



**Langley Research Center**

**LPR 5310.1**

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## **Foreign Object Damage (FOD) Prevention Program**

**National Aeronautics and Space Administration**

**RESPONSIBLE OFFICE: Safety and Mission Assurance Office**

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## **PREFACE**

### **P.1 PURPOSE**

a. This Langley Procedural Requirements (LPR) sets forth roles and responsibilities and procedural requirements for the Langley Research Center (LaRC) Foreign Object Damage (FOD) Prevention Program.

b. The purpose of the FOD Prevention Program is to prevent injury to personnel and/or prevent damage to critical hardware, experiments, systems, aircraft and facilities through proper classification of FOD areas, training of personnel and implementing appropriate FOD prevention and detection techniques.

### **P.2 APPLICABILITY**

a. The LaRC FOD Prevention Program applies to all personnel performing fabrication, assembly, maintenance, operations and inspection on LaRC aircraft, models, tunnels, facilities and flight hardware for Center Projects where FOD can potentially cause damage or loss of mission success.

b. The program shall be used for operations both at LaRC and away from Center.

### **P.3 AUTHORITY**

a. NPD 8730.5, "NASA Quality Assurance Program Policy"

b. LAPD 1700.1, "Safety Program"

c. LAPD 5300.1, "Program/Product Assurance"

### **P.4 APPLICABLE DOCUMENTS AND FORMS**

a. NPD 8700.1, "NASA Policy for Safety and Mission Success"

b. NPD 8730.5, "NASA Quality Assurance Program Policy"

c. NPR 8715.3, "NASA General Safety Program Requirements"

d. LPR 1440.7, "Langley Research Center (LaRC) Records Management Procedural Requirements"

e. LPR 1710.12, "Potentially Hazardous Materials - Hazard Communication Standard"

f. LMS-TD-0940, "LaRC General Aircraft Maintenance Manual for RSD"

- g. LMS-TD-8735, "Housekeeping Instruction for the Fabrication of Foreign Object Debris (FOD) Free Products in the Fabrication Facilities"
- h. LF 360, "Foreign Object (FO) and Foreign Object Damage (FOD) Incident Report"
- i. LF 361, "FOD Prevention Survey Checklist"
- j. National Aerospace FOD Prevention, Inc. "FOD Prevention Guideline"
- k. Quality Management System SAE Aerospace Standard AS9100

## **P.5 MEASUREMENT/VERIFICATION**

Compliance with this LPR is verified through responses to the following questions:

- a. Do Organizational Units have the applicable processes in place that include provisions for the prevention, detection, and removal of foreign object debris?
- b. Are inspections conducted against procedural requirements?
- c. Do Organizational Units maintain and verify records of FOD prevention training, incidents, and corrective actions?

## **P.6 CANCELLATION**

LPR 5310.1 dated October 29, 2010

*Original signed on file*

Stephen G. Jurczyk  
Deputy Director

### DISTRIBUTION:

Approved for public release via the Langley Management System; distribution is unlimited.

## 1.0 INTRODUCTION

1.1 A Foreign Object (FO) is defined as a substance, debris or article alien to hardware or system which could potentially cause damage. The object may be foreign to an area or system and may be ingested by, or lodged in a mechanism. Foreign Object Damage (FOD) is defined as any damage attributed to a FO that can be expressed in physical or economic terms, which may or may not degrade the product's required safety and/or performance characteristics. Some examples of how a FO causes damage include ingestion of loose hardware by an aircraft engine or passing debris through wind tunnel blades, short circuiting of flight electronics, contamination of sensors and optics, mechanisms that fail to operate properly and chemical attack on the physical properties of materials.

1.2 Most FOD can be attributed to poor housekeeping, facilities deterioration, improper maintenance or careless assembly, not keeping full account of hardware, tools and materials, and inadequate operational practices. An effective FOD prevention program identifies potential problems, corrects negative factors, provides awareness, effective employee training, and uses industry "lessons learned" for continued improvement. LaRC management is committed to strive for excellence in the conduct of operations to ensure the quality and safety of products and services. Quality Systems such as AS9100 require FO and FOD to be addressed and many LaRC Projects are required to meet AS9100 requirements. Organizational planning and function shall include provisions for the prevention, detection, and removal of FOs in FOD sensitive areas.

1.3 The requirements contained in this document describe the provisions that shall be followed to ensure the development, implementation, verification and continuous improvement of a sound FOD Prevention Program at LaRC.

## **2.0 ROLES AND RESPONSIBILITIES**

### **2.1 FOD PROGRAM MANAGER**

**2.1.1** The FOD Program Manager shall:

a. Oversee LaRC's FOD Program by interfacing with Managers, Project Managers, Quality Assurance, FOD Representatives Safety and Mission Assurance Office (SMAO) Facility System Safety Engineer, Facility Safety Heads and Employees working in FOD sensitive areas.

b. Update Center LPR FOD prevention processes and procedures as needed.

c. Provide FOD Representatives training on the FOD Prevention Program's content and changes, as needed.

d. Provide general training materials, both for Center Awareness information and FOD Prevention Program content training.

e. Conduct FOD Area assessments with FOD Representatives, by evaluating site-specific FOD Inspection Checklists, FOD/Tool Control Logs and FO and FOD Incident Reports.

(1) Assessment will also consist of sampling actual FOD sensitive areas, using LF 361, "FOD Prevention Survey Checklist " and/or other assessment tools/checklist(s).

f. Record results of assessments into a yearly report and maintain in the Mission Assurance Branch (MAB) document library.

g. Arbitrates FO and FOD issues that aren't resolved at the supervisor/FOD Representative level.

h. Performs continuous improvement activities for the FOD Prevention Program by staying abreast of changes/improvements in FOD Prevention Programs and techniques.

### **2.2 MANAGEMENT OF AREAS WHERE FOD IS A CONCERN**

**2.2.1** Organizational Unit Managers (OUM) shall assign a FOD Representative(s) for their organization.

**2.2.2** Branch Heads shall perform the risk assessments on all work areas to determine the proper level of FOD classification for each affected work area (see chapter 3.1.1).

**2.2.3** OUMs shall concur on risk assessments and the proper level of FOD sensitivity for each affected area (see chapter 3.1.1).

2.2.4 Supervisors shall ensure that proper signage, consistent with the FOD sensitive area, is posted in those areas.

2.2.5 Supervisors shall determine site specific FO and FOD control techniques as well as the frequency of any needed inspections (as determined by management) and include these in the appropriate facility or project documentation.

2.2.6 Supervisors shall ensure that all personnel with access to FOD sensitive areas have the appropriate training and authorization to perform work in each respective area (see chapter 3.2.1).

2.2.6.1 Supervisors shall keep records of all FOD training.

2.2.7 Supervisors shall include any specific FO and FOD control techniques, procedures, documentation and inspections for their respective areas as part of the required training for personnel working in those areas

2.2.8 Supervisors shall ensure employees performing work in FOD sensitive areas follow the assigned FO elimination policies and procedures for each designated area, including their normally assigned work stations.

2.2.9 Supervisors shall include reviewing FOD prevention compliance as an integral part of the monthly supervisory safety inspections.

2.2.10 Supervisors shall implement additional site-specific or project-specific requirements upon request by the customer (i.e., a customer can be someone who brings an item to a wind tunnel to be tested. A Project Manager is also considered a customer, if they go to the Fabrication Service Activity to have something built for a project.)

2.2.11 Branch Heads and Supervisors shall ensure implementation of corrective actions relating to FO prevention, detection, and removal throughout the organization.

2.2.12 Supervisors shall inform the FOD Representative, FOD Program Manager, Safety and Mission Assurance Office (SMAO) Facility System Safety Engineer, and Facility Safety Head or Project Manager (as applicable) of any FO and/or FOD incident as soon as practical.

2.2.13 The Project Manager or Facility Safety Head shall work with the supervisor in developing a corrective action plan.

2.2.14 After completing the corrective action portion of the LF 360, "Foreign Object (FO) and Foreign Object Damage (FOD) Incident Report", supervisors shall notify the FOD Representative, FOD Program Manager, SMAO Facility System Safety Engineer, and Facility Safety Head or Project Manager (as applicable).

2.2.15 Supervisors and the Project Manager or Facility Safety Head shall sign off Corrective Action Completed on the LF 360 after closure activities are performed. Corrective Action Plans are to be completed in a timely manner commensurate with the effort required.

2.2.16 Supervisors shall maintain records of site specific FOD inspection checklists (see 2.2.5 and 2.2.7), LF 360, and LF 361 in a manner that the records are readily accessible to support audits and assessments.

2.2.17 Supervisors shall provide records requested by the FOD program manager during yearly FOD manager program assessments or other Center audits/assessments.

### **2.3 PROJECT MANAGEMENT:**

2.3.1 The project management shall:

- a. Identify the proper FOD classification and requirements for the project in the appropriate documentation.
- b. When additional or enhanced procedures need to be implemented, ensure project-specific FOD requirements are provided to the appropriate implementing organization.
- c. Ensure all FO and FOD reported incidents are reviewed and that corrective actions are taken to prevent recurrence.
- d. Ensure all FO and FOD incident documents become part of the project work package and records.
- e. Include the design considerations for FOD control in section 4.0 as a part of their system engineering approach.

### **2.4 QUALITY ASSURANCE BRANCH (QAB)**

2.4.1 Quality Assurance Branch personnel support flight projects and their role with respect to FO and FOD is limited to such, and the facilities where the Project hardware is being processed (i.e., not involved in wind tunnels, aircraft or research facilities).

2.4.1.2 QAB personnel shall include FO and FOD inspections during receipt inspection and quality assurance testing of safety critical products (LAPD 4520.1, "Langley Research Center (LaRC) Requirement for Safety-Critical Product Testing").

2.4.1.3 QAB personnel shall ensure the appropriate FO and FOD requirements, controls and inspections are included in project work packages and procedures.

2.4.1.4 QAB personnel shall inspect for FO and FOD and ensure FOD controls are being followed as part of general project quality assurance duties. QA personnel shall perform and sign off FOD inspections as required by any project documentation.

2.4.1.5 QAB and project personnel shall ensure all project FO and FOD incidents are documented in the appropriate project problem reporting and corrective action system and become part of the project work package or records.

## **2.5 FOD REPRESENTATIVES:**

2.5.1 FOD Representatives shall:

- a. Provide the FOD Program Manager a listing of all FOD sensitive areas and their locations (building and room number) and any subsequent changes.
- b. Maintain the FOD sensitive list for their responsible areas.
- c. Perform and document periodic assessments of the execution of the FOD Prevention Program in their respective organizations, using the LF 361.

(1) The supervisor shall keep records of LF 361s. A copy may be requested by the FOD Program Manager.

- d. Ensure that the FOD Program Manager has been notified, if any FO and FOD has been found, or of any other FO and FOD related issues, incidents or concerns.
- e. Ensure that the LF 360 corrective action plans are completed and report the status of the corrective action plans up the management chain as necessary.
- f. Provide support when requested by the FOD Program Manager during yearly FOD Manager Program assessments or other Center audits/assessments.
- g. Work with FOD Program Manager on reviewing and assessing the effectiveness of the organization's FOD prevention program.

## **2.6 FACILITY SAFETY HEAD (FSH):**

2.6.1 Facility Safety Head (FSH) shall assist the Branch Head, when determining the risk associated with a FO for the activities being performed in an area, and the FOD sensitivity designation (see chapter 3.1.1 for FOD Area Designation information).

2.6.2 If a FO and/or FOD is found, and a Project Manager is not assigned, work with the supervisor in developing a correction plan to be filled out on the LF 360.

2.6.3 Supervisors and the Project Manager or Facility Safety Head shall sign off Corrective Action Completed on the LF 360 after closure activities are performed (See clause 2.2.15).

2.6.4 The supervisor shall keep records of LF 360s.

## **2.7 EMPLOYEES**

2.7.1 All personnel who work in FOD sensitive areas shall:

a. Be responsible for conducting work in a manner that provides for the prevention, detection and removal of FOs.

b. Complete required FOD Prevention Program training designated by each organization.

c. Perform scheduled walk-downs as determined by management using site specific FOD Inspection Checklists (see 2.2.5 and 2.2.7).

(1) The supervisor shall keep records of FOD inspection checklists.

d. Immediately report any FO and/or FOD that is found and any other FO and FOD related issues and concerns to their immediate supervisors and to FOD Representatives.

e. Fill out employee portion of the LF 360, and forward it to their immediate supervisor.

2.7.2 Employees shall obtain an effective understanding of FO and FOD policies and requirements for project-specific and site-specific work.

2.7.3 Employees shall practice effective housekeeping techniques (see section 3.2.2.2) and a “clean-as-you-go” (see definitions, Appendix A) work ethic.

2.7.4 Employees shall follow the requirements listed in the FOD control requirements, chapter 3 of this LPR.

2.7.5 Employees shall work with management to help develop specific inspections, control measures and techniques for FOD sensitive areas.

### 3.0 FOD CONTROL REQUIREMENTS

#### 3.1 GENERAL

##### 3.1.1 FOD Area Designation

3.1.1.1 FOD sensitive areas shall receive a designation based on the risk associated with a FO, for the activities being performed in the area. (Most areas of the Center will be Non-FOD Sensitive and will not need any FOD designation or any FOD control measures).

3.1.1.1.1 The risk shall take into account both the consequences and probability a FO will not be found/controlled.

3.1.1.2 Using Figure 3.1 as a guide for combining the two risk factors (i.e., consequence and probability), FOD sensitive work areas shall be designated as follows:

- a. **Non- FOD Sensitive** An area where the risk associated with a FO is negligible and no FOD control measures are needed.
- b. **FOD Awareness Area** An area where the risk associated with a FO resulting in hardware damage/contamination is low.
- c. **FOD Control Area** An area where the risk associated with a FO resulting in hardware damage/contamination is medium.
- d. **FOD Critical Area** An area where the risk associated with a FO resulting in hardware damage/contamination is high.

3.1.1.3 To determine the consequences, the following question should be answered: If a FO is not found/controlled, what is the worst-case scenario?

3.1.1.3.1 For example, contamination causing loss of a multi-million dollar spacecraft should be considered catastrophic, whereas the consequences of contamination resulting in the need to repeat a low cost experiment may be considered minimal.

3.1.1.3.2 The consequences of a FO impacting a wind-tunnel fan blade may lie between minimal and catastrophic, depending on the monetary loss expected and the programmatic impact.

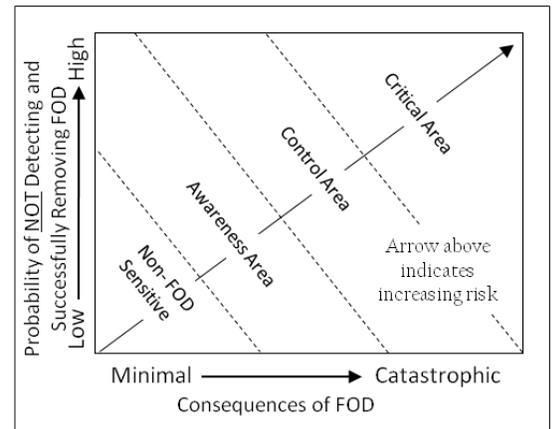


Figure 3.1, Guidance for combining risk factors (note this is only a conceptual drawing).

3.1.1.4 Some factors to be considered when determining the probability a FO will not be detected and successfully removed are:

- a. Can a FO be found easily during planned future inspections?
- b. How susceptible is the product/hardware to damage by a dropped object or tool?
- c. Is the activity being performed a final close-out inspection of a payload?
  - (1) Factors 3.1.1.4.b and 3.1.1.4.c in this document should be evaluated at the high end of the probability axis.
  - (2) Evaluation of factor one is a judgment call that can vary from low to high depending on several factors, such as the lighting during the inspection, the number of additional times inspection will occur, the number of locations for a FO to “hide,” and the physical ease of conducting an inspection.

3.1.1.5 Figure 3.1 (found on page 11) and the examples in paragraph 3.1.1.3.1 in this document provide only qualitative guidance to assist a manager in making a final risk classification.

3.1.1.6 For further assistance with determining the risk, consult with the area Facility Safety Head (FSH) or the FOD Program Manager in the Safety and Mission Assurance Office (SMAO).

### 3.1.2 General Guidance

3.1.2.1 The following statements are provided to establish general control requirements for the primary purpose of preventing FOD to facilities, aircraft and quality sensitive aerospace products being designed, developed, manufactured, assembled, operated, repaired, modified, refurbished and maintained.

3.1.2.2 Designated FOD sensitive work areas shall be identified by management with proper signage to designate the level of sensitivity.

3.1.2.3 The level of FOD sensitivity in a given area, determined by management is subject to increase or decrease based on the sensitivity and criticality of the system or product being worked on at the time.

3.1.2.4 Controls for FOD sensitive area levels shall be established using Appendix B, Foreign Object Damage (FOD) Areas, and section 3.2 of this LPR as guidance.

3.1.2.5 Personnel working in FOD sensitive areas shall comply with the requirements for that level of sensitivity.

3.1.2.6 Personnel entering FOD sensitive areas shall be held accountable for items carried into these areas.

3.1.2.7 Materials and parts received shall be checked and/or inspected for FO and FOD prior to use.

3.1.2.8 All visitors entering FOD sensitive areas shall be trained or escorted by the FOD Representative or other FOD trained personnel, as determined by management consistent with the FOD classification area.

3.1.2.9 All tasks shall include the applicable level of provisions for the prevention, detection, and removal of FOs to ensure and preserve the conformity of product and service.

### 3.1.3 FO and FOD Incident Reporting

3.1.3.1 For purposes of this document, a FO and FOD incident is defined as “an instance where a Foreign Object (FO) or Foreign Object Damage (FOD) is found in a FOD sensitive area or product.”

3.1.3.2 FOD discovered prior to, during or after final inspection is to be removed immediately if possible, and documented on the proper form. An LF 360 shall be used to document the discovery of FOs in FOD sensitive areas or products, except for quality sensitive/flight project hardware which is addressed below.

3.1.3.3 For quality sensitive/flight hardware, the FO and/or FOD incident needs to be documented in the appropriate preventive and corrective action reporting system (i.e., NCR or CxPraca) prior to taking corrective action.

3.1.3.4 When an incident occurs, the following reporting requirements shall be followed:

- a. The employee that discovers the debris and/or damage shall notify their immediate supervisor and fill out an LF 360 and gives the LF 360 to his/her supervisor.
- b. The supervisor contacts/notifies the FOD Representative, FOD Program Manager, SMAO Facility System Safety Engineer, and Facility Safety Head or Project Manager (as applicable) of the incident.
- c. The supervisor and the Project Manager or Facility Safety Head determines a corrective action plan to prevent future occurrences.
  - (1) The corrective action plan is not the direction necessary to remove the FO and restore the hardware.
  - (2) The details on directing how to remove the FO and restore the hardware are situational and should be handled on a case-by-case basis.

d. After the corrective action plan has been specified on the LF 360, the supervisor shall notify the FOD Representative, FOD Program Manager, SMAO Facility System Safety Engineer, and Facility Safety Head or Project Manager (as applicable).

e. Upon completion of the corrective action plan, the supervisor and Project Manager or Facility Safety Head will close the LF 360 by signing the form. The supervisor will then maintain the LF 360 in the appropriate filing system.

## **3.2 IMPLEMENTATION AND CONTROL METHODS**

### **3.2.1 Training**

3.2.1.1 Employees directly involved with FOD sensitive work shall receive the appropriate training prior to working in the area and on a biennial recurring basis thereafter, by the employee's management.

3.2.1.2 Recurring training can be done more frequently if determined as a need by an organization's management.

3.2.1.3 Training shall consist of briefing the FOD Prevention Program content to the employees and/or requiring the employees to read and understand the information contained in this LPR.

3.2.1.4 The FOD Program Manager will provide briefing charts when requested, to provide clarification to FOD Prevention Program content.

3.2.1.5 Any information, forms, procedures or inspections specific to the work and/or work site shall be included in the training (provided by management, see section 2.2.6 and 2.2.7).

3.2.1.6 Organizations are responsible for training, and certifying employees and also maintaining training currency and records.

3.2.1.7 A general awareness of the FOD Prevention Program shall be provided to all employees annually.

3.2.1.7.1 Examples of providing general awareness include using public outreach venues such as informational brochures and periodic articles in the Center safety newsletter.

### **3.2.2 Housekeeping**

3.2.2.1 Effective housekeeping standards shall be implemented and maintained by all employees in order to protect all personnel, products and facilities from FO and FOD.

3.2.2.2 Employees shall:

- a. Incorporate a “Clean-As-You-Go” as a required work ethic to prevent debris from migrating into FOD sensitive areas and hardware.
- b. Ensure that all FOD sensitive areas meet “good housekeeping” standards that enhance FO elimination. This includes sweeping and vacuuming production, wind tunnel, test cells and rigs and model build-up areas. Appendix B lists some common housekeeping practices for the various FOD sensitive areas.
- c. For Fabrication facilities, follow LMS-TD-8735, “Housekeeping Instruction for the Fabrication of Foreign Object Debris (FOD) Free Products in the Fabrication Facilities.
- d. Maintain grounds and surfaces on which aircraft and ground support equipment are operated and maintained free of objects that could cause damage due to ingestion of FOs or jet blast effects per LMS-TD-0940, “LaRC General Aircraft Maintenance Manual for RSD”

3.2.3 Material Handling and Parts Protection

3.2.3.1 Production and service operations shall include processes necessary to protect all products from FO and FOD.

3.2.3.2 Controlled conditions are to be established for material handling, including consumables, and parts protection in order to eliminate FO hazards as follows:

- a. Identify quality sensitive parts, assemblies, surfaces, areas, etc. to be protected from FO and FOD.
- b. Evaluate cleanliness and care requirements.
- c. Sequence events for packaging, handling, shipping and storage

3.2.3.3 All employees shall follow identification, tracking, packaging, handling, shipping, and storage requirements.

3.2.3.4 Materials and accessories used in the packaging, handling, shipping and storage, of parts or assemblies shall be clean and free of contamination.

3.2.3.5 Parts and assemblies shall be packaged in a manner that shall include provisions to prevent damage as a result of making contact with another object during normal handling and shipping operations.

3.2.3.6 Protective and packaging materials shall be chosen by Project Engineering based on their ability to adequately resist penetration by tearing, parting, or piercing from forces either external or internal during normal handling operations.

3.2.3.7 Protective devices (edge protectors, caps, plugs, covers, filters, rub strips) shall be cleaned and secured to prevent accidental damage.

3.2.3.7.1 Once installed, unauthorized removal of the protective devices is prohibited and shall be controlled through assembly or maintenance paperwork.

3.2.3.7.2 Consideration shall be given to the visibility and removal of material used for protection so that the material itself does not become a FO.

3.2.3.7.3 Consideration shall include:

a. Color of packaging or protective devices so they don't appear to be a part of what they are protecting.

b. Streamers for removal for critical items.

3.2.3.8 Materials shall be compatible with the environmental and physical stresses expected to be encountered during product service.

3.2.3.9 Static sensitive devices shall be properly protected to avoid damage. Materials used to protect electro-explosive devices and sensitive electronic components shall be kept clean, covered, and stored away from ordinary non-static safe materials.

3.2.3.10 QAB for quality sensitive/flight hardware or facility/aircraft personnel as applicable - visually inspect all packaging, handling, shipping and storage containers for the following:

a. Nicks, dents, holes, abrasions, scratches, burns, etc., which may be detrimental to the function and integrity of the part or assembly.

b. Grease, preservatives, corrosion products, weld slag, dirt, and other materials foreign to the item.

### 3.2.4 Tool Accountability

3.2.4.1 Tool accountability methods shall be maintained in FOD sensitive areas based upon the level of risk.

3.2.4.2 Recommendations include, but are not limited to:

- a. Use of shadow boards, shadowboxing, bar coding, special canvas layouts with tool pockets, tool counters, chit system tool tags, or consolidated tool kits.
- b. Unique control methods shall be implemented for special tools used in checkout, test and operational environments.
- c. Tools/equipment shall be tethered or suitably restrained to the user in FOD sensitive areas where a dropped article could result in damage to flight project hardware, or where it would be difficult to retrieve a dropped tool.
- d. All loose tools shall be contained in a tote tray, soft tool bag or other suitable spill-proof container and not placed in a manner that would cause damage to flight project hardware.

3.2.5 Hardware Accountability

3.2.5.1 Hardware accountability methods shall be maintained in FOD sensitive areas based upon the level of risk.

3.2.5.2 Recommendations include, but are not limited to:

- a. Kit (package) hardware by task (nuts, bolts, screws, cotter pins, rivets, etc.):
- b. Proper disposal containers shall be placed near the work area.
- c. "Clean-As-You-Go." Debris generated from hardware shall be properly monitored.
- d. Removal/installation documentation to track loose parts as required by project.
- e. Furnish and specify tote trays.
- f. Covered containers with spring-loaded mechanism or other device for securing lids.

3.2.6 Lost Items

3.2.6.1 Anytime an item is lost in a FOD control or FOD critical area, cease activity in the affected area and initiate a search for the item.

3.2.6.2 Continue a thorough search until the item is found or adequate assurances are made that the item is not in the area.

3.2.6.3 Searching for critical FOs or other items may require parts removal or nondestructive inspections.

3.2.6.4 If an item cannot be located after an appropriate search has been conducted, facility/project management with concurrence from SMAO may allow activities to resume.

3.2.6.5 Project-specific or site-specific rationale and/or operational constraints shall be developed and documented for any lost items and in the case of constraints, followed.

### 3.2.7 Hazardous Material

3.2.7.1 Management of hazardous materials and waste generated is important in the prevention of FOD.

3.2.7.2 Disposition of hazardous waste materials is dependent upon the commodity discarded.

3.2.7.3 Hazardous materials are to be managed in accordance with LPR 1710.12, "Potentially Hazardous Materials - Hazard Communication Standard."

### 3.2.8 Assembly Operations

3.2.8.1 Plan and sequence maintenance/manufacturing tasks to preclude FOD and entrapment of debris or contamination.

3.2.8.2 Documents shall contain necessary processes and procedures for controlling and removal of contamination and debris during fabrication and assembly operations.

3.2.8.3 As applicable, the following shall be included in work instructions:

- a. Upon completion of final machining operation, clean or flush the machined component to assure that it is free of debris. Protect exposed openings to prevent FO entry.
- b. Adequately protect hardware and equipment from splatter accumulation during brazing, soldering, welding, bonding, and like operations.
- c. Inspect components and equipment for damage prior to installation and repair as necessary. Always ensure part integrity before installation.
- d. Verify required protective devices (dust covers, temporary seals, cushioning, etc.) are present and properly installed. Items with protective devices missing are to be inspected for FO and FOD, cleaned (if necessary) and protective devices installed.
- e. After fluid and pneumatic system lines and tubing are cut and deburred, assure thorough cleaning and cap ends of lines.
- f. Inspect for and remove extraneous material as part of the assembly step, conduct a FO inspection and remove debris.

g. Inspect production tooling (jigs, fixtures, handling equipment, or other production tools) to assure it is clean, undamaged and free of foreign material prior to installation and build-up of components or assemblies. Exercise this same care for scaffolding, work stands, ladders, special test equipment, or like equipment, which shall be placed on, in, or around critical hardware to accomplish specific tasks.

h. Protect products by using FO barriers, foam pads, covers, etc. Always protect sensitive areas and potential FO entrapment areas.

i. Provide for proper instruction, performance of and inspections necessary to remove any caps or seals used for FO and FOD prevention that must be removed during assembly/build-up of a system.

### 3.2.9 Physical Entry Into FOD Critical Areas

3.2.9.1 When physical entry into a FOD Critical Area is required, personnel shall remove all loose objects, badges, jewelry, etc from clothing.

3.2.9.2 Pocket-less coveralls should be worn in FOD Critical Areas to preclude FOs dropping from pockets.

3.2.9.3 Personal items that are required in FOD Critical Areas, such as eyewear, ear protection, etc shall be accounted for upon exit of the FOD Critical Area by using FOD/Tool Log sheets.

### 3.2.10 Physical Entry Into FOD Control or Awareness Areas

3.2.10.1 Refer to Appendix B, Foreign Object Damage (FOD) Areas, for some controls used in FOD Control or Awareness Areas.

#### **4 DESIGN CONSIDERATIONS**

4.1 Begin the reduction of damage potential and elimination of FOD hazards with the design process.

4.2 Design considerations may include:

- a. Identify and eliminate FO entrapment areas.
- b. Identify and seal areas through which FOs can migrate.
- c. Use screens over exposed openings when appropriate: e.g., intakes, exhausts, etc.
- d. Install special access panels, ports, etc., for inspection and clean-out of FOs that could potentially cause damage.
- e. Use blind fasteners in critical areas that are not prone to leaving debris during installation.
- f. Use fasteners with self-retaining features to secure high usage access panels.
- g. Locate service points, ground points, and built-in test equipment in areas, which are least FOD sensitive.
- h. Use compatible metals and seals to prevent accelerated deterioration and subsequent failure of seal materials.
- i. Use conformal coatings as a positive seal against entry of minute FO including dust and water vapor.

## APPENDIX A Definitions

**A.1 Clean-As-You-Go** - Defined by National Aerospace FOD Prevention, Inc. (NAFPI) as follows: "Clean the immediate area when work cannot continue. Clean the immediate area when debris has the potential to migrate to an out of sight or inaccessible area and give the appearance of poor workmanship. Clean the area prior to leaving it unattended, when work cannot continue, after work is completed or at the end of shift, whichever comes first. If you see something, drop something, see or hear something drop, pick it up."

**A.2 Consumables** - For the purposes of this procedure, supplies provided to workers that are considered expendable; i.e., personal protective equipment, sealants, solvents, paint, brushes, applicators, sandpaper, rags, wipes, rivets, washers, fasteners, and other hardware.

**A.3 Corrective Action Plan** - Steps to be taken to prevent the root cause(s) of a FO and/or FOD incident from occurring again. The corrective action plan is not the direction necessary to remove the FO and restore the hardware.

**A.4 Critical Foreign Object** - FO debris that has a significant probability of causing system or component malfunction or deterioration if the item containing the FO debris is put into use.

**A.5 Foreign Object Damage (FOD)** - Any damage attributed to a FO that can be expressed in physical or economic terms, which may or may not degrade the product's safety and/or performance characteristics.

**A.6 Foreign Object (FO)** - A substance, debris or article alien to a vehicle or system that would potentially cause damage.

**A.7 Foreign Object Damage (FOD) Awareness Area** - Any area designated as a low-risk area where quality sensitive products or hardware are in place and exposure to FOs would potentially cause a system or product malfunction or failure. Organizational Culture is focused on safety, reliability, and functionality by protecting all personnel, products and services from FO debris and damage.

**A.8 Foreign Object Damage (FOD) Control Area** - Any area identified as a medium-risk area where quality sensitive products or hardware are in place and exposure to FOs would potentially cause system or product damage, malfunction or failure. Stringent accountability measures shall be applied to control the risk of FOD in the area.

**A.9 Foreign Object Damage (FOD) Critical Area** - Any area identified as a high-risk area where quality sensitive products or hardware are in place and exposure to FOs would potentially cause system or product damage, malfunction or failure. Strict accountability measures shall be applied to control the risk of FOD in the area.

**A.10 Foreign Object Damage (FOD) Sensitive Area** – any area designated as either a FOD Awareness Area, a FOD Control Area, or a FOD Critical Area.

**A.11 Foreign Object Damage (FOD) Sensitive Work** – Work that is being conducted in a FOD sensitive area.

**A.12 Foreign Object (FO) and Foreign Object Damage (FOD) Incident** - An instance where a FO or FOD is found.

**A.13 Housekeeping** - Basic element of controlling a safe and effective work environment. Proper cleaning and organizing techniques are followed to ensure the prevention and elimination of FOs. Maintenance, manufacturing, testing and all other operational areas shall remain clean and organized with the ultimate goal to prevent debris from migrating into critical and complex hardware and facilities. The clean-as-you go work ethic is one of the most effective provisions for production, service, and preservation of products.

**A.14 Non-FOD Sensitive** - An area where the risk associated with a FO is negligible and no FOD control measures are needed.

**A.15 Shadowbox** - A tool box with specific, marked locations for each tool so that a missing tool will be readily noticeable.

**A.16 Tether** - A lanyard of sufficient strength (wire, rope, cable, etc.) attached to the tool/equipment and to the user or fixed secure object. The tether should be minimum length to preclude damage from tethered tool “free swing”.

**A.17 Tote Tray** - A device for storing/carrying/transporting tools or equipment in a secure manner to prevent inadvertent dropping: i.e., a tool holder, an apron with pocket rings to which tools can be secured. Tote trays with lids will have the lid secured to the tote tray body.

## APPENDIX B Foreign Object Damage (FOD) Areas

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Attribute	Area Level			
	FOD CRITICAL	FOD CONTROL	FOD AWARENESS	Non-FOD Sensitive
<b>Training</b>	FOD General Awareness. FOD Specific Area.	FOD General Awareness. FOD Specific Area.	FOD General Awareness.	FOD General Awareness.
<b>Area Access (signage)</b>	"FOD CRITICAL" signs posted. Controlled entry and exit.	"FOD CONTROL" signs posted. Limited area access.	"FOD AWARENESS" signs posted.	None
<b>Housekeeping</b>	Practice superior housekeeping standards. Practice "Clean-As-You-Go." Perform scheduled walk downs. No smoking, food or drink allowed.	Practice superior housekeeping standards. Practice "Clean-As-You-Go." Perform scheduled walk downs. . Smoking, food or drink in authorized areas only.	Practice good housekeeping standards. Practice "Clean-As-You-Go." Perform scheduled walk downs. Smoking, food or drink in authorized areas only.	Customary Janitorial Practices
<b>Tool Accountability</b>	Strict tool (temporary and personal) accountability enforced. Accountability shall include any items taken into the FOD area. No FOs allowed in tool boxes.	Stringent tool accountability enforced including temporary and personal tools.	Standard tool accountability recommended.	None
<b>Consumables</b>	Storage separate from point of use, carried in sealable containers, strict accountability of quantity and type during use. Unused or spent consumables returned to storage or dispositioned after use.	Storage separate from point of use, carried in sealable containers. Use only items needed to accomplish task. Unused or spent consumables returned to storage or dispositioned after use.	Users take only items needed to accomplish task. Unused or spent consumables returned to storage or dispositioned after use.	No requirement
<b>Material Handling, Packaging, Shipping (see chapter 3.2.3)</b>	Clean containers prior to use, install FO barriers during movement and storage, and use packaging that does not produce FOs.	Clean containers prior to use, install FO barriers during movement and storage, and use packaging that does not produce FOs.	Clean containers prior to use, install FO barriers during movement and storage, and use packaging that does not produce FOs.	Customary practice
<b>Attire and Personal Items</b>	No personal items (i.e., jewelry, keys wallets permitted). No phones or pagers (unless safety / communication requirement). Ensure eyewear, ear protection and badges are secure. Personal items should be accounted for upon exit of the FOD area, by using FOD/Tool Log sheets.	Secure jewelry and badges. Authorized use of phones and pagers. Personal items should be accounted for upon exit of the FOD area, by using FOD/Tool Log sheets	Secure jewelry and badges. Authorized use of phones and pagers.	No restrictions.