

26th National Aerospace FOD Prevention Conference

August 9-11, 2005

NAS 412



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NAS 412 Topics



Today we're going to talk about-

- **Purpose/Goal**
- **The FOD Advisory Board**
- **Basic Definitions**
- **Basic FOD & Tool Control Guidance**
- **Specific Program Concepts**





NAS 412 Purpose



To establish standards for military and commercial industry to prevent foreign object damage (FOD) to aerospace products.



Goal



**To promote ground and flight safety
and the preservation of private and
national assets.**



Not an Instruction/ Regulation/Rule



Provides Guidance not Directives.

Provides information on the areas that *must* be addressed if you want to have an effective FOD & Tool Control Program.

Contains proven processes, but there may be better methods out there.

There's more than one way to shadowbox a cat!



FOD Advisory Board



Manages and updates NAS 412 as needed.

Composed of Representatives from

- **NAFPI**
- **AIA's Engineering Management and Quality Assurance Committees**
- **The Defense ~~Logistics~~ Agency**



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- **The Defense *Contract Management Agency.***



FOD Advisory Board



Web Addresses

- www.nafpi.com
- www.aia-aerospace.org
- home.dcma.mil



Definitions



**So we're all
playing from the
same sheet of
music.**



FOD



**Foreign
Object
Debris**



**Also known as
Foreign Objects
or "FO"**

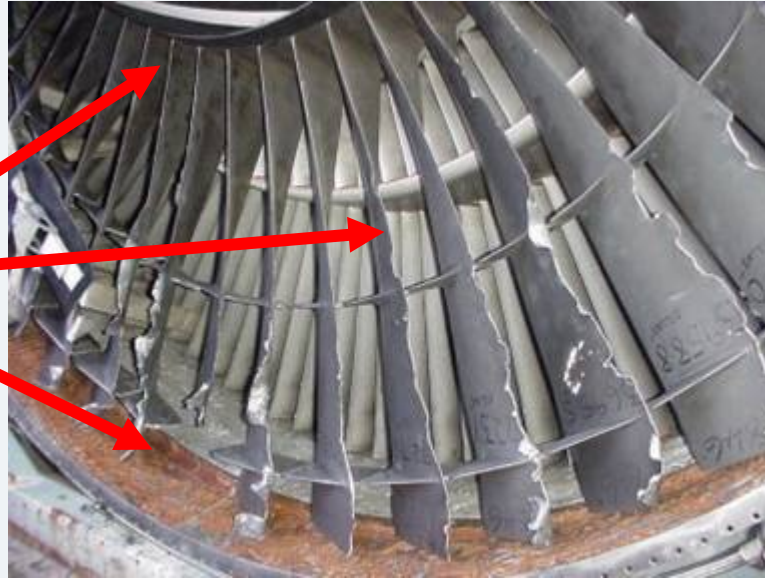
**A substance, debris or article alien to a
vehicle or system which would potentially
cause damage.**



FOD



Foreign Object Damage



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



FOD Circle





Potential FOD



The condition where foreign object debris may cause damage, and/or failure should the product be put into use.





Potential FOD



- **Metal or wire clippings, solder balls and debris lying in vicinity of electrical terminals, circuitry, connectors, components, etc.**
- **Tools, hardware, or debris left in vicinity, or in a migratory path or a path of a vehicle's system or engine inlets.**
- **Debris lying on runways, ramps and taxiways**
- **Propeller/jet exhaust and tilt-rotor downwash**
- **Inclement weather**
- **Ice, Salt**
- **Birds, and other animals (like snakes)**
- **Electro-Static Discharge (ESD)**
- **Construction Debris**



FOD Critical Areas



Any area where flight hardware is in place and exposure to foreign objects would potentially cause a system or product failure due to deterioration, malfunction or damage.

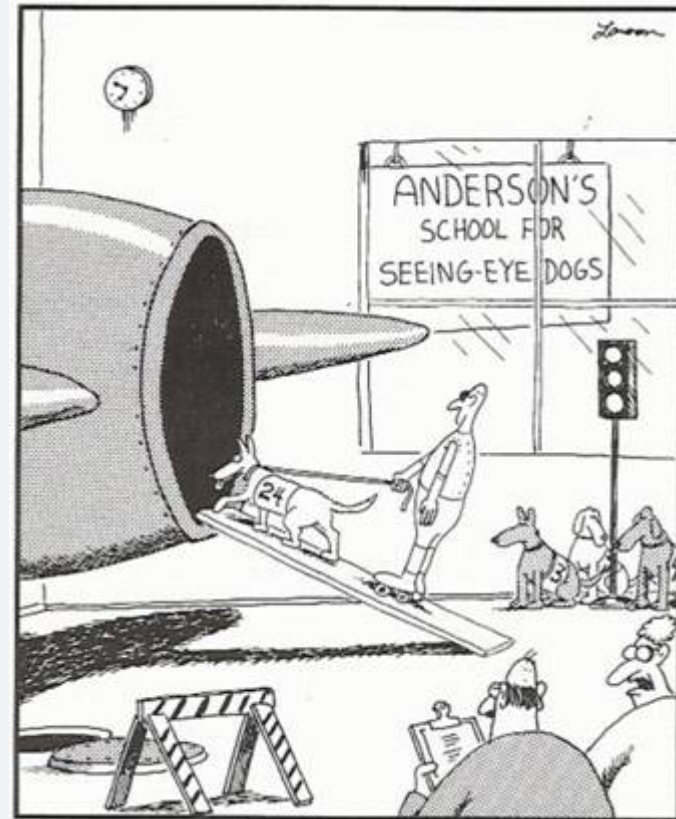




Critical FO



Foreign objects in areas from which migration is possible, e.g., through tooling holes, bend relief cutouts, drain holes, intakes, etc., which are probable to cause system or component malfunction or deterioration should the product be put to use.



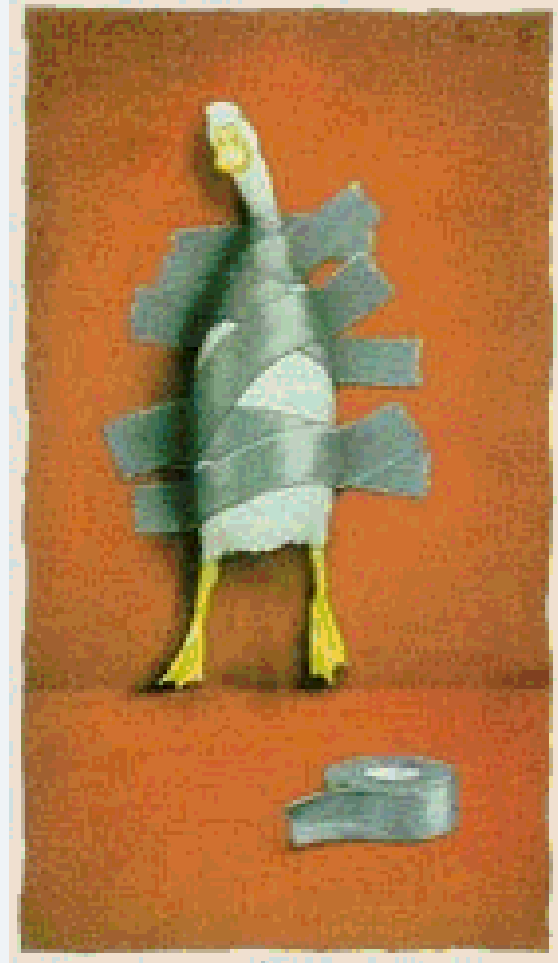
“Well scratch No. 24. He did pretty good though, right up to the jet engine test.”



Foreign Object Elimination (FOE)



A program or process used to assure a FOD-free product/system.





Tote Tray



A device for storing/carrying/transporting tools or equipment in a secure manner to prevent inadvertent losses.





Clean-As-You-Go



- **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 and cause damage and/or give the appearance of poor workmanship.**
- **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!**



Consumables



Supplies provided to workers that are expendable.

- **Issued apparel**
- **Safety glasses**
- **Glue, paint, sealant**
- **Rags**
- **Sandpaper, brushes, applicators**
- **Stock items such as rivets, washers, fasteners and other hardware.**



Shadowbox & Shadow board



A tool box or storage board with specific, marked locations for each tool so that a missing tool will be readily noticeable.





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.”

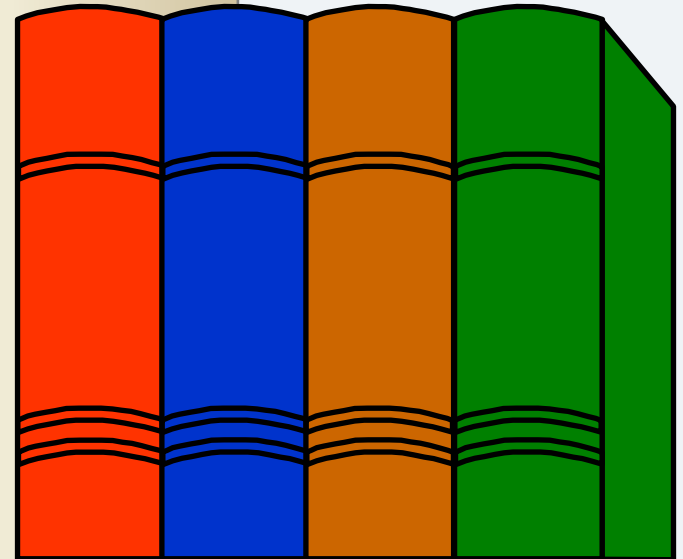




References



1. MIL-STD-980 (deleted 11/95)
2. AFI 21-101, ACCI 21-101
3. OPNAV 4790.2
4. ISO-9000/9001
5. NAFPI Guidelines



[www.nafpi.com/nafpiguide.pdf]



Basic FOD Guidance





Basic FOE Guidance



Establish and maintain an effective FOD prevention program that is planned and implemented using a “continuous improvement” approach.



Basic FOE Guidance



Basic Elements:

- Training
- Early Design Considerations
- Assembly Sequencing
- Handling of Material
- Housekeeping
- Awareness

- Control of tools and personal items
- Hardware control
- Metrics
- Incident analysis
- Hazardous material
- Access Controls



Basic FOE Guidance



Preventive Practices:

- Follow Procedures
- Practice good housekeeping “Clean-As-You-Go”
- Account for tools & hardware at specific intervals
- Develop procedures for inspecting inaccessible areas

- Awareness training
- Provide storage areas for ladders, hoses, tool boxes & other work aids
- Brief lessons learned
- New employees must complete FOD training before beginning work in FOD prone areas



Specific Program Guidance

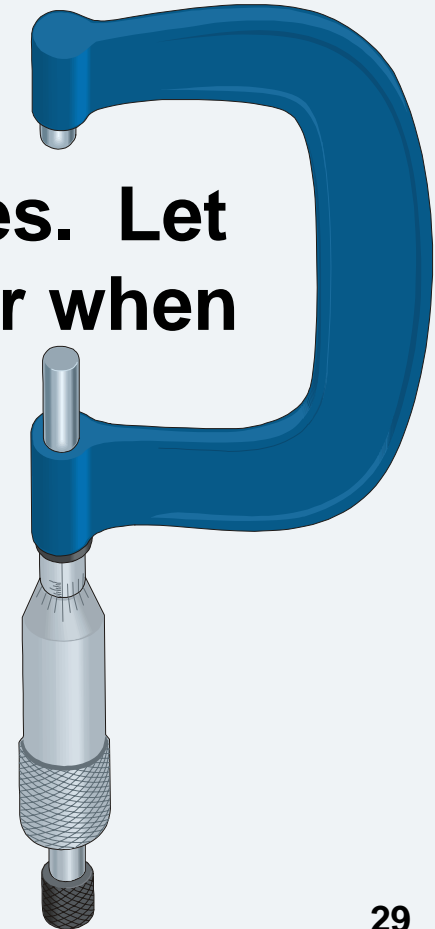




Measuring Performance



Workers need *specific* information about what is wrong before they can be expected to improve processes. Let them know when they're doing well or when they're not. Feedback is vital to the process improvement.





Measuring Performance



- **How do you know if your FOD Prevention Program is working?**
 - **Formally track program**
 - **Analyze data**
 - **Take appropriate actions**
 - **Repeat**





Gather Data



FOREIGN OBJECT ELIMINATION/HOUSEKEEPING CHECK LIST

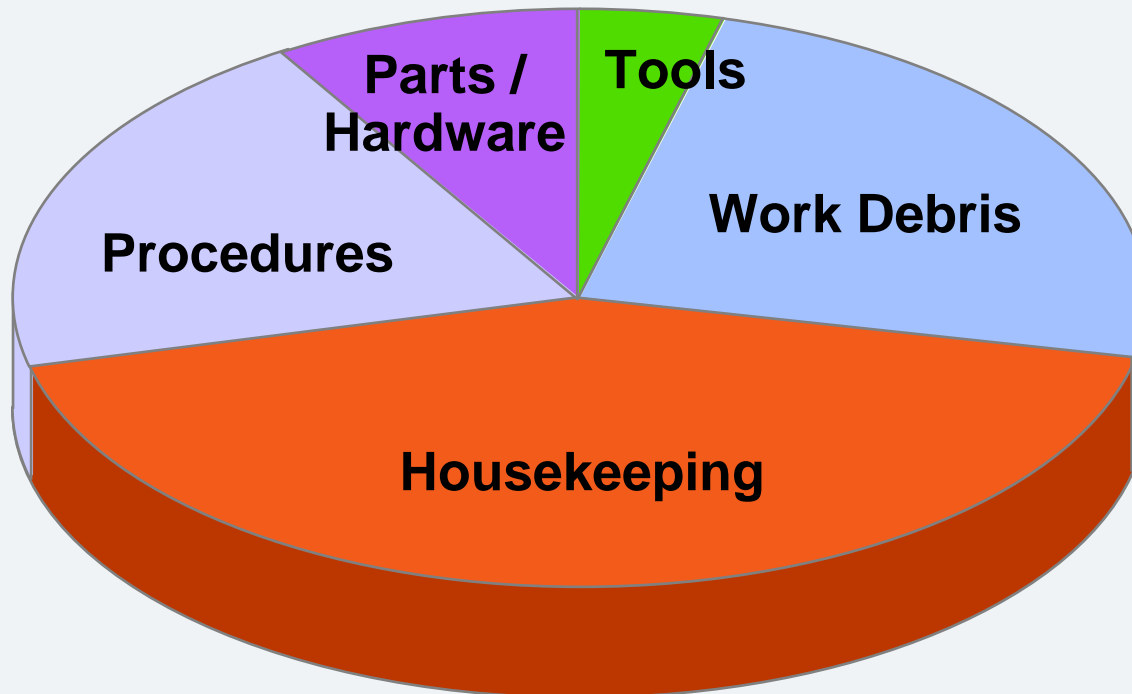
SECTION _____ MONITOR _____ SUPERVISOR _____

	SAT	SUN	MON	TUE	WED	THUR	FRI
Foreign Object Elimination and Housekeeping Daily Inspection Requirements							
Assemblies are free of loose standard parts, tools, and other foreign objects or any excess accumulation of assembly debris.							
F.O.E. bags are available and in use.							
Tables, rollaways, standards or staging that are in close proximity of major assemblies are clean and free of tools, standard parts or other foreign objects unless properly contained.							
During work in process, standard parts are kept in flip lid containers; tools, clamps, clecocs, etc, are in plastic tote trays.							
Fluid fittings and lines (test or assembly) stored or installed, are capped and kept in clean storage. Bearings, bushings, RDP ends are protected.							
Electrical plugs are capped and in clean storage.							
Opening into areas that cannot be cleaned are covered.							



Analyze

Look for patterns, trends, and areas that need greater focus



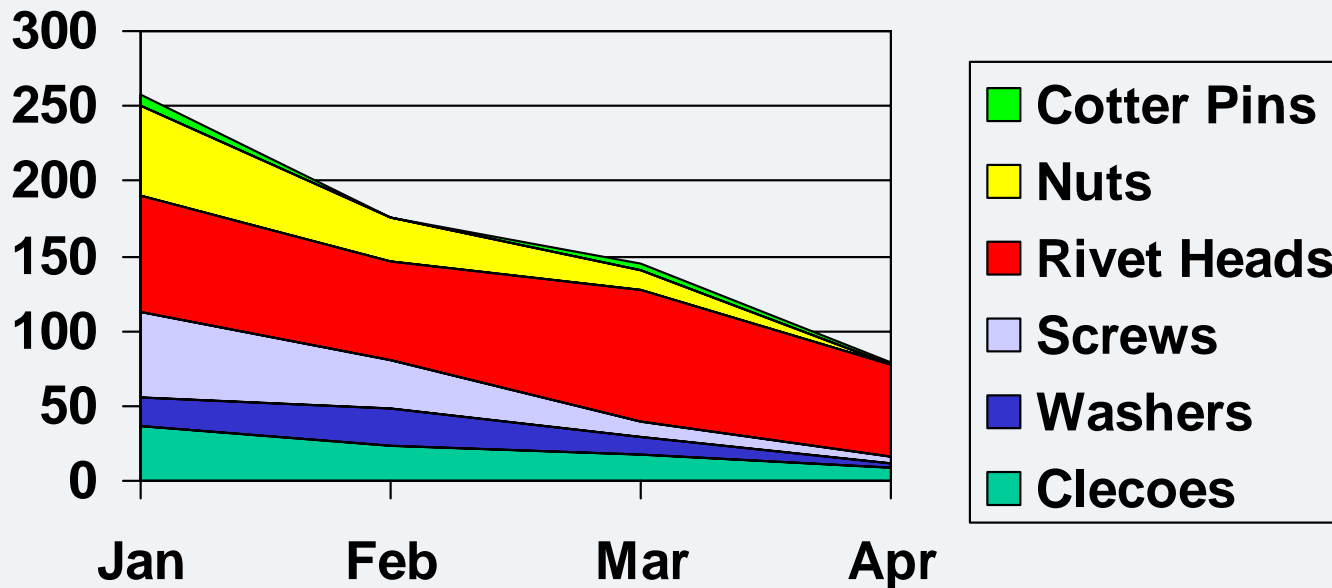
Monthly FOD Discrepancy Cause Rollup



Analyze



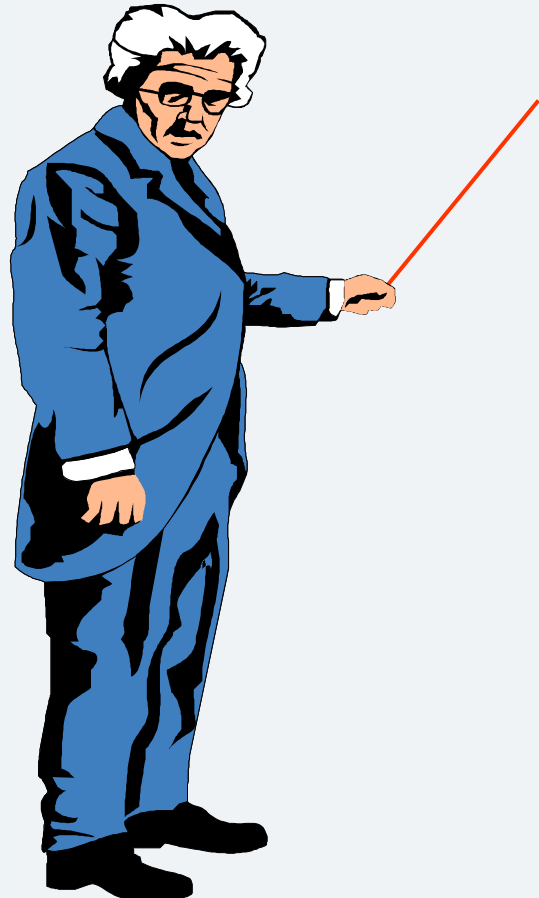
Miscellaneous Spare Parts Found



NOTE: Downward trend in all categories except Rivet Heads



Training



The primary objective of a FOD prevention training program is to increase employee awareness to the causes and effects of FOD, promote active involvement through specific techniques, and stress good work habits.

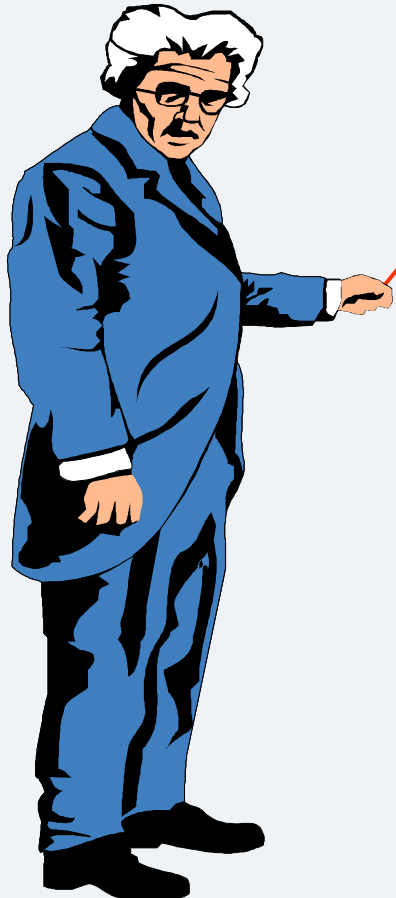


Training



Training subjects include:

- Proper storage, shipping and handling of material, components, and equipment.
- Techniques to control debris.
- Housekeeping.
- Cleaning and inspection of components and assemblies.
- Accountability/control of tools and hardware.



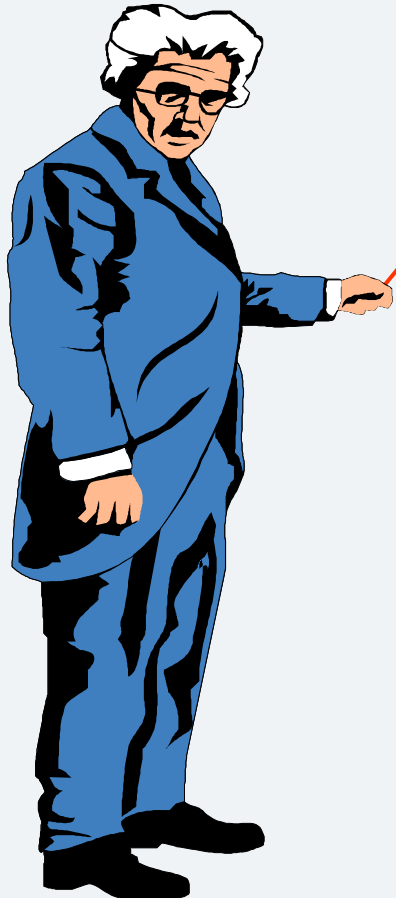


Training



Training subjects include:

- Control of personal items, equipment and consumables.
- Care and protection of end items.
- Quality Workmanship (“Clean-As-You-Go,” inspection).
- Flight line, taxiway and ramp control methods.
- How to report FOD incidents or potential incidents.





Material Handling & Parts Protection



A Well-established plan for material handling and parts protection can eliminate many potential FOD hazards.

First, identify the specifics such as sensitive parts, assemblies, surfaces, areas, etc.

Then, sequence events for packaging, handling, shipping and storage, and finally, evaluate cleanliness and care requirements.



Material Handling & Parts Protection



Example Processes:

- **Materials and accessories used in packaging, handling, shipping and storage should be clean and free of contamination.**
- **Select colors for packaging or protective devices so they don't appear to be a part of what they are protecting.**

- **Use streamers for removal for critical items**
- **Materials should be compatible with the environmental and physical stresses expected to be encountered.**
- **Static sensitive devices should be properly protected to avoid damage.**



Housekeeping



Maintenance, manufacturing and operational areas must remain clean.

Employees should be informed that housekeeping is a part of their job and they will be graded on their performance.

Incorporate “Clean-As-You-Go” to prevent debris from migrating into flight hardware.

FO containers placed in key locations within the work area and at entry and exit points.

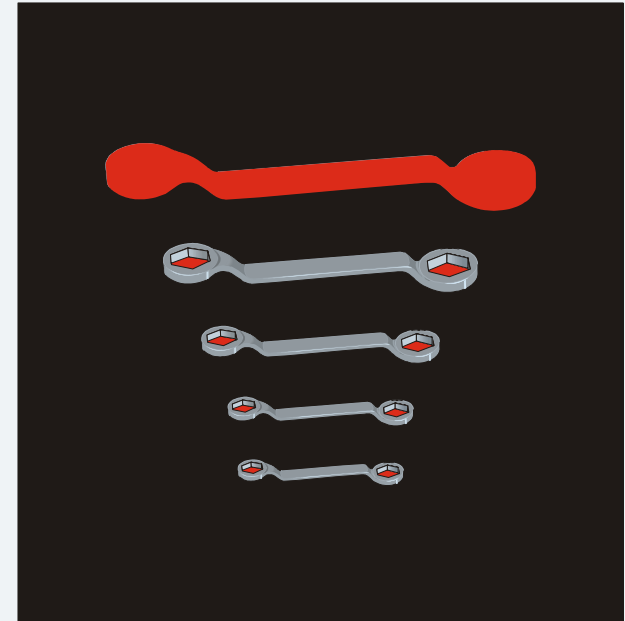


Tool Accountability



Example processes include:

- Shadow boards & shadowboxing
- Bar coding
- Special canvas layouts with tool pockets
- Tool counters
- Chit system
- Tool tags
- Consolidated tool kits.





Hardware Accountability



Example processes include:

- Kit hardware by task.
- “Clean-As-You-Go.”
- Removal/installation paperwork to track loose parts.
- Furnish and specify tote trays.
- Covered spring-loaded containers.

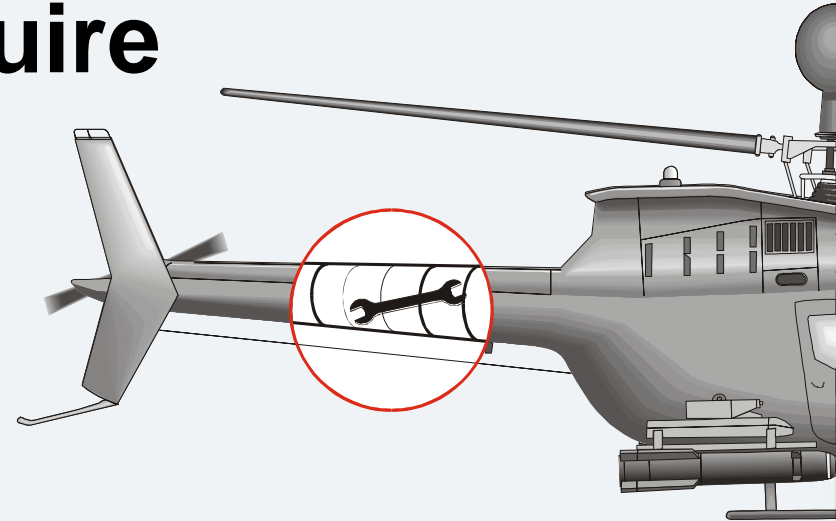




Lost Tool Procedures



- ✓ **Search until tool is found or you're sure it's not on the aircraft**
- ✓ **Searching may require depaneling or NDI**
- ✓ **Annotate incident on aircraft forms if tool is not located**





Hazardous Material



Control of Hazardous waste materials must be addressed in the unit's FOD prevention program.

Consult federal, state and local Hazardous Material Procedures for process requirements.





Physical Entry into FOD Critical Areas



When physical entry is required into the crew compartment, engine intake, exhaust, fuel tank areas, etc., personnel should remove all loose objects, badges, jewelry, etc., from clothing.

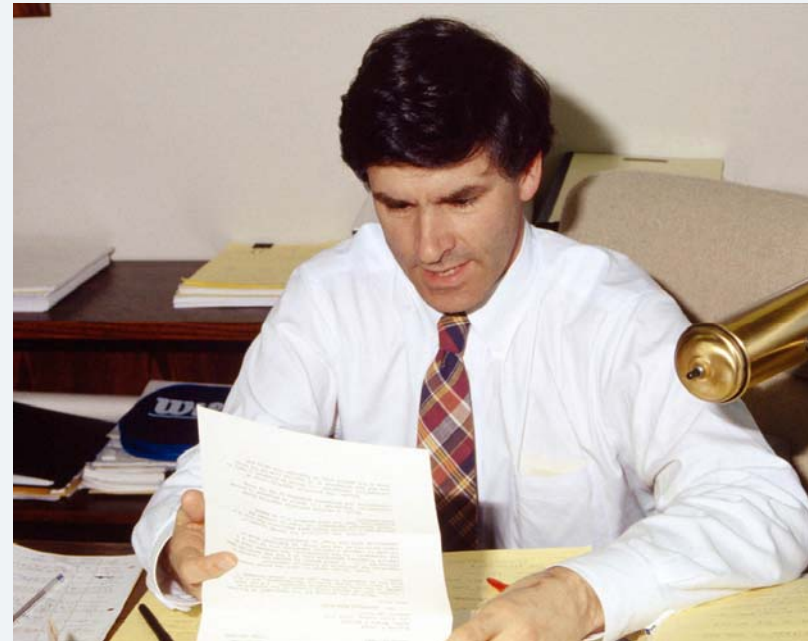
Pocketless or closed zippered pocket coveralls should be worn to preclude foreign objects dropping from pockets onto a FOD critical area.



FOD Focal Point



The focal point(s) should be appointed by the chief operating official and have sufficient authority and organizational freedom to identify and implement FOD preventive measures whenever and wherever required.



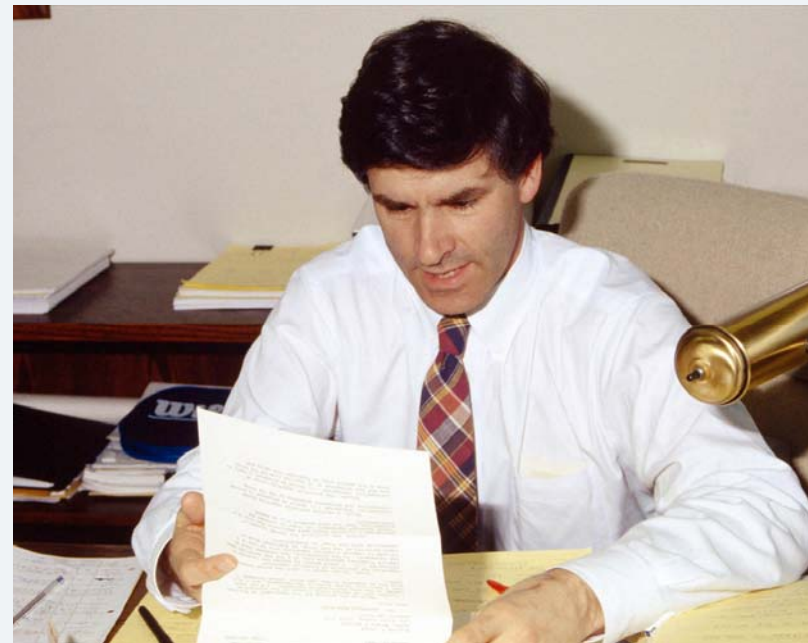


FOD Focal Point



Responsibilities:

- **Conduct FOD Audits**
- **Investigate FOD incidents**
- **Ensure corrective actions address root causes**
- **Oversee overarching FOD prevention training curricula**





Design Considerations



You can reduce the probability FOD will cause damage and eliminate many FOD hazards entirely by addressing FOD in the design process. Design considerations include, but are not limited to:

- **Eliminate FO entrapment areas.**
- **Seal areas through which FO can migrate.**
- **Use screens over exposed openings.**
- **Use blind fasteners in critical areas, such as fuel cells, that are not prone to leaving debris during installation.**



Design Considerations



- **Use fasteners with self retaining features to secure high usage access panels.**
- **Use compatible metals and seals to prevent accelerated deterioration and subsequent failure of seal material.**
- **Use conformal coatings as a positive seal against entry of minute foreign object including dust and water vapor.**
- **Design aircraft inlets to minimize traps where water can collect and freeze. Inlets should be easily plugged and completely sealed against water when plugged.**



Assembly Operations



Plan and sequence maintenance/manufacturing tasks to preclude foreign object damage and entrapment of debris or contamination.





Assembly Operations



Clean or flush the machined components to assure that they're free of debris, and immediately cap or seal exposed openings to deny foreign object entry.

Protect equipment from splatter accumulation during brazing, soldering, welding and like operations.

Always ensure part integrity before installation.

Ensure protective devices (dust covers, temporary seals, cushioning, etc.) are present and properly installed.



Assembly Operations



Inspect for and remove extraneous material as part of the assembly step, conduct a foreign object inspection and remove debris.

Inspect production tooling (jigs, fixtures, handling equipment, etc.). Exercise the same care for work stands, ladders, and special test equipment.

Protect products by using FOD barriers, foam pads, covers, etc.



Test Cell Operations



Inspect the area before introduction of the test article to the test environment to be sure that it is clean, tools are secured, fixtures, dollies and special test equipment are properly prepared and secured, and that the required protective devices (engine inlet screens, covers for engine components and instruments, etc.) are on hand, clean and undamaged.





Test Cell Operations



Prior to start, visually inspect the engine intake/exhaust areas for potential FOD and rotate the engine through sufficient revolutions to ascertain if there is unusual noise or binding condition. Instrumentation lines, hoses and wires should be taped or clamped to eliminate vibratory failure. Use of lock wire or cotter pins for this purpose is prohibited.





Field Operations



Field operation primarily involve scheduled modifications, inspection, care and maintenance of

ramps, structures, runways and taxiways.



Field Operations



- Tarmac repair/inspections
 - Vehicular traffic patterns and controls
 - Sweepers
-
- Support equipment cleanliness
 - FOD control procedures for all personnel, vehicles, equipment and special events having access to the airport operations area.
 - Consider FOD prevention in the design, and construction of all airfield projects.

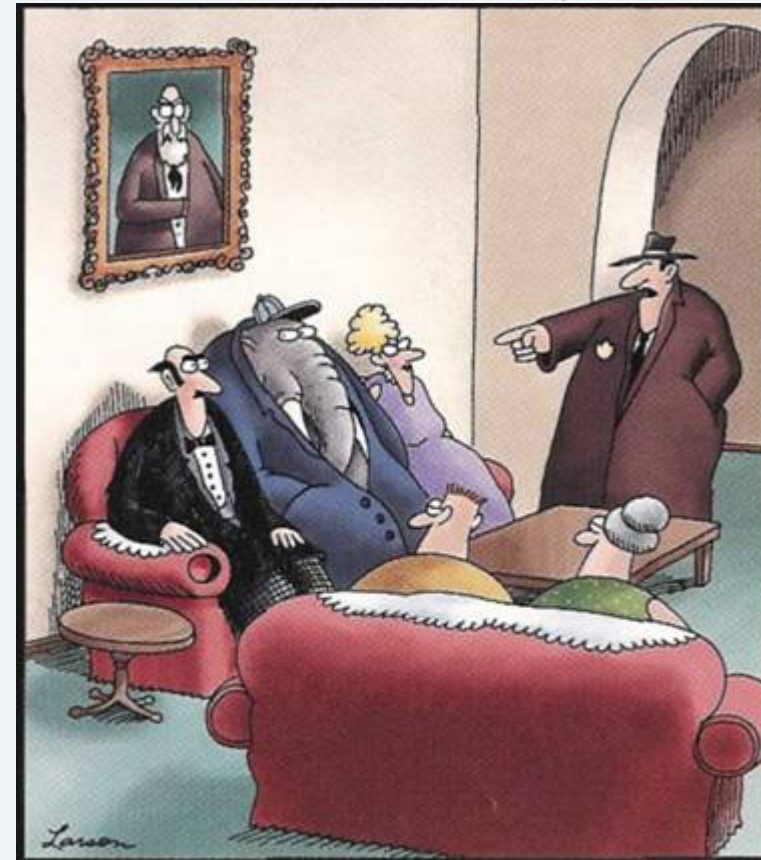


Reporting and Investigating FOD Incidents



All incidents of actual or potential FOD should be reported and investigated.

When a FOD incident occurs, operations should immediately cease and an investigation initiated to determine the root cause



"And the murderer is ... THE BUTLER! Yes, the butler. ... Who, I'm convinced, first gored the Colonel to death before trampling him to smithereens."

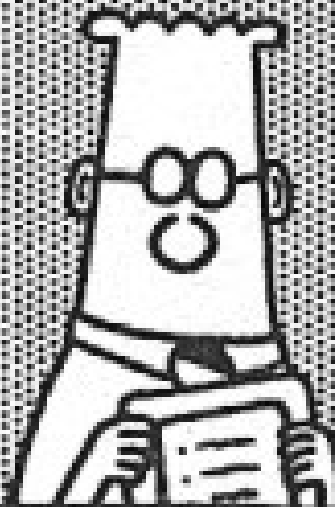


National Aerospace FOD Prevention Inc.

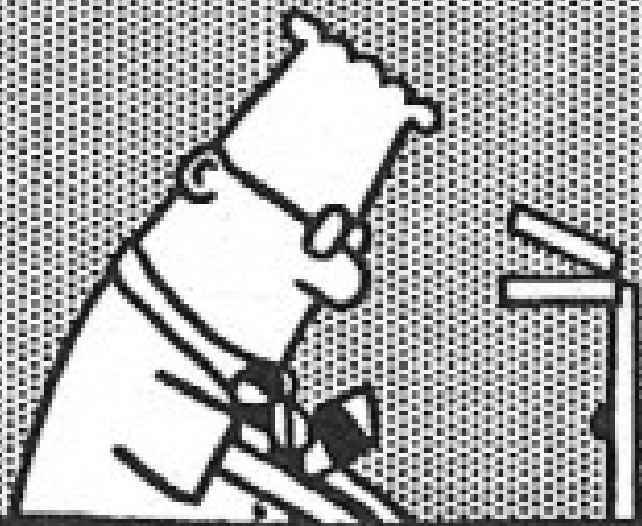


NAFPI is a non-profit, educational organization developed to standardize terms and methods for the prevention of FOD to aircraft and aerospace vehicles. As part of their educational material, they produce a FOD Prevention Guideline which contains the most current and best practices and lessons learned on FOD prevention and is the basis for the periodic update of the NAS 412. To obtain the FOD Prevention Guideline, call 1-800-FOD-1121.

I'VE BEEN ASKED
TO SUMMARIZE
MY PROJECT INTO
THREE BULLET
POINTS.

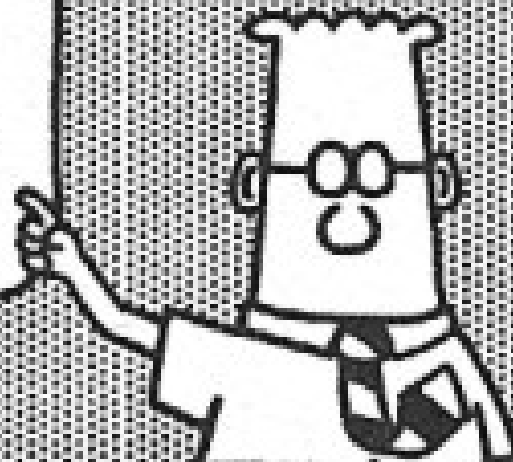


I HAD TO
INVENT SOME
NEW WORDS.



BELIEVE ME, YOU
DON'T WANT TO BE
ANY OF
THESE
THINGS.

- SPLURBY
- NOOBAH
- PIZKWAT





The Real NAS 412 Summary



Today we talked about-

- **Purpose/Goal**
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- **Basic Definitions**
- **Basic FOD & Tool Control Guidance**
- **Specific Program Concepts**





Questions?



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