Foreign Object Debris/Foreign Object Damage (FOD) Prevention Training Program

C-ASE PN 704822-001 Rev D

FOD Training Program: Objectives

- To increase employee awareness to the causes and effects of FOD
- Promote active involvement through specific processes & prevention techniques
- Stress good work habits and disciplines

FOD Training Program Definitions

Foreign Object Debris (FOD)

A substance, debris, or article alien to the component, assembly, system or vehicle that could cause damage.

Foreign Object Damage (FOD)

Any damage or incident attributed to a foreign object that can be expressed in physical or economic terms that may or may not degrade the product's required safety and/or performance characteristics.

FOD Training Program, Summary

- In the case of engine test and wind tunnel facilities, FOD is any object or substance that, if permitted to become airborne, can cause:
  - Injury to personnel
  - Damage to test components
  - Damage to test equipment
  - Damage to surrounding facility components

FOD Training Program, Summary

- To prevent FOD from becoming airborne and causing damage, it is essential that engine test facilities and wind tunnels be:
  - Properly designed for all environmental and operating conditions
  - Properly fabricated and installed
  - Of high quality construction
- Facility clean-up must be complete and thorough:
  - Conducted by individuals who understand FOD and how to prevent it

FOD Training Program, Summary

- Maintenance and operation must be conducted in a way to prevent the presence and generation of FOD.
- All personnel (including General Contractors and Sub-contractors) involved in the design, fabrication, construction, operation and maintenance of engine test and wind tunnel facilities must:
  - Understand the nature and causes of FOD
  - Actively participate in practices necessary to prevent the presence and formation of FOD.

FOD Training Program, Materials and Sources

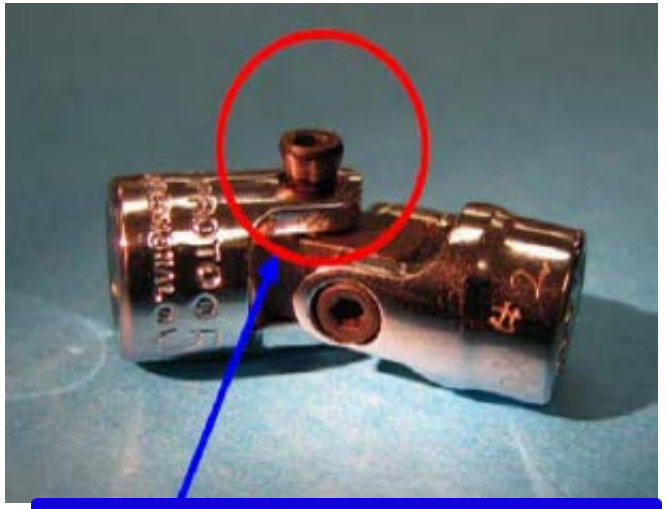
- FOD can originate during:
  - Construction and equipment installation
  - Equipment fabrication
  - Operation and Maintenance
- Common FOD materials are:
  - Wire, bolts, nuts, washers, or screws
  - Sand, gravel, concrete fragments, twigs, or sticks
  - Birds, rodents, or other small creatures
  - Pens, pencils, paper and packaging
  - Plastic, rags, brushes, applicators, loose caulk, and RTV
  - Tools, paint chips, cable ties, security badges, personal articles, etc.

FOD Training Program, Materials and Sources

- Common sources of FOD are:
  - Exterior roof areas local to vertical inlets
  - Exterior ground areas within 40 feet of horizontal inlets
  - Facility concrete floors, walls, and ceilings that are not cleaned properly, deteriorated, spalled, or otherwise damaged.
  - Steel construction that is oxidized, damaged, or has loosened connections and/or fasteners.
  - Acoustic treatment and supporting structure
  - Debris and flow conditioning screens and their supporting structure
  - Access platforms and stairs
  - Test equipment and supporting structures
  - Lift, work, and overhead supported engine handling platforms
  - Interior utilities, cables, hoses, junction boxes, and CCTV cameras, including all supporting hardware

FOD Training Program, Materials and Sources

- Common sources of FOD are:
  - Abandoned, misplaced, dropped, or forgotten tools, hardware, or personal artifacts within an area where FOD could become airborne



After repeated use, the screw backs out of flex socket

FOD Training Program, FOD Prevention

- **NOTE:** At this point, content is specialized and tailored for each department's unique activities. Skip to the relevant section for the group you are training.
  - Design Considerations, slides 11-12
  - Construction and Equipment Installation, slides 13-17
  - Equipment Fabrication, slides 18-19
  - Materials and Fastener Retention, slide 20
  - Tools and Equipment, slides 21-22
  - Test Apparatus Installation, slides 23-24
  - Cleaning, slides 25-27
  - Final Inspection and Rework, slide 28

FOD Training Program, Design Considerations

- Design considerations may include:
  - Identify and eliminate foreign object entrapment areas
  - Identify and seal areas through which foreign objects can migrate
  - Use screens over exposed openings when appropriate
  - Use fasteners with self-retaining features to secure high usage access panels
  - Locate service points, ground points and built-in test equipment in areas which are least FOD sensitive
  - Use compatible metals and seals to prevent accelerated deterioration and subsequent failure of seal materials

FOD Training Program, Design Considerations (cont.)

- All facility components and equipment shall be designed for all environmental, operating and accident loading conditions in strict accordance with all applicable design and local codes
- All equipment components and members including welds and fasteners shall be designed and sized with due consideration of high cycle fatigue to reduce the risk of cracking that can lead to FOD
- Fastener installation torques shall comply with C-ASE Specification MS-198 and fastener retention system requirements shall comply with C-ASE Specification MS-173 and Military Standard NASM 33540

Design Considerations

END

FOD Training Program, Construction and Equipment Installation

- Construction and equipment installation practices shall be configured to result in high quality finished products with a constant focus on the prevention of FOD
  - All facility interior surfaces within areas where FOD could become airborne shall be free of defects and loose or unsound concrete, brick, block, etc.
    - Surfaces shall be periodically inspected to ensure they are mechanically sound
    - Mechanically unsound surfaces shall be reworked until acceptable to C-ASE
  - After completion of construction and equipment installation, all equipment and facility wall, ceiling, and floor surfaces shall be properly inspected and cleaned

FOD Training Program, Construction and Equipment Installation

- All construction equipment, tools, materials, debris, etc. shall be removed
- Should the surfaces remain unfinished for more than two weeks, the procedure shall be repeated until the surfaces have been coated and/or finished

– In addition to other contract specifications, concrete formwork used in construction of the air-flow chamber shall be maintained in excellent condition to prevent the formation of ribs at the form joints on the concrete surface that may be rubbed, bumped, or chipped off the finish surface to create FOD

- Avoid form ties that do not break off cleanly at the surface without spalling significant amounts of concrete from the surface

FOD Training Program, Construction and Equipment Installation

- Concrete materials shall be properly mixed and placed to ensure a monolithic surface appearance with only small voids less than 5mm in diameter and no spalling
  - Patching of non-compliant areas shall not be conducted without written approval by C-ASE
- Unless specified to remain unfinished, structural steel and steel embedded in concrete exposed in the air-flow chamber shall be new material, free of rust and corrosion
  - If rusting occurs before final painting can be accomplished, the material shall be ground smooth and primer shall be re-applied according to primer manufacturer's specification for field application.

FOD Training Program, Construction and Equipment Installation

- All metal components shall be handled in such a manner to prevent scraping, scratching and otherwise marring the surfaces which could result in shavings or burrs being dislodged in the facility
- Welded assemblies, whether preassembled or welded on site, shall have the welds ground smooth to eliminate small pockets of moisture or paint buildup, when applied to the finish surface
  - Prior to welding connections in the field, all debris, dirt, primer, and corrosion shall be ground from the area to be welded
  - Welds shall be ground smooth free of pits and ridges greater than 2mm from the smooth contour

FOD Training Program, Construction and Equipment Installation

- Construction and Equipment Installation (cont.):
  - After welding, ferrous metals shall be primed with a highly effective field primer compatible with the manufacturer's instruction from the finish paint supplier

Construction and Installation

END

FOD Training Program, Equipment Fabrication

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  - Welds shall be ground smooth free of pits and ridges greater than 2mm from the smooth contour

FOD Training Program, Equipment Fabrication

- At the completion of fabrication, prior to packaging for shipping, all equipment shall be properly inspected for FOD and thoroughly cleaned of unused materials, debris, weld slag, drill filings, tools and other items that could become FOD

Equipment Fabrication

END

FOD Training Program, Materials and Fastener Retention

- All fasteners shall be secured from loosening per the requirements indicated on the contract documents.
  - Fastener retention methods include:
    - Safety wiring per the requirements of MS-173 and NASM 33540 using stainless steel safety wire not less than 0.025 inches in diameter
    - Full height solid metal locknuts; all locknuts shall be torqued per the locknut manufacturer's written instructions
    - Tack welding fastener components to each other and/or to the base component after installation
    - Applying a suitable RTV to smaller bolts and screws where safety-wiring is impractical

Materials and Fastener Retention

END

FOD Training Program, Tools and Equipment

NOTE: "Tools and Equipment" includes Construction, Equipment, and Test Apparatus Installation T&E.

- The General or Specialty Contractor (GC/SC) shall maintain inventory and control over the use of tools in all areas where facility equipment installation takes place
  - Records of each of those inventories shall be made and retained for inspection purposes
- Immediately prior to equipment installation, the GC/SC shall perform a complete cleaning of the facility, including the removal of all foreign objects that are not properly secured and attached according to this specification
- If all facility construction has been completed prior to equipment installation then the GC/SC shall perform a complete cleaning and inspection of the entire facility per 2.05 A. 3

FOD Training Program, Tools and Equipment

- Defective and surplus materials shall be retained and kept for a final inventory of the unused components
  - Workers are to justify that no material is logically missing that could have remained in the test facility
  - Records of the inventory shall be made and retained for inspection purposes
- Upon completion of the installation, a complete inventory of the tools, gauges, and equipment used in the installation shall be taken to determine that all are accounted for

Tools and Equipment

END

FOD Training Program, Test Apparatus Installation

- The test apparatus installation Specialty Contractor shall commence his installation work by making a complete inventory of all materials and tools required for the installation of the test apparatus
  - Records of the inventory shall be made and retained for inspection purposes
- Those items that do not remain in the chamber during the test shall be allowed into the test facility after they have been checked out to a responsible installer
  - Installer will return the item(s) to the location of the primary inventory and check them back in
  - On a weekly basis, the inventory of tools and installation equipment shall be verified

FOD Training Program, Test Apparatus Installation

- Records of the inventory shall be made and retained for inspection

– When the test apparatus has been completely installed and is ready for testing, the tools and materials shall be thoroughly removed and checked back into the inventory per item 2.05.C.2

– Each Test Apparatus remaining in the facility shall be checked to ensure that all fabrication materials, fasteners, and connections are secure according to this specification and ready for the test run

Test Apparatus Installation Tools

END

FOD Training Program, Cleaning

- Prior to equipment installation and after completion of all construction, (including abrading and preparing the surfaces for subsequent coating system application), thoroughly clean all surfaces removing all loose materials by high pressure washing, vacuuming, compressed air or other effective means
- Clean as you go:
  - Continuously remove work debris as it accumulates, keeping the work area clean while performing tasks in FOD sensitive areas
  - Clean the immediate area when work cannot continue
  - Clean the immediate area when work debris has the potential to migrate to an out-of-sight or inaccessible area
  - Inspect and clean all tools after job completion or end of shift

FOD Training Program, Cleaning

- Clean the immediate area after work is completed and prior to inspection
- Clean at the end of each shift
- If you drop something or hear something drop, pick it up

– As equipment installation work and cleaning proceed, all tools used shall be maintained, stored and formally tracked to assure accountability

– After installation of equipment, thoroughly clean all facility wall, ceiling, floor, and equipment surfaces by vacuuming, high pressure washing, compressed air or other effective means

- Care should be taken to remove debris from all corners, trenches and sumps

FOD Training Program, Cleaning

- High pressure washing and compressed air shall be used only after an initial broom or vacuum cleaning that removes the majority of all debris
  - high pressure washing and compressed air have the potential to wedge or lodge FOD into crevices
  - These could be dislodged and become a FOD hazard
- Upon completion of the Final Clean-up, a representative from each of the participating contractors shall sign a statement that the clean-up has been properly executed as per the FOD prevention plan
  - This statement shall be turned over to C-ASE as a declaration that the facility is ready for the Final Inspection for FOD

Cleaning

END

FOD Training Program, Final Inspection and Rework

- High pressure washing and compressed air shall be used only after an initial broom or vacuum cleaning that removes the majority of all debris
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Cleaning

END