



**PREFERRED
RELIABILITY
PRACTICES**

FOREIGN OBJECT DEBRIS (FOD) PROGRAM AT KSC

Practice:

Enhance the Reliability of Flight Hardware Processing Systems by including in the Program a reliable Foreign Object and Debris (FOD) policy and related procedures for use during launch and landing operations, vehicle and payload processing, and maintenance activities at designated areas of Kennedy Space Center (KSC) and off-site landing facilities under KSC responsibility.

Benefits:

Use of a FOD prevention program will minimize the possibility of damage or loss of flight hardware or injury to personnel due to lost items within the flight hardware elements, resulting in preservation of national resources.

Programs Which Certify Use :

National Space Transportation System Space Shuttle Program. All processing areas of Kennedy Space Center, including the three Orbiter Processing Facilities (OPF's), Vehicle Assembly Building (VAB), Launch Pads A & B, as well as other processing facilities. Military and civilian Aircraft operations.

Center to Contact for More Information :

Kennedy Space Center (KSC)

Implementation Method :

FOD, as it is viewed at KSC, is defined as follows:

Damage to, or malfunction of, a launch vehicle or payload caused by any foreign object(s) that are alien to flight systems. FOD may cause material damage or it may make the system or equipment inoperable, unsafe or less efficient.

But what is FOD? FOD is somewhat ambiguous, because it varies depending on the situation. A paper clip on a desk is not FOD, because it is not foreign to that environment, but a paper clip in a commercial passenger jet engine or space shuttle main engine could prove catastrophic to either the flight vehicle, crew or both. FOD can consist of staples, paper clips, paper, particles generated from operations such as sanding, drilling and welding, liquids and chemicals,

**KENNEDY
SPACE
CENTER**

FOREIGN OBJECT DEBRIS (FOD) PROGRAM AT KSC

food, clothing, hair, insects, lost screws, nuts and washers, tools such as wrenches and screwdrivers, jewelry such as earrings, bracelets, watches and rings, eye glasses, plastic and rubber, tape, string, tie wraps, safety wire. Anything can be FOD if it is foreign to that environment. Its effect on the environment depends on many things, including a measure of luck. There are numerous facilities at KSC used for servicing and processing the Shuttle and its Payloads, External Tank (ET) and Solid Rocket Boosters (SRB's), and their various components. Each facility has its own unique tasks to perform, and associated hazards, both to the flight hardware and personnel.

A FOD prevention program was implemented to improve the reliability of Space Shuttle processing. The primary goals of the FOD program is to:

- Provide a standardized approach, maintaining awareness, prevention, compliance and continued reinforcement.
- Ensure operational processing areas maintain a safe, clean, FOD-Free environment.

The key to success is in a simple formula. AWARENESS + PREVENTION = COMPLIANCE. Figure 1 describes the attributes for each of these members. A FOD training program was established and a certificate of training is issued to each employee upon completion of the training. The employee signs the certificate as a pledge and personal commitment to help prevent Foreign Object Debris and Damage and to acknowledge their personal responsibility to the space program and flight safety.

To attain a successful FOD program, total employee involvement is required. Everyone needs to be responsible. The SPC at KSC utilizes a 10 point plan to implement its FOD program. These 10 points are shown in Figure 2. The success of the FOD program has resulted in a decrease in incidents at the rate of approximately 50% per year.

FOD Prevention Guidelines

The following are general guidelines in establishing a FOD Prevention program, and can be tailored as needed to the specific requirements of particular work sites.

- Monitor in service tool Control Kits inventoried 100% each shift.
- Tooling, parts and equipment stored in a neat and orderly manner.
- Work area cabinets are maintained in a neat and orderly manner. No chemicals stored in cabinets.
- All chemicals and empty chemical bottles returned to the proper storage area.
- All "Hazardous Waste" trash cans and FOD bags are emptied each shift.

FOREIGN OBJECT DEBRIS (FOD) PROGRAM AT KSC

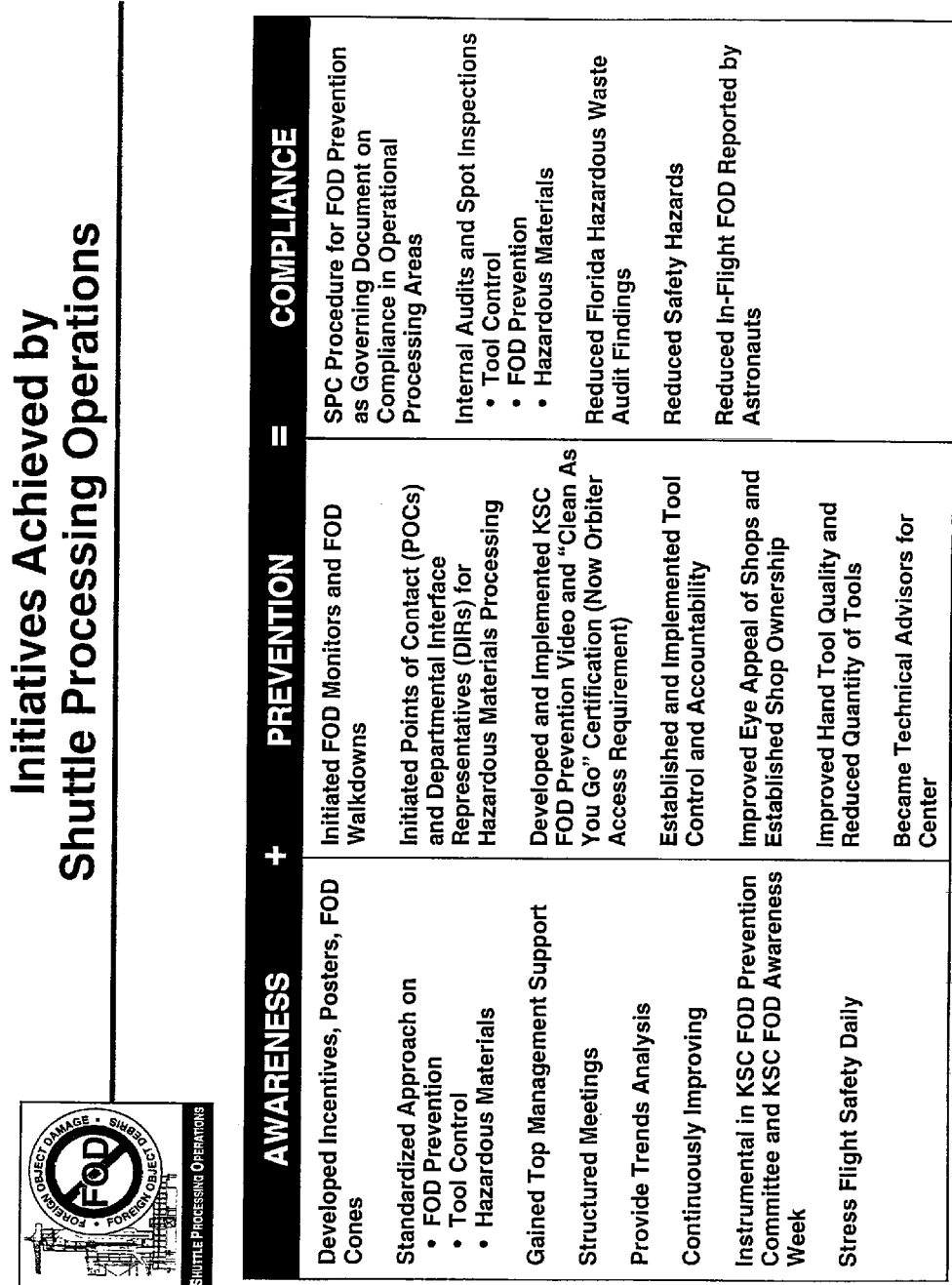


Figure 1: Attributes for Awareness, Prevention and Compliance

FOREIGN OBJECT DEBRIS (FOD) PROGRAM AT KSC

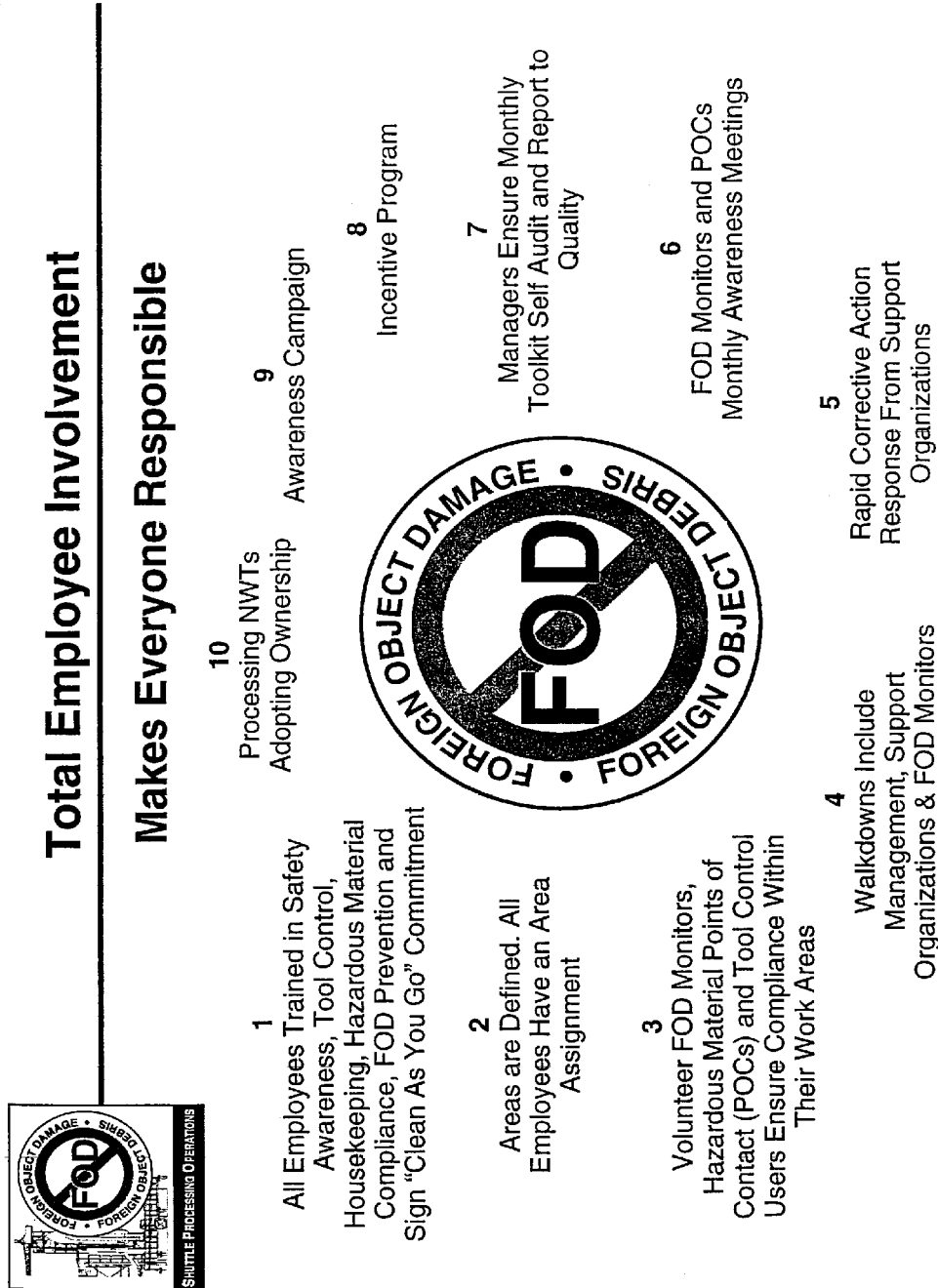


Figure 2. The Ten Points of the KSC Program

FOREIGN OBJECT DEBRIS (FOD) PROGRAM AT KSC

- Work areas and work levels are clean and free of any debris. No wood, cardboard, bubble wrap, etc.
- Work area storage racks are maintained in a neat and orderly manner.
- No chairs on work stands or levels. Exception's are tethered chairs in approved areas.
- All equipment, tooling, trash cans, parts, etc., located above the floor level are tethered.
- All cables and flex hoses are routed and secured in an approved manner to prevent damage.
- All gloves, booties, razor blades, safety wire and miscellaneous items are disposed of in the proper manner.
- All paperwork turned in at the end of the shift.
- All emergency egress lanes are clear of any obstacles.
- Facility deficiencies are reported and recorded in the record log.
- All safety hazards reported to the supervisor immediately.
- All backup team members have taken care of assigned areas.
- Personal items such as watches, rings and eye glasses are either removed prior to entry to clean areas or are secured by taping or tethering.

Definitions

"Clean As You Go - The practice of cleaning assigned tools, parts equipment, worksite, etc. (as practical), during and at the end of an assigned task, and / or shift, to promote flight safety and ensure that the areas remain safe, clean and FOD-Free.

Designate Flight Hardware Operational Processing Area - Sites with flight hardware and processing activities in place in support of Shuttle Processing Operations.

Site FOD Monitor - An individual in the flight hardware operational processing area designated to promote FOD awareness, check specific areas of responsibility for potential FOD and/or hazards, correct discrepancies and report open items to his / her supervisor for closure.

Site FOD Prevention Office - A control center for management support, trend analysis, concerns committees, incident reporting, suggestions, and any other relevant items that meet the objectives of FOD prevention.

Site FOD Team - A team consisting of the Site Manager and applicable representatives from other organizations, to perform FOD prevention walkdowns in the flight hardware operational processing areas.

FOREIGN OBJECT DEBRIS (FOD) PROGRAM AT KSC

Site Manager - An individual who has primary responsibility for processing and/or maintenance tasks in an operational flight hardware processing area.

Tool Control - The method used to ensure that tools are individually marked from other like items, identified to the user and storage location, and inventoried at the beginning and end of each task or shift.

Work Area Rules - The requirements for ingress to and egress from the orbiter, external tank (ET), solid rocket booster (SRB), Space Shuttle Main Engine (SSME), and respective operational processing areas.

General Requirements

1. The procedures apply to all organizations that support flight hardware processing.
2. The designated flight hardware operational processing areas will be maintained FOD free, clean, and safe at all times. There will be no abandoned debris, tools, parts, equipment, materials, chemicals, shavings, trash, flammables, contaminants, etc.; no ingress or egress obstacles; no unmarked or unidentified tools, parts, equipment, chemicals, etc.; no unsecured or untethered items above ground level; no unkempt areas; no hazards; nothing left in the area that does not have a specific purpose for work in process or functional requirement or is not stored properly.
3. Only authorized personnel with valid requirements to perform work or surveillance will be allowed in the controlled work areas.
4. Personnel entering into the designated flight hardware operational processing area will practice the "clean as you go" method, cleaning up assigned tools, parts, equipment, worksite, etc. as practical, during and at the end of the assigned task and/or shift.
5. Organizations having possession of hardware inventories and/or tools and equipment will be responsible for those items and have a closed-loop tracking system, with tools and equipment traceable to location and user.
6. The user is responsible for the physical location of all items carried into the flight hardware operational processing area and will be held accountable.
7. Perform random inventory of toolbags upon ingress and egress of the flight element for compliance with the requirements. Report discrepancies.

FOREIGN OBJECT DEBRIS (FOD) PROGRAM AT KSC

8. Each employee is expected to practice safety and good housekeeping habits and prevent FOD at all times in the designated flight hardware areas.
9. Each operational processing area will have a FOD control board to hold clipboards for daily checklists and related FOD prevention data. FOD boards will be kept neat and clean.
10. All personnel will view the KSC FOD Prevention Video and sign a personal commitment to "Clean As You Go". A copy will be on record in individual administrative files.
11. Site Managers will be appointed by the Site Director.
12. FOD prevention walkdowns will be scheduled on a regular basis in all operational processing areas by the Site Manager and the Site FOD Prevention Office. The Site Manager or delegate will attend all FOD prevention walkdowns. The work area will be checked for potential hazards and anything out of place that could potentially cause damage to flight hardware or injury to personnel. In addition to the scheduled walkdowns, daily walkdowns will be conducted by Site FOD Monitors.
13. Site FOD Monitors will be selected for each shift at regular shift meetings, on a volunteer basis. Alternates will be appointed to cover absenteeism. Monitor duty will last for 1 month and will be in addition to normal work responsibilities. Before an employee can be selected for a second time, each work group member will have the opportunity to serve as Site FOD Monitor.
14. Ensure that FOD prevention is stressed with subcontractors prior to award of contracts, have subcontractors sign a letter agreeing to follow the "clean as you go" method, and post a copy of this letter on the jobsite.

Incentives

As an incentive for good performance, rewards are given out. At SPC, the reward is a "FOD Buster Chit". These chits are good for a \$1 credit at the KSC cafeterias or mobile snack trucks. This provides positive reinforcement for the FOD program, and recognizes and encourages continued good performance.

FOREIGN OBJECT DEBRIS (FOD) PROGRAM AT KSC

Organizations

The Shuttle Processing Contractor is a member of National Aerospace FOD Prevention, Inc. The National Aerospace FOD Prevention, Inc. is a non-profit educational association. The organization's primary goal continues to be to promote awareness of the dangers of FOD and provide the aerospace industry with information on preventing foreign object damage to aircraft and aerospace vehicles with proven practices. Members are from military aerospace companies, as well as commercial aerospace companies, the various branches of the military itself, defense contractors and commercial business. A National Aerospace FOD Prevention Conference is held annually. The conferences have speakers on various topics, interactive learning sessions, and exhibitors. Member companies share their FOD program experiences, successes, and training programs with other with other members for the mutual benefit of all concerned.

The annual conference promotes FOD prevention by keeping personnel who build or use aerospace products informed about the best practices in eliminating foreign objects. Topics discussed at the conferences and in the newsletter include Preventive Practices, Measuring Performance, Training, Material Handling and Parts Protection, House Keeping, Tool Accountability, Hardware Control, Lost Items, Hazardous Materials, Design Considerations, Assembly Operations, Reporting & Investigation.

The National Aerospace FOD Board of Directors and the National Aerospace FOD Prevention Conference have been vital sources for disseminating current and effective FOD prevention ideas and techniques.

Conclusions

All flight hardware operational processing personnel are responsible for supporting the Site FOD Monitors and their supervisors to ensure the effectiveness of FOD prevention. Compliance will be monitored by random walkdowns conducted in addition to the scheduled walkdowns.

The KSC / SPC FOD program has been successful.

- By involving all hands-on employees, the Shuttle processing operations FOD Prevention Program has been able to Lead by Example.
- Operational areas reflect pride in ownership, accountability and a safe, clean work environment.

FOREIGN OBJECT DEBRIS (FOD) PROGRAM AT KSC

- Awareness has significantly improved and Hazards have been reduced.
- Astronauts are reporting **exceptionally clean** Orbiters.

Technical Rationale:

A FOD program reduces costs in lost tools, damaged equipment, schedule impacts due to rework, and reducing unnecessary risks in a business that is inherently risky.

Impact of Nonpractice:

Since implementing a comprehensive FOD program, FOD incidents have decreased significantly from levels prior to the program. The lack of such a program can result in unacceptable performance of equipment, scrapping of otherwise usable hardware, expenditure of unnecessary resources, and possible schedule delays, or major penalties which could include loss of mission capability, injury to personnel or loss of life, and damage to, or loss of, the shuttle vehicle.

References:

1. National Aerospace FOD Prevention Newsletter - FAST, P.O. Box 5489, Pine Mtn., CA 93222
2. Kennedy Space Center Handbook for the Foreign Object Control Program - KHB 5330.10