completed. Action items and program issues are essentially the same, except that program issues require action outside the scope of the supplier's contract. Depending on the item being addressed, either Boeing or NASA would be responsible for resolving program issues. Boeing's configuration management staff summarizes action items and program issues for all the FCA/PCAs on a status tracking report to provide ISS Program management a tool to help ensure that all items are corrected and closed.

### **Waivers, Deviations, and Exceptions**

Guidance for ISS configuration management classifies changes as waivers, deviations, and exceptions. Specifically, SSP Document 41170, SSP Document 50123, and Department of Defense Military Standard 973, "Configuration Management," dated April 17, 1992, provide guidance for handling configuration changes. The procedures ISS Program management used for reviewing, approving, and obtaining equitable consideration for the changes were satisfactory.

Waivers are written authorizations to accept a contractor's nonconformance to specifications during or after production for a specific period. Waivers are generally one-time changes that accept an item "as is," usually associated with hardware changes, and are accomplished through a letter approved by the contracting officer. On the other hand, deviations are specific authorizations to accept temporary nonconformance to specifications before production. Like waivers, deviations are also accomplished through a letter approved by the contracting officer.

Exceptions are permanent changes to the contract requirement in order to match design specifications. Exceptions are normally made in the design phase of the process and are accomplished through contract modifications.

All changes (waivers, deviations, and exceptions) undergo a review process by both ISS Program management and the contracting officer. The NASA Configuration Management Department maintains a log that tracks all actions. Changes that have cost, schedule, or technical effects on the existing contractual baseline or other Agency controlled configuration baseline are tracked in the Change and Commitment Tracking Information System. Configuration Management Department personnel meet weekly with the contractor and the control boards to review changes. The documentation we reviewed adequately supports the ISS configuration change process.

The universe for our sample consisted of 97 changes (7 completed and 90 in-process changes) to configuration items made during fiscal years 1995 through 1997 and through March 1998. For the completed changes, we reviewed all five waivers and two exceptions. There were no completed deviations at the time of our review. From the universe of 90 in-process changes, we randomly selected a sample of 16 items (8 deviations, 2 waivers, and 6 exceptions). All the selected items were included in the Change and Commitment Tracking Information System. We evaluated all 23 changes (7 completed and 16 in-process) for cost consideration, timeliness, and documentation. (See Appendix B for listing of changes reviewed.)

At the time of our review, the ISS Program had not issued any major waivers or deviations. NASA does not adjust Boeing's target costs and fee if the cost of the change does not exceed a \$500,000 cost threshold specified in the contract. Any cost savings due to waivers, deviations, or exceptions are realized through a reduced cost to the contract. None of the completed changes we reviewed required cost consideration because they were less than the \$500,000 cost threshold.

The ISS Configuration Management Department does not have specific metrics to measure timeliness. The time taken to process changes varied from 8 days to 9 months. Some changes take much longer than others because of extensive testing and verification, meeting with contractor and NASA review and approval boards, and obtaining the necessary information and documentation (acceptance rationale, part numbers, etc.). On the other hand, the Johnson Space Center Procurement Office has measurable criteria for timeliness. For example, the Procurement Office has a goal that minor changes costing less than \$500,000 should be definitized within 30 to 60 days and that major changes costing \$500,000 or more should be definitized within 180 days.

The ISS Configuration Management Department and the Procurement Office documentation for the selected changes contained the necessary authorization signatures, problem description, rationale, directives, and drawings. As an added control, the contracting officer now requires the cognizant ISS Board Panel Chairman to submit a form to the contracting officer to support whether a cost adjustment is appropriate.

### **Single Process Initiative**

In addition to reviewing waivers, deviations, and exceptions, we reviewed Boeing's efforts under the Single Process Initiative. The Single Process Initiative is a Department of Defense acquisition reform designed to reduce contractor operating costs and to achieve cost, schedule, and performance benefits for the Government. Cost reduction is achieved by (1) transitioning contractor facilities from multiple, Government-unique management and manufacturing systems to the use of common, facility-wide processes and by (2) using a "block change" modification approach that unifies requirements in existing contracts on a facility-wide basis, rather than on a contract-by-contract basis. Contractors usually explain proposed changes in the form of concept papers, which are reviewed by Department of Defense officials. NASA also reviews the concept papers if Agency contracts may be affected by the proposed changes.

Boeing has participated in the Single Process Initiative effort and produced 30 (58 percent) of the 52 concept papers submitted to Johnson Space Center from October 1, 1996, through June 25,

1998. The concept papers associated with the ISS Program accounted for 24 (46 percent) papers submitted to Johnson Space Center. Of the 11 ISS concept papers that had been approved as of June 25, 1998, 8 had total projected savings of about \$4.5 million for all Government contracts affected by the proposed changes.<sup>2</sup>

### **Management Comments**

Management concurred with the overall report. In addition, management provided additional information and minor clarification of items in the draft report which we have incorporated into this final report. See Appendix C for the complete text of management's comments.

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<sup>2</sup> For additional information on the Single Process Initiative, please see the NASA OIG Partnerships and Alliances Review Report, "Review of National Aeronautics and Space Administration Single Process Initiative (SPI)/Block Change Process Implementation," Report Number P&A-98-002, dated August 17, 1998.

**FUNCTIONAL CONFIGURATION AUDITS/PHYSICAL CONFIGURATION AUDITS  
REVIEWED**

We identified a universe of 93 completed FCA/PCAs as of June 26, 1998. The FCAs and PCAs are normally combined but can be performed separately. The universe included both combined and separate FCAs and PCAs. We judgmentally selected six combined FCA/PCAs for review. We sought to obtain a representative sample of the FCA/PCAs. Therefore, we selected the following six FCA/PCAs from various Boeing sites and subcontractors; the configuration items varied in size and complexity.

- Mission Build Facility - The Boeing Company (Boeing Huntington Beach)
- Standard Multiplexer/Demultiplexer - Honeywell, Inc. (subcontractor)
- Avionics Air Assembly - United Technologies Hamilton Standard (subcontractor)
- Hatch Operations Kit - The Boeing Company (Boeing Huntsville)
- Rack Standard Payload - The Boeing Company (Boeing Huntsville)
- Node 1 Assembly (Final) - The Boeing Company (Boeing Huntsville)

The Node 1 Assembly (Final) was an overall review of the Node 1 Assembly. Node 1 contained 36 lower level configuration items. NASA and/or Boeing officials reviewed these items during their individual FCA/PCAs or first article inspection reviews. NASA and Boeing officials reviewed the status of completion of the FCA/PCAs or other reviews for these items during the Node 1 Assembly FCA/PCA.

**WAIVERS, DEVIATIONS, AND EXCEPTIONS REVIEWED**

<b>NO.</b>	<b>TYPE</b>	<b>SPACE STATION CHANGE NOTICE</b>	<b>DESCRIPTION/TITLE</b>
1	Exception	451	Administrative change
2	Exception	470	Administrative change
3	Waiver	1060	IATC system cleanliness
4	Waiver	698	Rigid flex board/motherboard harness-reduced annular ring
5	Waiver	698	MDM CCA PWB via holes exposed copper due to solder mask rework
6	Waiver	698	MDM CCA PWB via holes exposed copper due to solder leveling
7	Waiver	Not available	Portable fire extinguisher
8	Deviation	742	Deviation from meeting the exposed corners requirement RFD-AJ-28
9	Deviation	754	Request for deviation - LEE curvic coupling sharp edges & corners CSA #RDF00031
10	Deviation	757	Request for deviation - orbiter PLB violation failure tolerance & contingency de-orbit time limits CSA #RFD00035-A
11	Deviation	760	Request for deviation - multiple system hazard controls CSA #RFD00039
12	Waiver	763	Request for waiver - use of assembly language CSR #RFW MSSP 3.047
13	Waiver	765	Request for waiver - welding qualification CSA #RFW00062
14	Deviation	785	Deviation from additional testing of ACTEL A1020A FPGAs RFD-AJ-01
15	Deviation	790	Deviation from having green LED transluminated color RFC-AJ-06
16	Deviation	799	Deviation from requirement that displays be within 30 degrees of the design eye point in the neutral posture RFD-AJ-16

**Appendix B**

<b>NO.</b>	<b>TYPE</b>	<b>SPACE STATION CHANGE NOTICE</b>	<b>DESCRIPTION/TITLE</b>
17	Exception	842	Request for exception to SSP 41172 for the TRRJ#2, S1 segment, and the PDGF drigid umbilical
18	Exception	844	Exception to SSP 41172 ramp rate requirement for radiator ORU thermal vacuum test
19	Exception	855	Exception to SSP 41172 thermal cycle acceptance cycle test dwell time for marotta valves
20	Exception	909	Exception for SSP 41172 acceptance thermal vacuum test for the solar array wing mass canisters
21	Exception	914	Designation for deviation/waiver of ionizing radiation requirements
22	Exception	1053	Exception to SSP 41172 thermal vacuum testing for the remote power controller module all types
23	Exception	1102	Exceptions to EME requirements f/SSP 30237, SSP 30243 & SSP 30245

## MANAGEMENT'S COMMENTS

National Aeronautics and  
Space Administration  
**Lyndon B. Johnson Space Center**  
2101 NASA Road 1  
Houston, Texas 77058-3696



Reply to Attn of: BD5

SEP 2 1 1998

TO: NASA Headquarters  
Attn: W/Assistant Inspector General for Auditing

FROM: AA/Director

SUBJECT: Management's Response to the OIG's Draft Report on the Space Station  
Configuration Management (Assignment Number A-HA-98-024)

We have reviewed the subject draft report, and acknowledge the positive findings regarding the Configuration Management Program for the International Space Station. While we concur with the overall report, we submit the following comments for accuracy.

On page 4 of the draft report the paragraph dealing with configuration management states: "As an added control, the contracting officer now requires the Configuration Management Department to submit a letter to the contracting officer to support whether a cost adjustment is appropriate." The sentence should be changed to read *the cognizant International Space Station Board Panel Chairman to submit a form...*

On page 5 of the draft report the paragraph dealing with the Single Process Initiative (SPI) states: "Boeing has participated in the Single Process Initiative program and produced 30 (63 percent) of the 48 concept papers submitted to Johnson Space Center from fiscal year 1996 to June 25, 1998. The concept papers associated with the ISS Program accounted for 13 (27 percent) papers submitted to Johnson Space Center. Of the 13 ISS concept papers that had been approved as of June 25, 1998, eight had total projected savings of about \$4.3 million per year."

For accuracy, the statement should be changed to reflect 52 concept papers submitted to the Johnson Space Center from Fiscal Year 1996 to June 25, 1998. The concept papers associated with the ISS Program accounted for 24 (46 percent) papers submitted to the Johnson Space Center. The amount of the projected savings should be changed to read *about \$4.5 million per year for all Government contracts*. We can not quantify how much of the projected savings will be realized on any specific contract, including JSC Contract NAS 15-10000.

With these changes made, we will consider the assignment closed on issuance of the final report. If you have any questions, please contact Pat Ritterhouse, Audit Liaison Representative, at 281-483-4220.

  
George W. S. Abbey

cc:  
OA/R. H. Brinkley  
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**Congressional Member**

The Honorable Pete Sessions, U.S. House of Representatives

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