

**AUDIT
REPORT**

**SAFETY CONCERNS WITH
KENNEDY SPACE CENTER'S
PAYLOAD GROUND OPERATIONS**

March 30, 2000



National Aeronautics
and
Space Administration

OFFICE OF INSPECTOR GENERAL

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Acronyms

CMR	Center Materials Representative
ESD	Electrostatic discharge
ISS	International Space Station
MUA	Material Usage Agreement
O&C	Operations and Checkout
OIG	Office of Inspector General
PFA	Plastic film, Foams, and Adhesive tapes
PGOC	Payload Ground Operations Contract
SSPF	Space Station Processing Facility

W

March 30, 2000

TO: A/Administrator

FROM: W/Inspector General

SUBJECT: INFORMATION: Safety Concerns with Kennedy Space Center's
Payload Ground Operations Redacted Report*
Report Number IG-00-028

The NASA Office of Inspector General has completed an audit of Safety Concerns with Kennedy Space Center's Payload Ground Operations. During the audit, we found materials that consistently failed required tests for flammability resistance and electrostatic discharge¹ in use in two processing facilities at the Kennedy Space Center. Such potentially hazardous materials include plastic films, foams, and adhesive tapes used by payload processing personnel under Boeing's Payload Ground Operations Contract. These materials have been used without approval of the Kennedy Safety Office since 1992. NASA authorized variances,² in the form of Materials Usage Agreements,³ for the use of some of the materials but not until 1999. However, the contractor continued unapproved uses of the materials even under the terms of the Materials Usage Agreements. Moreover the variances were ineffective because neither the NASA nor Boeing safety offices reviewed the variances and Boeing had not performed required risk analyses to support the variances. As a result, NASA has not identified,

*We have redacted portions of this report due to deliberative process information. The redacted passages do not affect the validity of this report or management's response.

¹ Kennedy Handbook 1710.2, "Kennedy Space Center Safety Practices Handbook," requires that plastic films and adhesive tapes pass acceptance criteria for flammability and ESD. The handbook makes reference to the Kennedy Materials Sciences division intranet, which also includes foams as materials that need to pass the acceptance criteria. The basic requirements are:

Flammability Resistance – the material should be self-extinguishing before 6 inches of the test sample is consumed, should not drip flaming particles, and should not permit fire to propagate to another object; and

Electrostatic Discharge – the material can hold a charge of only 350 volts for less than 5 seconds after termination of the initial charge.

² NASA Handbook 1700.1, "NASA Safety Policy and Requirements Document," defines a variance as documented and approved permission to perform some act contrary to established requirements.

³ Material Usage Agreements are Kennedy's variance mechanisms for allowing the use of materials that fail required tests for flammability and electrostatic discharge. Scant criteria exist that address the use of Material Usage Agreements.

documented, and appropriately mitigated the risks of using the potentially hazardous materials, exposing personnel and flight hardware to increased risks.

Background

As Kennedy's Payload Ground Operations contractor, Boeing performs payload-processing activities for Space Shuttle and expendable launch vehicle payloads, including flight elements of the International Space Station. Boeing performs such work primarily at two Kennedy Space Center processing facilities: the Space Station Processing Facility and the Operations and Checkout building.⁴ Safety is a critical element of contractor performance. A single mishap could adversely affect flight or key processing milestones or result in risks to NASA equipment, flight hardware, and personnel. The Payload Ground Operations Contract requires that all plastic films, foams, and adhesive tapes meet basic standards for flammability resistance and electrostatic discharge. Processing personnel can use materials that do not pass required tests; however, NASA and Boeing should prepare a variance for the use of such materials. To ensure that the associated risks are properly managed, variances should include appropriate risk mitigation plans. NASA and Boeing safety officials should also review the variances.

Recommendations, Management's Response, and Evaluation of Response

We recommended that the Director, John F. Kennedy Space Center (1) implement procedures to ensure the safe use of all materials that do not meet standards, (2) clarify instructions for preparing Material Usage Agreements, and (3) increase surveillance of Boeing's inspection procedures. We also recommended that the Payload Ground Operations Contract Contracting Officer (1) determine whether there is a basis to withhold contract costs related to noncompliant plastics, foams, and adhesives, and (2) ensure that proper contract award fee action is taken based on Kennedy's increased surveillance of the Payload Ground Operations contractor.

Management concurred with the recommendations. Kennedy has planned or implemented additional procedures to ensure the safe use of materials that do not meet standards for flammability and electrostatic discharge. The Center has also agreed to clarify the procedures for preparing Material Usage Agreements and to increase surveillance of the Payload Ground Operations contractor. Details on the status of the recommendations are in the recommendations section of the report (pages 9-10).

Kennedy management provided extensive comments on our findings (see Appendix E).

⁴ The Space Station Processing Facility was built for processing International Space Station flight hardware. It is a three-story, 457,000 square foot building that includes two processing bays, an airlock, operational control rooms, laboratories, office space, and a cafeteria. The Operations and Checkout building is used for receiving, assembling, and integrating Shuttle payloads. It is a five-story building containing 600,00 square feet of offices, laboratories, astronaut crew quarters, and spacecraft assembly areas.

Management contends that plastics, foams, and adhesives are not inherently hazardous materials but can create potentially hazardous conditions if not properly handled. Our concerns address the weakness in Kennedy's process for verifying the acceptability of materials that failed required tests. We respond to management's comments in Appendix F of the report.

[original signed by]

Roberta L. Gross

Enclosure

Final Report on Audit of Safety Concerns with Kennedy Space Center's
Payload Ground Operations

FINAL REPORT
AUDIT OF SAFETY CONCERNS WITH
KENNEDY SPACE CENTER'S
PAYLOAD GROUND OPERATIONS

W

March 30, 2000

TO: Q/Associate Administrator for Safety and Mission Assurance
AA/Director, John F. Kennedy Space Center

FROM: W/Assistant Inspector General for Auditing

SUBJECT: Final Report on Audit of Safety Concerns with Kennedy Space Center's
Payload Ground Operations
Assignment Number A9900301
Report Number IG-00-028

The subject final report is provided for your information and use. Our evaluation of your response is incorporated into the body of the report. The corrective actions planned for the recommendations are responsive. Recommendation 4 is considered closed for reporting purposes. Recommendations 1, 2, 3, and 5 will remain open for reporting purposes until corrective actions are completed. Please notify us when action has been completed on the recommendations, including the extent of testing performed to ensure corrective actions are effective.

If you have questions concerning the report, please contact Mr. Kevin J. Carson, Program Director, Safety and Technology Audits, at (301) 286-0498, or Mr. Karl M. Allen, Auditor-in-Charge, at (202) 358-2595. We appreciate the courtesies extended to the audit staff. The final report distribution is in Appendix G.

[Original signed by]

Russell A. Rau

Enclosure

cc:

B/Chief Financial Officer

B/Comptroller

BF/Director, Financial Management Division

G/General Counsel

JM/Director, Management Assessment Division

M/Associate Administrator, Office of Space Flight

QS/Director, Safety and Risk Management Division

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W/K. Carson

K. Allen

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NASA Office of Inspector General

IG-00-028
A9900301

March 30, 2000

Safety Concerns with Kennedy Space Center's Payload Ground Operations

Introduction

The Office of Inspector General (OIG) is performing an audit of NASA contractor safety programs. The overall objective is to evaluate the safety procedures of Agency contractors. As part of this assignment, we also addressed concerns the House of Representatives Committee on Science provided to the OIG. The Committee's concerns focused on the safety functions of the John F. Kennedy Space Center's (Kennedy) Payload Ground Operations Contract (PGOC) performed by McDonnell Douglas Aerospace, Space and Defense Systems; a subsidiary of The Boeing Company (Boeing). We reviewed the PGOC contractor's operations to determine whether:

- safety responsibilities between Boeing and NASA had been clearly defined,
- hazardous materials were being used in Kennedy's processing facilities, and
- hazardous materials, if used, were properly controlled.

A January 1997 modification to the PGOC (number NAS10-11400) defines Boeing's safety responsibilities relating to the PGOC. With this modification, NASA converted the contract to a performance-based contract and revised the statement of work to more clearly establish safety responsibilities for Boeing, NASA, and other contractors at various Kennedy processing facilities, including the Space Station Processing Facility (SSPF) and the Operations and Checkout (O&C) building.⁵

Appendix A contains further details on the audit objectives, scope, and methodology.

⁵ The SSPF was built for processing International Space Station flight hardware. It is a three-story, 457,000 square foot building that includes two processing bays, an airlock, operational control rooms, laboratories, office space, and a cafeteria. The O&C building is used for receiving, assembling and integrating Shuttle payloads. It is a five-story building containing 600,00 square feet of offices, laboratories, astronaut crew quarters, and spacecraft assembly areas.

Results in Brief

Ground workers⁶ at Kennedy were using potentially hazardous materials in both the SSPF and O&C building that consistently failed required tests for flammability resistance and electrostatic discharge (ESD). This occurred because Boeing's safety office did not perform adequate, contract-required inspections of the facilities to ensure that NASA had approved all plastic films, foams, and adhesive tapes (PFA's) being used or that ground workers removed unapproved materials from the premises. NASA records show that the materials failed required tests as far back as July 1992. Beginning in September 1999, NASA authorized variances⁷ for the use of some of the materials. However, these variances were ineffective because neither the Kennedy nor Boeing safety offices reviewed the variances, and Boeing did not perform any risk analyses to support the variances, as required by the PGOC. As a result, NASA has not identified, documented, and appropriately mitigated the risks of using the potentially hazardous materials, exposing ground workers and flight hardware to increased risks. NASA and Boeing Safety and Materials personnel met in December 1999 and acknowledged that problems exist regarding the use of potentially hazardous materials in both the SSPF and O&C building.

Background

NASA awarded the PGOC to McDonnell Douglas Astronautics Company on January 1, 1987. The cost-plus-award-fee contract was valued at \$1.9 billion and had a period of performance extending through December 2001. Through a subsequent merger with The Boeing Company, the contractor became McDonnell Douglas Aerospace, Space and Defense Systems; a subsidiary of Boeing. As the PGOC contractor, Boeing performs payload-processing activities for Space Shuttle and expendable launch vehicle payloads, including flight elements of the International Space Station (ISS). Boeing performs such work primarily at Kennedy in the SSPF and O&C building. Safety is a critical element of contractor performance. A single mishap could adversely affect flight or key processing milestones or result in risks to NASA equipment, flight hardware, and ground workers. According to the PGOC, Boeing is responsible for ensuring industrial and operational safety⁸ in most areas of the SSPF and the O&C building. This includes inspections of all work areas to detect, eliminate, and control hazards. Also, the Kennedy safety office provides insight into Boeing's operations.

⁶ Ground workers include personnel from NASA-Kennedy, Boeing PGOC, Boeing Space Station Contract, and other contractor personnel authorized to work on payloads in the SSPF and O&C building.

⁷ NASA Handbook 1700.1, "NASA Safety Policy and Requirements Document," defines a variance as documented and approved permission to perform some act contrary to established requirements.

⁸ According to the Boeing PGOC Safety and Health Plan, industrial safety includes safety procedures such as mishap reporting, facilities design, fire prevention, handling of hazardous materials, and personal protective equipment. The plan defines operational safety as the development of safety support into payload handling, testing, and checkout operations processes.

The PGOC, by reference to several sources, requires that all PFA's used in Kennedy processing facilities meet standards for flammability resistance and ESD.⁹ At Kennedy, the NASA Materials Sciences Lab is responsible for testing all materials against flammability and ESD requirements. NASA and Boeing personnel can use materials that do not pass required tests; however, NASA and Boeing should prepare a variance for the use of such materials and ensure that the associated risks are properly managed.

Use of Potentially Hazardous Materials in Kennedy Processing Facilities

Finding. Ground workers were using potentially hazardous materials in Kennedy processing facilities without exercising proper control and safety precautions. This condition exists because (1) Boeing safety personnel have not performed adequate, contract-required inspections of the facilities and (2) Kennedy or Boeing safety personnel had not reviewed the Materials Usage Agreements (MUA's) authorizing use of the potentially hazardous materials, which were not supported by risk analyses. As a result, NASA lacks assurance that associated risks are adequately identified, documented, reviewed, and mitigated. Improper use of these materials is potentially hazardous to ground workers and increases the risk of damage to Space Shuttle payloads, including ISS hardware and equipment.

Materials Usage Requirements

There are numerous NASA-wide and Kennedy-specific requirements that address the testing and control of potentially hazardous materials. Appendix B lists the sources of such requirements. Kennedy Handbook 1710.2, "Kennedy Space Center Safety Practices Handbook," which is incorporated into the PGOC by reference and which refers to the Kennedy Materials Sciences Division intranet, requires that PFA's pass acceptance criteria for flammability and ESD. The Kennedy Materials Application Advisory Board maintains a list of the materials that have passed the required tests and are approved for use in Kennedy facilities. The PGOC Safety and Health Plan, which is also part of the contract, addresses the procedures for authorizing the use of materials that do not pass such criteria. Section 3.13 of the PGOC Safety and Health Plan states:

The need for a variance to a safety requirement normally results from a situation where standard safety precautions and regulations do not permit accomplishment of, or unacceptably delay, a particular mission or

⁹ Kennedy Handbook 1710.2, "Kennedy Space Center Safety Practices Handbook," requires that plastic films, and adhesive tapes pass acceptance criteria for flammability and ESD. The handbook makes reference to the Kennedy Materials Sciences division intranet, which also includes foams as materials that need to pass the acceptance criteria. The basic requirements are:

Flammability Resistance – the material should be self-extinguishing before 6 inches of the test sample is consumed, should not drip flaming particles, and should not permit fire to propagate to another object; and

ESD – the material can hold a charge of only 350 volts for less than 5 seconds after termination of the initial charge.

operation. . . . All out-of-family safety variances will be forwarded to NASA-KSC [Kennedy] Safety for approval. . . . For safety variances forwarded to NASA Safety for approval, [Boeing] Safety will prepare a risk assessment of the safety impact of the variance and forward with the request to NASA-KSC [Kennedy] Safety. . . .

Kennedy uses MUA's as the variance mechanism for potentially hazardous materials. Scant criteria exist that address the use of MUA's other than KSC (Kennedy Space Center)-LO-8060.1, "KSC [Kennedy Space Center] Materials and Processes Control Program," July 15, 1997, which states:

The Directors of Engineering Development; Shuttle Management and Operations; Payload Management and Operations; Installation Management and Operations; Safety and Mission Assurance; and the cognizant program/project manager are responsible for: . . . Ensuring that only approved M&P [materials and processes] are used (including contractor usage) and that MUA's are provided to the CMR [Center Materials Representative] in a timely manner for evaluation prior to operations use.

Potentially Hazardous Materials Used

In the SSPF and O&C building, Kennedy ground workers are using the following materials that have failed the required tests:

- Polyethylene foams are used to pad pieces of flight hardware and test stands and to protect pallets and flooring surfaces.
- Plastic bubble wrap that often comes into the facilities as packing materials is used. Photographs from the Kennedy archives of the SSPF high bay showed bubble wrap used for other than packing material (Appendix D, Figure 3).
- Flash breaker tape is on ISS lab flight hardware surfaces in the SSPF.

We obtained NASA test records, dating from 1992 through September 1999, that show these materials have failed required flammability and ESD tests, making them noncompliant with the Space Shuttle Payload Ground Safety Handbook and other Kennedy safety requirements. In September 1999, the Kennedy Center Materials Representative (CMR)¹⁰ approved the use of some of the materials by signing MUA's. A full description of the materials, test results, and MUA data is provided in Appendix C.

We also obtained a list of 73 other PFA's from the Kennedy Materials Sciences Lab that were not on the Kennedy-approved material listing and that Boeing may have been using under the PGOE in the SSPF. These materials were various types of plastic tape, electrical tape, and

¹⁰ The CMR is responsible for administering Kennedy's materials and processes control program.

plastic bags that may have been used throughout the SSPF. An employee of the Materials Sciences Lab told us that he instructed the Boeing safety office to have all the materials tested; however, Boeing never complied with the request. There were no MUA's for any of these materials. We could not identify the extent of use of the materials through either our visual inspections of the SSPF and O&C building, or through pictures from those facilities.

Boeing Safety Inspections

The Boeing safety office has not performed adequate, contract-required inspections of the SSPF and O&C building. The PGO Safety and Health Plan, which is incorporated as part of the contract, states:

Safety inspections of all work areas (payload processing and administrative) under the jurisdiction of the PGO will be performed on a regular basis The primary reasons for performing safety inspections are detection, elimination or control of hazards in the workplace, and the assurance that compliance requirements are being met.

Boeing safety personnel told us they performed regular inspections of both the SSPF and O&C building high bay areas. However, the effectiveness of those inspections is questionable. For example, records show that as of September 1997, the Boeing safety office was aware that polyethylene foams and plastic bubble wraps had failed required flammability and ESD tests. Despite those results, Boeing continued to use the materials. Photographs in Figure 1 and Appendix D show their use in both facilities as of March 1998 and as recently as November 1999.

On November 3, 1999, Boeing safety officials, including the Senior Managers for Safety, and Quality Assurance, stated that they were not aware of any (1) PFA's in either the SSPF or O&C building or (2) variances allowing ground workers to use such materials. When we toured the SSPF high bay a week later on November 10, 1999, we observed that all the various polyethylene foams were in abundant use throughout the facility. The Kennedy Chief Safety Officer stated that noncompliant PFA's were used only as packaging material and did not pose a hazard.

MUA's Obtained for Some Materials

Although MUA's were authorized for Boeing's use of some of the materials, the MUA approval process was not effective. On five occasions beginning on September 21, 1999, or after the start of our audit, NASA used MUA's to approve the use of some of the materials that failed required tests. Four of the materials were polyethylene foam, and one was flash breaker tape used on ISS hardware. The Kennedy CMR approved the MUA's for the five materials based only on oral assurance by Boeing materials and processes personnel that Boeing would use the materials safely. The MUA approval process was not effective because (1) the CMR did not approve the MUA's in a timely manner, (2) Boeing did not support the MUA's with documented risk

analyses, and (3) neither the Kennedy nor Boeing safety offices reviewed and approved the MUA's.

- **Timely Completion.** The Kennedy CMR approved the MUA's 7 years after the materials first failed required testing. Although test records show that some of the materials failed required tests as early as July 1992, the Kennedy CMR and the Boeing materials and processes representative did not sign the MUA's until September and October 1999. KSC-LO-8060.1 states that the CMR must have sufficient time for evaluation of the MUA prior to the scheduled use of the material.
- **Analyses.** Boeing did not support the MUA's with adequate analyses to identify and mitigate potential risks. In addition, Boeing did not adequately monitor its use of potentially hazardous materials and ensure that all affected parties clearly understood control procedures. The PGOC requires that the Boeing PGOC Office of Safety prepare a risk assessment of the safety impact for variances that are forwarded to NASA for approval.
- **Safety Office Review.** Neither the Kennedy nor Boeing safety offices reviewed the MUA's to ensure that Boeing personnel would use the materials in a manner that would not put personnel or equipment at risk. The PGOC requires that all safety variances be reviewed and approved by the NASA safety office. Boeing safety staff responsible for monitoring and inspecting the SSPF and O&C building high bay areas told us that they were not aware of any variances or waivers for the materials in use.

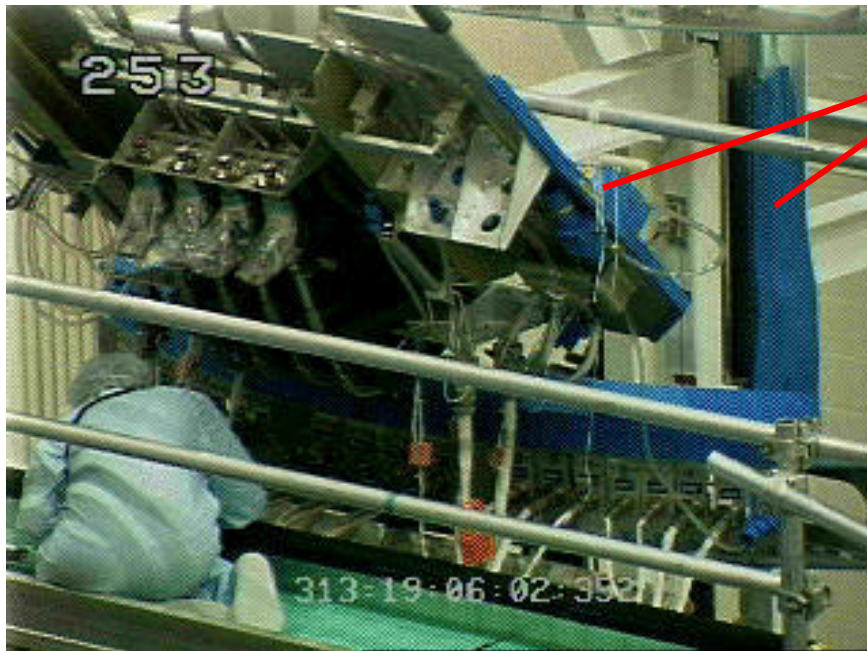
Risks of Using Potentially Hazardous Materials

By not ensuring that Boeing followed documented procedures and contract requirements for the use of PFA's, NASA lacks assurance that ground workers are using these materials in a safe and controlled manner, especially with regard to their potential flammability and ESD.

- **Flammability.** For each of the flammability tests conducted, when personnel in the NASA Materials Science Lab ignited the foam padding, the foam did not self-extinguish. In addition, the foam padding dripped particles to lower surfaces, causing it to fail testing. Boeing materials and processes personnel stated in the MUA's that flammability risks were mitigated by (1) covering the foam with film that passes required flammability tests or (2) using the foam only on the floor of the SSPF. However, when we walked through the SSPF high bay areas, we observed that the foam was abundantly used throughout the facility, including on vertical surfaces. Furthermore, photographs of the SSPF and O&C building show that the foam was used throughout both facilities, including on vertical surfaces. We did not observe foam covered with film. Figure 1 shows ISS equipment in the O&C building, with the blue foam¹¹ used in a non-horizontal position. If this material ignited and ground workers did not detect

¹¹ An employee of the NASA Materials Science Lab identified the blue material in Figure 1 as L380FR polyethylene foam.

the fire, there is a risk that it would not extinguish itself and would drip particles to lower surfaces, causing more damage.



**L380FR
Polyethylene
Foam**

Figure 1. Blue Foam Used on the S Zero Truss Element of the ISS in O&C Building High Bay, November 9, 1999.

- **ESD.** When the NASA Materials Science Lab tested the foam padding, it held a static electrical charge longer than the acceptable period. To pass testing, material can hold a charge of only 350 volts for less than 5 seconds after termination of the initial charge. The foam for which NASA issued MUA's held a residual charge of more than 19,000 volts. Boeing materials and processes personnel stated in the MUA's that the contractor would mitigate ESD risks by using the foam only where ESD was not a concern. However, Boeing did not identify the location of those particular areas. When we toured the SSPF, we observed that the foam padding was being used throughout the facility's intermediate and high bays, which significantly increased the risk of ESD. In addition, in January 1998, a mishap occurred in the SSPF in which a test technician incorrectly disconnected an energized cable in the ISS Unity Node element.¹² A NASA employee who was a witness to the incident told us that the disconnect caused an electrical arc that was both visible and audible. The witness further stated that the mishap could have been much worse because the cable was surrounded by polyethylene foam that had failed the required ESD tests.

The ultimate risk of improper use of these materials is damage or destruction of ISS hardware or harm to ground workers. The Kennedy Director of Space Station and Shuttle Payloads acknowledged this risk in a June 11, 1999, memorandum, which states:

¹² The Unity Node is a connecting passageway to living and work areas of the ISS. It is the first major U.S.-built component of the ISS and was launched into orbit in December 1998.

. . . With the introduction of ammonia, isopropyl alcohol, gaseous oxygen and other hazardous materials into the O&C and SSPF, it is important that materials and process (M&P) engineers control the use of plastic films, foams, adhesive tapes (PFA's) and solvents in these facilities. . . .

In that same memorandum, the Kennedy Director of Space Station and Shuttle Payloads directed personnel to improve safety in the O&C building and the SSPF:

. . . all providers of hardware elements, support equipment, and payloads shall remove and discard all noncomplying PFA's within 24 hours of arrival in a processing area

Customers currently on site and not using PFA's that meet requirements . . . will have 90 days upon receipt of this letter to remove noncompliant PFA's.

We did not observe any additional safety procedures implemented as a result of the memorandum.

Contract Award Fees Received

Despite Boeing's use of the potentially hazardous materials, it continually received the full award fee for safety and mission assurance for each award fee evaluation period since January 1997. The PGOE states that one of the purposes of the award fee provisions is to encourage and reward the contractor for safe, timely, quality, cost-conscious performance in fulfilling the requirements set forth in the contract. Item III. C.3 of the award fee evaluation criteria states:

Safety will be emphasized in all evaluations. Incidents attributable to the contractor's effort involving mission failure or degradation, employee safety, equipment or hardware damage, or potential hazards will result in significant loss of fee earning opportunity.

We reviewed the PGOE award fee data for the five completed evaluation periods since the contract was converted to a performance-based contract in January 1997. For each period, Boeing's award fee was not affected by potentially unsafe practices including:

- Boeing's continued use of polyethylene foam and plastic bubble wrap despite the Boeing safety office's knowledge that these materials failed required tests for flammability and ESD.
- The January 1998 close call in the SSPF when an energized cable in the ISS Unity Node that was surrounded by the polyethylene foam was mistakenly disconnected.
- Input from an award fee performance monitor that stated that Boeing used incorrect methods to obtain approval of unknown material, failed to follow proper procedures on material

approval, and failed to remove materials from the premises that had not passed required testing.

Deliberative process information omitted.

Recommendations, Management's Response, and Evaluation of Response

Kennedy management provided extensive comments on our finding that are addressed in Appendix F of this report.

The Director, John F. Kennedy Space Center, should:

- 1. Implement procedures to ensure the safe use of all materials (materials currently in use and new materials introduced into the SSPF or O&C building) that do not meet NASA and Kennedy requirements for flammability and ESD.**

Management's Response. Concur. Kennedy has undertaken additional measures to ensure the safe use of materials that do not meet requirements for flammability and ESD. The complete text of management's response is in Appendix E.

Evaluation of Management's Response. Management's planned actions are responsive to the recommendation. The recommendation is resolved, but will remain undispositioned and open for reporting purposes until corrective actions are completed.

- 2. Clarify instructions for preparation of MUA's to ensure that each MUA is prepared in a timely manner, supported by a documented analysis, and reviewed and approved by both contractor and Kennedy safety offices.**

Management's Response. Concur. The Kennedy Logistics Operations Directorate's Materials Science Laboratory, in conjunction with other Kennedy organizations, is rewriting the procedure for the Center Materials and Processes Control Program, which covers the preparation of MUA's (see Appendix E).

Evaluation of Management's Response. The actions planned by management are responsive to the recommendation. The recommendation is resolved, but will remain undispositioned and open for reporting purposes until corrective actions are completed.

3. Increase surveillance of Boeing's inspection procedures. The surveillance should ensure that Boeing (a) regularly inspects all potentially hazardous materials including PFA's; (b) ensures that all materials used are approved; (c) determines whether an MUA was authorized, or is planned to be authorized for the use of the materials not approved; and (d) promptly removes all materials that have not been approved or for which an MUA has not been authorized.

Management's Response. Concur. Among other noted implemented and planned corrective actions, (1) the Kennedy Space Station and Payload Assurance organization has implemented an increased awareness program for PFA's (2) the NASA Safety Assurance Division will assure that the contractor uses PFA's in a safe, documented, and controlled manner, and (3) the NASA Quality Assurance Division will conduct special audits on the contractor, and all nonconformance noted will require contractor corrective and preventative action plans (see Appendix E).

Evaluation of Management's Response. The actions planned by management are responsive to the recommendation. The recommendation is resolved, but will remain undispositioned and open for reporting purposes until corrective actions are completed.

4. Direct the PGOC Contracting Officer to determine whether there is a basis to withhold all contract costs relating to noncompliant PFA's

Management's Response. Concur. The PGOC took prompt action to put appropriate processes in place to assure proper control of PFA's. The PFA's in question are materials that have multiple valid uses on the contract, including in the SSPF and O&C building facilities when used according to required procedures. Therefore, the costs of these materials meet the "reasonableness" and "allocability" tests prescribed in Federal Acquisition Regulation section 31.201-2 in determining whether they are allowable. There is not a basis to consider disallowance of costs (see Appendix E).

Evaluation of Management's Response. The actions taken by management are responsive to the recommendation. We consider the actions sufficient to disposition the recommendation, which will be closed for reporting purposes.

5. Direct the PGOC Contracting Officer to ensure that proper surveillance of contractor activities with regard to the proper use and control of PFA's is conducted and appropriate contract award fee action is taken if necessary.

Management's Response. Concur. Kennedy has taken aggressive action to assure the proper use of PFA's. The contractor has, at this time, demonstrated that it has the proper policies and procedures in place to ensure the safe and proper use and control of PFA's. Monitoring of this area of performance is being conducted to ensure that compliance with the requirements continues (see Appendix E).

Evaluation of Management's Response. The actions planned by management are responsive to the recommendation. The recommendation is resolved, but will remain undispositioned and open for reporting purposes until corrective actions are completed.

Appendix A. Objectives, Scope, and Methodology

Objectives

Our objectives, as discussed in this report, focused on safety concerns with Kennedy's PGOC that the Chairman of the U.S. House of Representatives' Committee on Science brought to the attention of the OIG in a February 25, 1999, letter. We reviewed the contractor's operations to determine whether:

- safety responsibilities between Boeing and NASA had been clearly defined,
- hazardous materials were being used in Kennedy's processing facilities, and
- hazardous materials, if used, were properly controlled.

The overall objective of the audit, which will be addressed in a separate report, is to evaluate the safety procedures of Agency contractors.

Scope and Methodology

To determine whether the PGOC clearly defined safety responsibilities for Boeing and NASA, we:

- Reviewed the official PGOC file.
- Discussed the contract safety requirements with the NASA Contracting Officer, the Contracting Officer's Technical Representative, the Director of the Kennedy Space Station and Shuttle Payloads Office, and staff in the Kennedy and Boeing safety offices.

To determine whether prohibited materials were used in Kennedy processing facilities and if so, whether they were properly controlled, we:

- Reviewed the NASA and Kennedy requirements for materials testing, control, and approval procedures.
- Reviewed Kennedy materials testing records dated from July 1992 through September 1999.
- Reviewed the applicable MUA's.
- Discussed materials testing, control, and approval procedures with the Kennedy CMR, NASA Materials Science Lab personnel, Boeing materials and processes officials, and safety staff.

Appendix A

- Toured the SSPF and O&C building high bays.

Management Controls Reviewed

We reviewed management controls relative to safety requirements for NASA contracts as described in NASA Handbook 1700.1, “NASA Safety Policy and Requirements Document.” Specifically, we reviewed the Contracting Officer’s procedures for ensuring that specific contractor safety tasks are clearly defined in the basic contract. The controls in place were considered adequate. We also reviewed Kennedy’s procedures for approving the use of materials that fail required testing procedures. As discussed in the finding, controls need to be strengthened to ensure that the Kennedy and Boeing safety offices review and approve all MUA’s and to ensure that a documented analysis is performed for each MUA.

Audit Field Work

We performed field work from October 1999 through January 2000 at NASA Headquarters and Kennedy. We performed the audit in accordance with generally accepted government auditing standards.

Appendix B. Materials Testing, Approval, and Control Requirements

The following policies are applicable to NASA's requirements for testing, using, and controlling hazardous materials:

NASA Handbook 1700.1, "NASA Safety Policy and Requirements Document," June 1, 1993. The handbook is the central Agency document containing policy, safety requirements, and guidelines that define the NASA safety program. The handbook states that the safety organization with authority to establish a safety requirement is responsible for:

- reviewing and ruling on variances to the requirement, or
- delegating the responsibility for ruling on variances with possible conditions placed on the approval process (e.g., requiring proper analysis, risk assessment, and safety factor limits).

Kennedy Handbook 1710.2, "Kennedy Space Center Safety Practices Handbook," Revision D, November 1, 1998. The purpose of the handbook is to establish consolidated safety requirements to define the parameters and boundaries required during design, operations, and maintenance activities at Kennedy. The Kennedy office responsible for the handbook is the Safety and Mission Assurance Directorate. The handbook states that when a requirement of the handbook cannot be met, the requesting organization shall provide variance data information to the Director of Safety and Mission Assurance.

Kennedy Handbook 1700.7, "Space Shuttle Payload Ground Safety Handbook," Revision C, August 19, 1999. The handbook aligns existing Department of Defense and NASA ground safety criteria and establishes requirements for ground processing of Shuttle payloads and associated ground support equipment. The Kennedy office responsible for the handbook is the Safety and Mission Assurance Directorate. The handbook requires all Kennedy payload organizations to comply with the established requirements or obtain a waiver for each case in which compliance is infeasible. For operations at Kennedy, requesting organizations should submit a waiver request to the Kennedy Director of Safety and Mission Assurance. Information provided on the request should include, among other things, reasons for noncompliance to the stated requirement and rationale for acceptance of the waiver, including any required support data and drawings, and a list of possible methods and techniques used in mitigating the hazards. Also, the handbook states that payload organizations shall select from the approved materials lists, those materials susceptible to the generation, collection, and holding of static electrical charges. The handbook further states that use of flammable materials and static-producing materials shall be kept to a minimum in all payload-processing areas.

Appendix B

KSC [Kennedy Space Center]-LO-8060.1, “KSC [Kennedy Space Center] Materials and Processes Control Program,” July 15, 1997. The document establishes the policy and steps to be followed by all organizational elements at Kennedy in the selection of materials. Organizations at Kennedy are required to submit to the Kennedy CMR analysis and test results to show that selected materials meet safety requirements. If NASA or contractor personnel choose materials that do not meet such requirements, the organization must submit an MUA to the CMR. The CMR must have sufficient time for evaluation of the MUA prior to the scheduled use of the material.

KDP [Kennedy Document Procedure]-P-2207, “Safety Variance Process,” Revision A, November 1998. The objective of this guidance is to provide an efficient and accurate method of documenting and tracking variances pertaining to established safety policies. The variance process assures (1) appropriate organizations are accountable, (2) operations are safe, (3) risks are acceptable, (4) contract requirements are met, and (5) Federal and agency requirements are met. Administrators from the Safety and Mission Assurance Directorate must review and evaluate variance requests to ensure that the risks and rationale associated with the variance are acceptable. The document states that the Kennedy Director of Safety and Mission Assurance shall approve all variances.

Payload Ground Operations Contract (PGOC), NAS10-11400. In accordance with Appendix 11 of contract NAS10-11400, Boeing shall “establish a means to analyze the safety impact” for proposed waivers and deviations.

NASA Technical Standard 6001, “Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments That Support Combustion,” February 9, 1998. This document establishes the technical requirements for evaluation, testing, and selection of materials to preclude unsafe conditions related to flammability and other hazards. This document does not address variance policies and procedures for using materials that fail the required test.

Appendix C. Hazardous Materials Test Results

Material	Test Dates & Results	MUA Date & Rationale for Use	Audit Observations
<p>Red, white, or blue L380FR-B Polyethylene Foam. Manufactured by United Foam Plastics Corporation.</p>	<p>NASA first tested these materials on 7/31/92. Test results were:</p> <p>Flammability: Failed. Samples of each material dripped flaming particles, igniting test paper below the test materials.</p> <p>ESD: Failed. Samples of each material maintained a residual charge of more than 19,000 volts of electricity 5 seconds after termination of a static charge. The minimum charge allowable was 350 volts.</p>	<p>The Kennedy CMR signed the MUA on 9/20/99, and the Boeing materials and processes representative signed on 9/21/99. Boeing will use the foam as a pallet protective pad and must cover or move material if ESD is a concern.</p>	<p>There was no MUA for the green foam. Figures 2 and 4 in Appendix D show these foams on ISS hardware throughout the SSPF.</p>
<p>Blue L380FR-B Polyethylene Foam. Manufactured by United Foam Plastics Corporation</p>		<p>The Kennedy CMR signed an MUA on 9/20/99, and the Boeing materials and processes representative signed on 9/21/99. Boeing will use the foam for ISS equipment.</p>	<p>None</p>
<p>Red, white, or blue L380FR-B Polyethylene Foam. Manufactured by United Foam Plastics Corporation</p>		<p>The Kennedy CMR and Boeing materials and processes representative signed an MUA on 10/7/99. Boeing will use material in only horizontal position, on the floor where ESD is not a concern.</p>	<p>The MUA did not include the green foam. Photographs of the O&C building (Figure 1 page 7) and the SSPF (Figures 2 and 4, Appendix D) show the foam in positions other than on the floor.</p>
<p>Miscellaneous foam padding, including L380FR-B Polyethylene Foam.</p>		<p>The Kennedy CMR and Boeing materials and processes representative signed an MUA on 10/7/99. The material failed all tests, but Boeing will cover material with an approved plastic film. If the plastic film tears, Boeing should remove materials immediately.</p>	<p>During our walk-throughs of the O&C building and SSPF, we observed that foam was not covered with plastic.</p>

Appendix C

Material	Test Dates & Results	MUA Date & Rationale for Use	Audit Observations
Flashbreaker 2 Tape. Manufactured by Airtech International, Inc.	<p>NASA tested this material in April 1999. Preliminary test results were:</p> <p>Flammability: Failed. A test sample did not self-extinguish within the allowable parameters.</p> <p>ESD: Failed. A sample of the material maintained a residual charge of more than 19,000 volts of electricity 5 seconds after termination of a static charge. The minimum charge allowable was 350 volts.</p>	<p>The Kennedy CMR signed an MUA on 9/20/99, and the Boeing materials and processes representative signed on 9/21/99. Boeing will use material on ISS hardware because it does not contaminate hardware surfaces. NASA could not find a tape that passed contamination, flammability, and ESD tests.</p>	None
Clear Bubble Wrap. Manufacturer unknown.	<p>NASA tested this material on 12/19/97. Preliminary test results were:</p> <p>Flammability: Failed. A sample of the material dripped flaming particles, igniting test paper below the test material.</p>	<p>The Kennedy CMR and Boeing materials and processes representative have not signed MUA's for these materials.</p>	<p>NASA and Boeing personnel told us that they do not permit bubble wrap in any of the processing facilities. Although vendors may use it as packing material, Boeing personnel are to immediately discard the material upon receipt of payloads from vendors. However, Figure 3, Appendix D, shows use of clear and pink bubble wrap.</p>
SC120 Pink Bubble Wrap. Manufactured by Sealed Air Corporation.	<p>NASA tested this material on 12/23/97. Test results were:</p> <p>Flammability: Failed. A sample of the material dripped flaming particles, igniting test paper below the test material.</p> <p>ESD: Failed. A sample of the material maintained a residual charge of more than 4,000 volts of electricity 5 seconds after termination of a static charge. The minimum charge allowable was 350 volts.</p>		

Appendix D. Polyethylene Foam and Bubble Wrap Usage

L380FR-B
Polyethylene
Foam

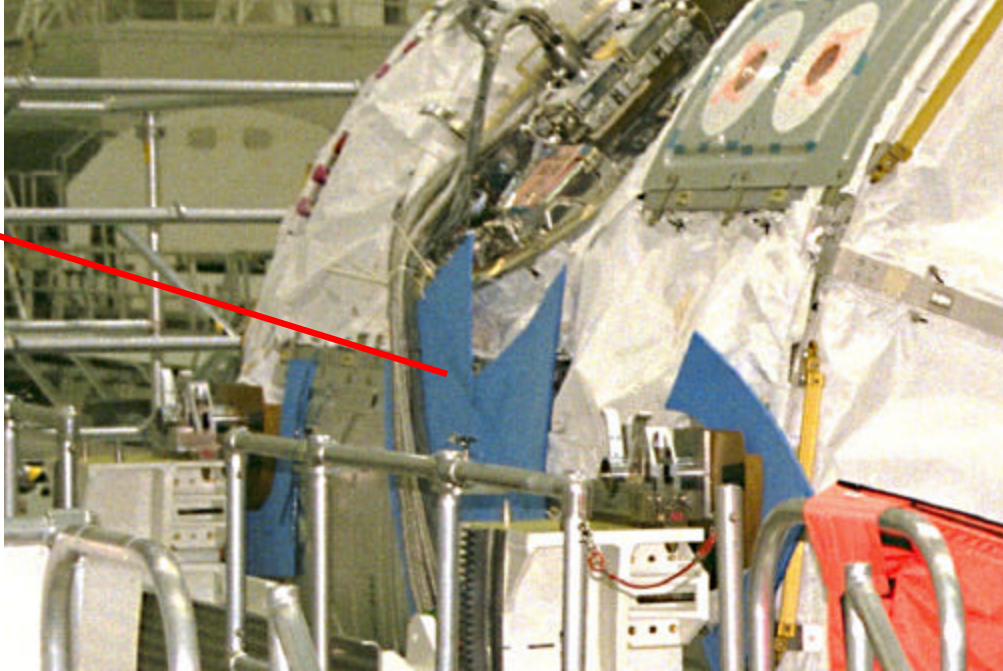
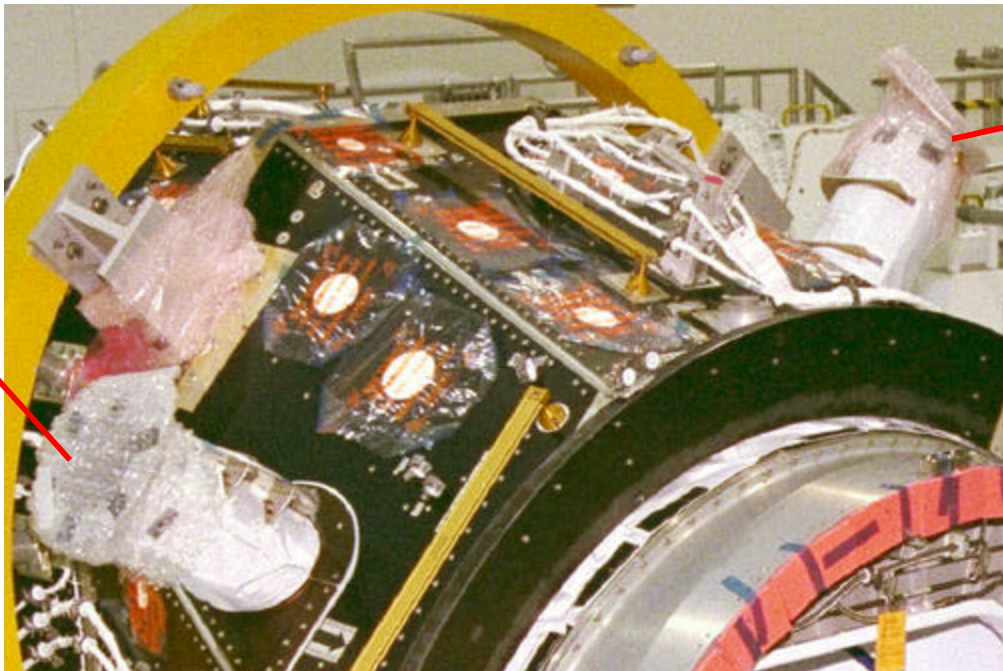


Figure 2. Blue Foam* on ISS Unity Module in SSPF High Bay, March 9, 1998.

Clear Bubble
Wrap



Pink Bubble
Wrap

Figure 3. Pink and Clear Plastic Bubble Wrap* on the ISS Pressurized Mating Adapter 2 in SSPF High Bay, April 28, 1998.

*An employee of the NASA Materials Science Lab identified the blue material in Figure 2 as L380FR-B polyethylene foam and the plastic materials in Figure 3 as clear and pink bubble wrap.

Appendix D

L380FR-B
Polyethylene
Foam

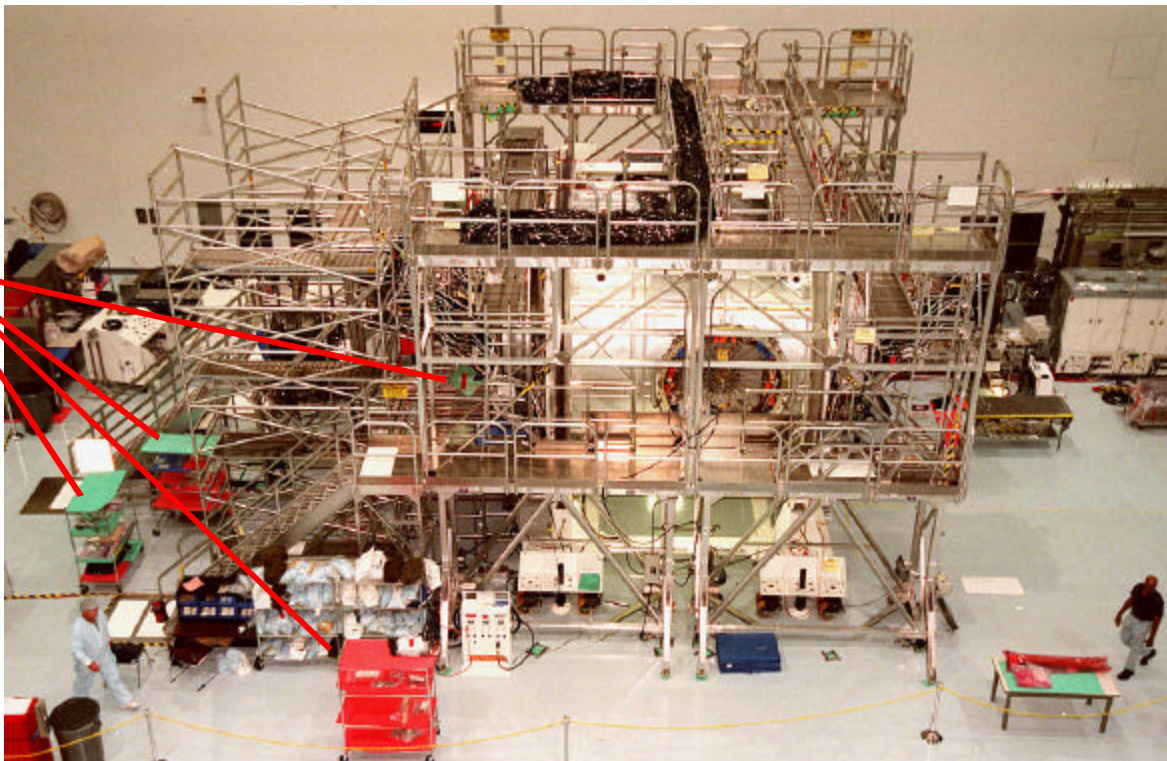


Figure 4. Red and Green Foams* on the ISS Unity Module in SSPF High Bay, August 27, 1998.

* An employee of the NASA Materials Science Lab identified the red and green material in Figure 4 as L380FR-B polyethylene foam.

Appendix E. Management's Response

National Aeronautics and
Space Administration
John F. Kennedy Space Center
Kennedy Space Center, FL 32899



Reply to Attn of: HM

MAR 23 2000

TO: NASA Headquarters
Attn: W/Assistant Inspector General for Auditing
THRU: Q/Office of Safety and Mission Assurance
FROM: AA/Director
SUBJECT: Draft Report on the Audit of Safety Concerns with Kennedy Space
Center's Payload Ground Operations, Assignment Number A9900301

Regarding your letter dated February 4, 2000, and subsequent revisions to that letter dated March 3, 2000, and March 22, 2000, subject as above, Kennedy Space Center (KSC) has assessed the recommendations made in the draft report. We concur in all five recommendations. Our responses have been reviewed and concurred in by the NASA Headquarters Office of Safety and Mission Assurance (Code Q).

Whereas we normally confine our comments concerning OIG Draft reports to the recommendations contained therein; in this case, we believe we need to vary from the norm. We concur with the intent of several of the recommendations and we are aggressively correcting shortcomings in our control processes; however, we do not believe that the report, taken as a whole, presents an accurate and factual answer to the audit's stated purpose. The purpose of the audit, as stated in the introduction of the report, is to provide a description of the safety of KSC payload processing. The report ignores the overall safety of KSC payload processing and focuses on one issue of questionable importance. Given some of the conclusions drawn by the auditors in the Findings section of this report, we are concerned about the wide distribution of the final report. Our concern is that persons, who do not possess in-depth knowledge of the subject matter, may be misled by some of the conclusions drawn by the auditors. Foremost among our concerns is that the general public and press will reach the conclusion that KSC and its Payload Ground-processing Contractor routinely tolerated the existence of hazardous materials in its payload processing facilities and that the level of risk is high. This is not now, nor was it ever, the case.

Many materials that exist in any workplace, including ours at KSC, if utilized under specific operational conditions, have the potential to create a hazardous condition. Plastics, foams and adhesives (PFAs) have the potential to create a hazardous condition if not properly handled or controlled, but to categorize PFAs as inherently hazardous materials is inaccurate and misleading.

See Appendix F,
OIG Comment 1

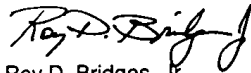
See Appendix F,
OIG Comment 2

Appendix E

We suggest that you closely examine the content of the report and substantially rewrite the narrative sections of the report to more fairly and accurately reflect the actual risk posed by the use of PFAs in payload processing areas.

Specific comments to the five recommendations are enclosed (Enclosure 1). We are also enclosing general and specific comments related to the overall report (Enclosure 2).

We appreciate the opportunity to respond to the draft report, but we suggest you reconsider the facts surrounding this audit and modify your conclusions reached.



Roy D. Bridges, Jr.

Enclosures

cc:
KSC/OIG/R. Andrade
HQ/MX/G. Gabourel
HQ/MX/A. Taylor
HQ/JM/M. Myles
HQ/Q/D. Moore
HQ/QS/J. Lloyd
HQ/W/K. Allen
GSFC/190/K. Carson

RECOMMENDATION 1

The Director, John F. Kennedy Space Center, should implement procedures to ensure the safe use of all materials (materials currently in use and new materials introduced into the SSPF or O&C building) that do not meet NASA and Kennedy requirements for flammability and ESD.

KSC RESPONSE

Concur. KSC has undertaken additional measures to ensure the safe use of materials that do not meet requirements for flammability and Electro-Static Discharge (ESD). While there has always been a policy and procedures for the use of these materials, additional measures have been undertaken. Below is a listing of the actions taken to address any real or perceived hazards arising from the use of Plastics, Foams, and Adhesives (PFA):

- The Director of Space Station and Shuttle Payloads, and Logistics Directorates wrote and distributed a letter to the PGOC contractor in June of 1999. The letter addressed the issue of usage and control of PFAs in payload processing facilities.
- The PGOC contractor and NASA formed a working group (PFA Strategy/Implementation Team) to identify and rectify any areas where compliance might be in question. A number of actions were identified. Most of the actions have been completed. A few long-term actions are yet to be completed. Actions and dates are listed below.
- The contractor established a committee to follow up on these action items and to review their documented processes. This committee shall be in place until all actions are closed.

Actions Completed

- Procedures for wrapping foams with Herculite have been demonstrated to technicians, engineering, safety, and quality. **Action completed Nov. 1999**
- Breadrack foams have been changed out with approved foam. **Action completed Feb. 18, 2000**
- SPP-018 SSPF Work Area Rules has been updated with PFA usage requirements for each processing footprint. **Action completed Feb. 2000**
- Information on PFA usage has been incorporated into all Launch Site Support Plans (LSSP). **Action completed Feb. 18, 2000**
- PFA usage requirements have been incorporated into the KSC payload processing orientation class required of all newcomers to KSC. **Action completed Dec. 1999**

Actions Complete with Follow-ons

- Update access controls - The initial update was to make sure all personnel know where the work area rules are, that explain access controls and where to find the instructions on uses of materials. **Action completed Nov. 1999**
 - An additional set of easier to follow instructions is in work and will be complete March 2000.
- NASA has coordinated with Boeing training to update the Cleanroom Requirements Class to include PFA requirements. **Action completed Dec. 1999**. The contractor

Enclosure 1

Appendix E

has added a follow-up action to review the changes in the training sessions and to make sure they cycle everyone through these training classes. **Action to be completed by March 2000**

- Four (4) roll material dispensers have been changed to only allow approved materials. This has been accomplished; however, we will be adding labeling to this and the items in the instrument library. **Action to be completed by March 2000**
- Daily walkdowns have been added to the Payload Integrated Control Schedule (PICS) to initially "cleanup" processing areas of all non-approved PFAs and then reduce walkdowns to a weekly requirement when proper controls are in place. **Action ongoing since April 1999.** A new action has been added to have a written procedure to follow for these walkdowns. **Action to be completed by March 2000**

Actions still in work

- Prepare Materials and Processing (M&P) Alert/information sheet. E-mail first line managers for dissemination. Link active and current Material Usage Agreements (MUAs) to the M&P homepage. **Action to be completed by March 2000**
- Compose a letter to all processing contractors, users, and customers that MDP-0808 is the governing document controlling PFA usage in all processing areas. **Action to be completed by March 2000**
- Develop a material identification process to easily identify and eliminate unapproved PFA materials from processing areas. The update to the instructions for controlling access will be one way this is accomplished. The contractor has also put into work development of a materials panel that will be displayed in the highbay showing the correct application for the use of materials. **Action to be completed by March 2000**

Based on actions completed and planned, we request that the recommendation be considered resolved, dispositioned and closed upon issuance of the final report.

RECOMMENDATION 2

The Director, John F. Kennedy Space Center, should:

Clarify instructions for preparation of MUAs to ensure that each MUA is prepared in a timely manner, supported by a documented analysis, and reviewed and approved by both contractor and Kennedy safety offices.

KSC RESPONSE

Concur. The Logistics Operations Directorate (LO) Materials Science Laboratory, in conjunction with other KSC organizations, is currently rewriting the procedure for the KSC Materials & Processes (M&P) Control Program, which covers the preparation of MUAs. We anticipate that the rewrite of this procedure will be completed by August 1, 2000. A copy of the rewritten procedure will be provided to you for verification purposes.

Enclosure 1

RECOMMENDATION 3

The Director, John F. Kennedy Space Center, should increase surveillance of Boeing's inspection procedures. The surveillance should ensure that Boeing: (a) regularly inspects all potentially hazardous materials including plastics, foams, and adhesives; (b) ensures that all materials used are approved; (c) determines whether an MUA was authorized, or is planned to be authorized for the use of the materials not approved; and (d) promptly removes all materials that have not been approved or for which an MUA has not been authorized.

KSC RESPONSE

3a) Concur. The NASA Space Station and Payload Assurance organization has already implemented an increased awareness program for Plastics, Foams, and Adhesives (PFAs). This is a bi-product of surveillance, assessments and internal audits conducted by that organization. The NASA Safety Assurance Division will assure that the contractor uses PFAs in a safe, documented, and controlled manner. The NASA Quality Assurance Division will conduct special audits on the contractor. All nonconformances noted will require contractor corrective and preventative action plans. NASA follow-up audits will determine the contractor's compliance to their plans. Data from NASA Safety Assurance Division and NASA Quality Assurance Division surveillance activities, assessments, and audits will be documented within the respective databases and form the basis for appropriate action.

KSC requests that recommendation 3a) be considered resolved, dispositioned and closed upon issuance of the final report.

3b) Concur. The NASA surveillance function will ensure that Contractor Materials and Processes (M&P) and/or Safety identifies and tracks materials used in operational areas. Materials that have not been tested or fail a testing qualification will be evaluated for appropriateness of use, and a usage permit written and signed by both the responsible Contractor and NASA representative. This permit will contain both the rationale for acceptance and the conditions that will apply to the usage of the permitted material.

3c) Concur. The NASA Safety and Quality Assurance Divisions, as stated in 3a) above, have implemented increased surveillance actions to assure that only approved materials are being used by the contractor.

KSC plans no further action on this recommendation and requests that recommendation 3c) be considered resolved, dispositioned and closed upon issuance of the final report.

3d) Concur. The NASA Safety and Quality Assurance Divisions through their surveillance, assessment, and audit programs have placed increased focus on PFAs to ensure that the contractor removes all materials that have not been approved, or for which an MUA has not been authorized.

Based on actions already taken and planned, KSC requests that recommendation 3d) be considered resolved, dispositioned and closed upon issuance of the final report.

Enclosure 1

RECOMMENDATION 4

The Director, John F. Kennedy Space Center, should direct the PGOC Contracting Officer to determine if there is a basis to withhold all contract costs relating to noncompliant plastics, foams, and adhesives.

KSC RESPONSE

Concur. The concern regarding PGOC's use of potentially hazardous plastics, foams and adhesives (PFA's) in the Space Station Processing Facility (SSPF) and Operations and Checkout (O&C) facility was examined as indicated in the response to Recommendation 1. We determined that there were areas requiring corrective action. The PGOC took prompt action to put appropriate processes in place to assure proper control of these PFA's. The PFAs in question are materials that have multiple valid uses on the contract, including in the SSPF and O&C facilities, when used according to required procedures. Therefore, the costs of these materials meet the "reasonableness and "allocability" tests prescribed in FAR 31.201-2 in determining whether they were allowable. The failure to properly use an otherwise reasonable and allocable material does not make the costs for the material unallowable. Rather, it is an indicator of the quality of contractor performance. Such a deficiency in performance would require immediate corrective action and be addressed via the award fee performance evaluation process. The NASA Award Fee Board and the Fee Determination Official determine the significance of the deficient performance and the consideration that it should be given when determining the award fee score.

For the reasons stated above, there is not a basis to consider disallowance of costs. The materials in question serve appropriate uses in the conduct of contract performance, although some of them may require special controls or may not be appropriate for use in certain areas or at certain times. Other materials, questioned in the report, were not items acquired for use, but were packing materials.

It would be appropriate to consider disallowance of the costs of such materials if: the acquisition of prohibited materials were occurring as a result of willful misconduct and lack of good faith on the part of the contractor's managerial personnel; or if it were established that the Contractor willfully failed to initiate a system to assure that prohibited materials would not be issued for use under the PGOC. There is no evidence that these circumstances existed in the past or exist in the present. Should such evidence be discerned, the contractor officer will take appropriate action, in consultation with the Legal Office, to disallow the associated costs.

Enclosure 1

RECOMMENDATION 5

The Director, John F. Kennedy Space Center, should direct the PGOC Contracting Officer to ensure that proper surveillance of contractor activities with regard to the proper use and control of plastics, foams, and adhesives is conducted and appropriate contract award fee action is taken if necessary.

KSC RESPONSE

Concur. KSC has taken aggressive action to assure the proper use of PFAs. This issue was addressed in the June 1999 letter, from the Directors of Logistics and Space Station and Shuttle Payloads, that is referenced in your draft report. The contractor since that time, as a result of that letter, has demonstrated heightened awareness of the situation. The contractor has actively pursued corrective actions to ensure compliance with the requirements for the safe and proper use of PFAs in processing areas as described in the response to Recommendation 1. The contractor has, at this time, demonstrated that it has the proper policies and procedures in place to ensure the safe and proper use and control of PFAs. Monitoring of this area of performance is being conducted to ensure that compliance with the requirements continues (see response to recommendation 3).

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Appendix E

General Comments

1. The report references NASA-STD-6001, "Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion," dated February 9, 1998. "The original ISS Contract references NHB 8060.1, "Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion." This document was later renamed NASA STD 6001, with the same name and identical contents. The document is approved for use by NASA Headquarters and all Field Centers to establish requirements for evaluation, testing, and selection of materials. Several statements in the audit report are in conflict with the requirements of the NASA standard, as detailed under our "Specific Comments."
2. Non-compliant plastics never posed a hazard to personnel in either the Space Station Processing Facility (SSPF) or the Operations and Checkout (O&C) building, since no operations or chemicals are involved which could conceivably react with any non-compliant plastics. Since compliant materials were not always available in the past, the use of materials (e.g., foams), which did not meet ESD requirements, was authorized in certain limited areas. The foam was specifically not allowed in areas where ESD poses a hazard to flight equipment. The flammability aspect is simply not an issue in the SSPF or O&C buildings, since no operations that would serve as a source of ignition are present. Foams were not allowed in the vicinity of ammonia operations. Regardless of the MUAs that may allow non-compliant PFAs into the work place, when a process changes that introduces a source of ignition (i.e., brazing), the standard procedure requires the PFAs to be removed or protected and additional precautions are taken to prevent or control fire (i.e., fire watch). If there are questions about what additional measures are needed to control the hazard, then the NASA safety organization is involved and assists to assure that a safe operation is guaranteed before the work proceeds.

Specific Comments

1. Pages 1-2, "**Results in Brief**"

- a. Line 1. The term "Hazardous Materials" is misused here and throughout the report. Plastics, Foams, and Adhesives (PFAs) are not classified by any regulatory agency as hazardous materials. These materials can contribute to a hazardous situation, if not properly controlled, but the PFAs used in the Space Program are no different than materials found in any average workplace or household.
Recommendation: Substitute the phrase "non-compliant materials" wherever the term "hazardous materials" is used.

Line 8. The term "variance" is a safety term and not one that applies to MUAs. The NASA/Contractor safety offices are not required to review the MUAs. Per NASA-STD-6001, "Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion," materials approval is the NASA Center Materials Representative's (CMR) responsibility, and not the safety organization's. NASA-STD-6001 does not use the term "variances," but rather only states that the responsible NASA center materials organization grants approval. In other words, all PFAs are approved by the Center Materials Representative as not

Enclosure 2

e Appendix F,
G Comment 3

e Appendix F,
G Comment 4

e Appendix F,
G Comment 5

e Appendix F,
G Comment 6

introducing a hazard into the workplace and, therefore, not requiring a "variance" to a safety requirement.

Recommendation: Remove all references to "safety variances" and their associated review and approval processes.

See Appendix F,
OIG Comment 7

- b. Line 11. NASA did identify the concern about non-approved PFAs in the KSC Director of Space Station and Shuttle Payloads letter, dated June 11, 1999, which is referenced in the report on pages 7-8.

2. Pages 2-3, "**Background**"

Second Paragraph. The first sentence is incorrect. The NASA Center Materials Representative, not Safety, is responsible for the testing and evaluation of materials against a set of requirements. A MUA is the result of an evaluation of materials, including PFAs, for appropriate (and safe) use. MUAs approved by the Center Materials Representative have to consider the flammability characteristics of the workplace and cannot introduce any PFA into the workplace that would create an uncontrolled hazard. By definition, an MUA does not equate to a variance. A variance is the acceptance of a nonconformance to a safety standard. While a MUA may allow use of a material which "varies" from the set of requirements, it is not a "variance."

See Appendix F,
OIG Comment 8

3. Page 3, "**Use of Potentially Hazardous Materials in Kennedy Processing Facilities**"

- a. The title should be changed to remove the "hazardous materials" term, and substitute "non-compliant materials" (See General Comments, item 2.)
- b. Line 6. NASA-STD-6001, "Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion." states that materials that do not meet the criteria of the required tests, and remain candidates for use, must be verified to be acceptable in the use configuration, and approved by the NASA center materials organization. The standard does not mention a "risk analysis" as stated in this sentence of the report.
Recommendation: Delete the term "risk analysis."
- c. Line 8. Add the word "potentially" before "hazardous to ground workers."

See Appendix F,
OIG Comment 5

See Appendix F,
OIG Comment 9

4. Page 3, **Footnote 5, ESD**

It is not the material being used that is sensitive to a static electric build up. The charge builds up on the material during use via rubbing with another material or the flow of a liquid or gas across the surface of the material. Once charged, the material will tend to discharge to a grounded object, person, or other material. **Delete this comment.**

See Appendix F,
OIG Comment 10

5. Pages 3-4, "**Potentially Hazardous Materials Usage Requirements**"

- a. The title should remove the "hazardous materials" term. (Reference 3.a (listed above))

See Appendix F,
OIG Comment 5

Enclosure 2

Appendix E

e Appendix F,
G Comment 5

- b. Lines 6-7. The "Kennedy Materials Application Advisory Board" is not the maintainer of the materials list. This responsibility belongs to the KSC Materials Science Division (LO-G).
- c. The first indented paragraph should be deleted – The "need for a variance to a safety requirement" does not apply to material approvals. MUAs are a Materials and Processes (M&P) owned process, not a safety process. See "Specific Comments," item 1.b.
- d. On the top of page 4, second paragraph, change the first sentence to read: "Kennedy uses MUAs as the approval mechanism for materials that do not meet flammability and ESD requirements."

6. Page 4, "**Potentially Hazardous Materials Used**"

The title should remove the "hazardous materials" phrase (Reference 3.a (listed above)).

7. Page 5, "**Boeing Safety Inspections**"

Last sentence of this section should read: The Kennedy Chief Safety Officer stated that any unapproved materials that were used only as packaging material, did not pose a hazard, and were removed from the facility as soon as possible.

8. Page 5, MUAs Obtained for Some Materials

What is a timely manner? Some MUAs require little or no modifications. However, under certain conditions, MUAs may require as many as three to six months to perform a complete analysis and any testing which may be required. **Delete this comment.**

9. Page 5, Timely Completion

Boeing was not building ISS components at KSC in 1992; therefore, no KSC MUAs were prepared until after the ISS program decided to move construction to KSC. **Clarify.**

10. Page 5, paragraph 2

The materials referred to being in abundance in the November walkdown of the high bay were already approved for use by MUAs dated September 1999.

11. Pages 5-6, "**MUAs Obtained for Some Materials**"

- a. Item 3 in the first paragraph is true; however, there is no requirement for the safety offices to approve MUAs.
Recommendation: Delete the statement.
- b. **Analyses.** The last sentence does not apply for MUAs. While a true statement, it is not applicable to this situation.
Recommendation: Delete the sentence.
- c. **Safety Office Review.** The first and last sentences do not apply for MUAs.
Recommendation: Delete the sentences.

e Appendix F,
G Comment 11

e Appendix F,
G Comment 12

e Appendix F,
G Comment 13

e Appendix F,
G Comment 14

Enclosure 2

12. Page 7, "ESD"

In the first paragraph, the last statement by the NASA witness should only be considered an opinion. This sentence is not supported by facts. Foam that failed ESD would not have made the close call worse. The statement implies that a fire could have resulted because of the arc. Failure of an ESD test is irrelevant to this mishap. A typical ESD arc would not generate either an audible sound or a visible arc of the nature connected with the described event. The arc had to be due to disconnection of the energized cable.

Recommendation: Delete this sentence.

See Appendix F,
OIG Comment 16

13. Photo on page 7

The S Zero truss is located in the Truss Processing Area (TPA) of the O&C Building. This area is specifically designated a commercial processing area belonging to the Boeing Prime Contract and anything that occurs in that area has no relationship or bearing on the PGOC contract. However, the photo is dated November 9, 1999, and the MUA approving the use of the materials shown was signed in September 1999.

See Appendix F,
OIG Comment 15

14. Page 8, "Contract Award Fees Received"

The second bullet concerning the close call in the SSPF was a Boeing Prime close call and not PGOC. (See attached "Close Call Report", Enclosure 3.)

Recommendation: Delete the sentence.

The use of the word hazardous here is inappropriate. There was no reduction in award fee, because this was never raised as an award fee issue with the safety community.

See Appendix F,
OIG Comment 16

The second bullet is not applicable as an award fee issue for 2 reasons: 1) This close call happened in a Boeing Prime contract processing situation. It had nothing to do with the PGOC contract and consequently was never written as an award fee issue on the PGOC contract. It may have been written as an issue on the Boeing Prime contract. 2) The policy of KSC is not to punish the contractor for close calls because NASA is encouraging its contractors to freely and openly report close calls.

****Deliberative process information omitted.****

See Appendix F,
OIG Comment 17

15. Page 12, "Management Controls Reviewed"

The last sentence is incorrect. During the audit, there were no requirements for these controls to be implemented.

Recommendation: Add the words "we recommend that" before the word "controls."

16. Page 13, "Appendix B. Materials Testing, Approval, and Control Requirements"
NHB 1700.1, KHB 1710.2, KHB 1700.7 (variance portion), KDP-P-2207, and the PGOC contract reference, are not applicable to PFAs and MUAs as related to the "safety variance" process.

Recommendation: Remove all reference to these documents in the report as related to "safety variance."

Enclosure 2

Appendix F. OIG Comments on Management's Response

Kennedy management provided the following general and specific comments in response to our draft report. Our responses to the comments are also presented.

Management's Comment. The report focuses on one issue of questionable importance.

1. OIG Comments. The scope of the audit focused on specific safety concerns provided to the OIG by the Chairman of the House of Representatives Committee on Science. One of these concerns was the use of potentially hazardous materials in the SSPF and O&C building. Implementation of our recommendations will help ensure the safe usage of PFA's in these facilities and possibly prevent the occurrence of incidents regarding their use.

Management's Comment. Foremost among our concerns is that the general public and press will reach the conclusion that Kennedy and its payload ground processing contractor routinely tolerated the existence of potentially hazardous materials in its payload processing facilities and that the level of risk is high.

2. OIG Comments. Based on our audit work, which was performed in accordance with generally accepted government auditing standards and included first-hand observations and a detailed review of materials testing records, we concluded that Kennedy and its payload ground processing contractor routinely tolerated the existence of potentially hazardous materials in its payload processing facilities. Kennedy management provided no documentation or risk analyses to support the level of risk associated with the materials. Therefore, we could not attest to the level of risk associated with using the materials.

Management's Comment. NASA-STD-6001, "Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion," dated February 9, 1998, is approved for use by NASA Headquarters and all Field Centers to establish requirements for evaluation, testing, and selection of materials. Several statements in the audit report are in conflict with the requirements of the NASA standard, as detailed under our "Specific Comments."

3. OIG Comments. NASA-STD-6001, "Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments That Support Combustion," February 9, 1998 is a technical document that specifies the actual testing procedures for materials. It does not address specific safety procedures to follow when using materials that fail required tests, the primary issue in the audit report. Paragraph 1 of the standard states:

Systems containing materials that have not been tested or do not meet the criteria of the required tests must be verified to be acceptable in the use configuration by analysis or testing. This verification rationale must be documented and submitted to the responsible NASA center materials organization for approval.

Our concern, as described in the report, is the weakness in Kennedy's process for verifying the acceptability of materials that failed the required tests. Furthermore, as stated in the introduction section of NASA-STD-6001, it is not intended to be the sole guidance for controlling materials. NASA-STD-6001 is one of many documents that comprise Kennedy's material control program and its requirements. Management stated in its response to recommendation 1 that it is notifying all payload processing contractors, users, and customers that McDonnell Douglas Procedure, MDP-0808, "Control Plans for Non-flight Materials and Equipment Approved for Use in and Around Shuttle Payloads During STS Payload Operations," is the governing document controlling the use of PFA's. Both the current version of MDP-0808, dated March 6, 2000, and the PGOC reference NASA, Kennedy, and Boeing safety requirements, which should apply to the conditions identified during the audit and detailed in the report.

Management's Comment. Noncompliant plastics never posed a hazard to personnel in either the SSPF or the O&C building since no operations or chemicals are involved that could conceivably react with any noncompliant plastics.

4. OIG Comments. Management's position that noncompliant plastics never posed a hazard to personnel has never been documented, supported by an adequate analysis, or reviewed and approved by safety personnel as required by the PGOC contract, NASA, or Kennedy safety requirements. Thus, we cannot attest to the level of risk associated with using this material other than to conclude that the material is potentially hazardous.

Management's Comment. The term "hazardous materials" is misused throughout the report. PFA's are not classified by any regulatory agency as hazardous materials. These materials can contribute to a hazardous situation, if not properly controlled, but the PFA's used in the Space Program are no different than materials found in any average workplace or household.

5. OIG Comments. We use the term "potentially hazardous materials" throughout the report. In contrast to this comment, management also states on the first page of its response that "PFA's have the potential to create a hazardous condition if not properly handled or controlled." As we found during the audit and as documented throughout the

Appendix F

report, Kennedy did not properly control these materials as evidenced by the lack of documented risk analyses and safety office review and approval. The abundant improper uses of the materials, as was observed during our walk-through and as evidenced in the report photographs, indicate the lack of control over these materials and the potential hazards that exist.

If management's position is that these materials do not pose a potential hazard, we question why Kennedy would subject the materials to expensive and elaborate testing requirements. Finally, household materials are generally not subject to the same detailed U.S. Government testing requirements as were the PFA's used in Kennedy's facilities.

Management's Comment. The term "variance" is a safety term and not one that applies to the materials control process. The NASA/contractor safety offices are not required to review the MUA's. NASA-STD-6001 does not require safety organizations to approve materials.

6. OIG Comments. Management stated that the materials in question could contribute to a hazardous situation if not properly handled or controlled. Further, some of Kennedy management's own actions indicate that the proper use and control of materials was indeed a matter of safety. For example, management:

- Formed a working group, with both Kennedy and Boeing safety office representatives, to address the control of PFA's.
- Placed a large placard in the lobby of the SSPF warning employees to use caution with PFA's.
- Issued a memorandum that stated, with the introduction of ammonia, isopropyl alcohol, gaseous oxygen, and other hazardous materials into the SSPF and O&C building, it was important to control the use of PFA's to ensure safety, contamination control, and mission success.

Further proof that safety applies to the materials control process is on the Materials Science Division's Intranet. The Intranet, referenced by the placard in the lobby of the SSPF, states that "the use of processing materials in hazardous and contamination controlled areas must be approved by the KSC Safety Office." Furthermore, the current version of MDP-0808, dated March 6, 2000, states, "Approval of an MUA is the responsibility of Boeing Materials and Process Engineering **and** [emphasis added] Boeing Safety Health and Environmental Affairs."

For these reasons, we believe that the proper control of PFA's is a safety matter requiring the preparation of a safety variance for any material that does not meet required testing criteria. According to KHB 1710.2, Kennedy Space Center Safety Practices Handbook, "Adhesive tapes and plastic films used in Kennedy flight hardware processing facilities shall only be used for operations where they meet the acceptance criteria for their specified use." As stated in Appendix B of this report, a deviation from a requirement of the handbook requires a safety variance from the Director of the Kennedy safety organization. An MUA would fit the criteria for a safety variance if it is supported by an adequate documented analysis and a safety office review and approval and if it is prepared before the material in question is used. As stated in the report, the MUA's that Kennedy used were not prepared in a timely manner, were not supported by an adequate analysis, and were not reviewed by the Kennedy safety office.

Management Comment. NASA did identify the concern about nonapproved PFA's in the Kennedy Director of Space Station and Shuttle Payloads letter, dated June 11, 1999, which is referenced in the report on pages 7-8.

7. OIG Comments. The June 11, 1999, letter from the Kennedy Director of Space Station and Shuttle Payloads identified only a concern about using nonapproved PFA's. The letter did not identify and appropriately mitigate the risks of using those materials. Kennedy had been using nonapproved plastics and foams for at least 7 years prior to the letter being signed. Further, we observed no additional safety procedures implemented as a result of the letter.

Management Comment. The Background paragraph contains a sentence that is incorrect. The NASA Center Materials Representative, not Safety, is responsible for the testing and evaluation of materials against a set of requirements.

8. OIG Comments. As stated in the second sentence of the same paragraph, we recognize that the NASA Materials Sciences Lab is responsible for testing all materials against flammability and ESD requirements. The word "safety" has been removed from the first sentence.

Management Comment. Add the word "potentially" before "hazardous to ground workers."

9. OIG Comments. The sentence has been revised to include the word "potentially."

Management Comment. In Footnote 5, it is not the material being used that is sensitive to a static electric build up.

10. OIG Comments. The footnote has been revised.

Management Comment. What is a timely manner? Some MUA's require little or no modifications. However, under certain conditions, MUA's may require as many as 3 to 6 months to perform a complete analysis and any testing that may be required.

11. OIG Comments. In our opinion, a timely manner would be to finalize the MUA before the material that has failed testing is used. An elapsed time of 7 years after the material is first tested is not timely.

Management's Comment. Boeing was not building ISS components at Kennedy in 1992; therefore, no MUA's were prepared until after the ISS program decided to move construction to Kennedy.

12. OIG Comments. PGOE personnel (McDonnell Douglas or Boeing) have been performing payload processing activities at various Kennedy facilities since the PGOE was awarded in 1987. Such activities have not been limited to the ISS program and have included other Space Shuttle and expendable launch vehicle payloads.

Management Comment. The materials referred to as being in abundance in the November walkdown of the high bay were already approved for use by MUA's dated September 1999.

13. OIG Comments. Although the CMR and Boeing materials and process representative may have signed the MUA's in September 1999, we observed that the foam was not properly controlled or used in accordance with the MUA's. The photographs in the report support our observations. For example, the MUA's required that the foam be used only on the floor of the SSPF or be covered with a film that passed required tests. We did not observe any foam covered with this film. We observed foam abundantly used on vertical surfaces, an unapproved use, as well as the floor of the SSPF, as permitted by the MUA. We also observed the use of green foam in the SSPF that did not have an approved MUA. As described in the report and acknowledged in management's response, PFA's have the potential to create a hazardous condition if not properly controlled.

Management Comment. There is no requirement for the safety offices to approve MUA's.

14. OIG Comments. As noted in OIG Comment 6, the current version of MDP-0808, dated March 6, 2000, specifically states that approval of MUA's is the responsibility of the Boeing materials and process engineering and safety offices. According to management's response to Recommendation 1, all processing personnel will be informed that MDP-0808 is the governing document controlling the usage of PFA's in Kennedy processing areas. As such, there clearly is a requirement for safety office approval.

Management Comment. The S Zero Truss, in the photograph on page 7 of the report, is in an area specifically designated as a commercial processing area that belongs to the Boeing prime contract, and anything that occurs in that area has no relationship or bearing on the PGO. The photograph is dated November 9, 1999 and the MUA approving the material was signed in September 1999.

15. OIG Comments. The purpose of the photograph was to show that foam padding was being used in a vertical position, which was contrary to the September 1999 MUA, which requires that the foam padding be used only on the floor of the building. Conversion of the PGO to a performance-based contract clearly established Boeing's overall safety responsibilities for various Kennedy processing facilities, including the O&C building.

Management Comment. The January 1998 close call in the SSPF was a Boeing Prime close call and not a PGO close call and, therefore, was not written as an award fee issue on the PGO.

16. OIG Comments. Regardless of who incurred the close call, a hazard was made potentially worse by the existence of the noncompliant foam. Despite this incident and Boeing's overall responsibility for safety, the situation was not even considered as part of the award fee evaluation process. As stated in the report, Boeing has industrial safety responsibilities for the SSPF, which includes mishap reporting. This close call was not recorded in Kennedy's Incident Reporting Information System for proper tracking and disposition, indicating a potentially serious flaw in Kennedy's safety program.

Deliberative process information omitted.

Appendix G. Report Distribution

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Assistant to the President for Science and Technology Policy

Deputy Associate Director, Energy and Science Division, Office of Management
and Budget

Branch Chief, Science and Space Programs Branch, Energy and Science Division,

Office of Management and Budget

Appendix G

Non-NASA Federal Organizations and Individuals (Cont.)

Associate Director, National Security and International Affairs Division, Defense
Acquisitions Issues, General Accounting Office
Professional Assistant, Senate Subcommittee on Science, Technology, and Space

Chairman and Ranking Minority Member – Congressional Committees and Subcommittees

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Senate Subcommittee on VA, HUD, and Independent Agencies
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Honorable Pete Sessions, U.S. House of Representatives
Honorable F. James Sensenbrenner, Jr., U.S. House of Representatives

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Report Title: Final Report on the Audit of Safety Concerns with Kennedy Space Center's Payload Ground Operations

Report Number: _____ **Report Date:** _____

Circle the appropriate rating for the following statements.

	Strongly Agree	Agree	Neutra l	Disagre e	Strongl y Disagre e	N/A
1. The report was clear, readable, and logically organized.	5	4	3	2	1	N/A
2. The report was concise and to the point.	5	4	3	2	1	N/A
3. We effectively communicated the audit objectives, scope, and methodology.	5	4	3	2	1	N/A
4. The report contained sufficient information to support the finding(s) in a balanced and objective manner.	5	4	3	2	1	N/A

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