Foreign Object Elimination

...for the Maintenance Technician

Student Handout
Course Objectives:

1. Establish standard terms and definitions relevant to foreign object elimination and prevention
2. Increase awareness of the causes and effects of foreign object damage
3. Present proven methods and practices aimed at preventing foreign object damage
4. Describe common procedures for reporting and investigating foreign objects and foreign object damage
5. Present case studies and “Lessons Learned” from real-world foreign object damage incidents
6. Prepare for the NCATT FOE Certification Exam

References


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Part 1: Basic Terms and Definitions

Objective: Become familiar with the following terms and definitions related to foreign object elimination and foreign object damage in the aerospace industry.

Critical Terms:

**FO (Foreign Object)** – A foreign object is any alien substance or article which has potential to cause damage to an aircraft, or otherwise diminish safety. Foreign Objects are sometimes referred to as ‘Foreign Object Debris’ with the accompanying acronym FOD. The acronym FOD also represents the term ‘Foreign Object Damage’.

**FOD (Foreign Object Damage)** – FOD is any damage attributed to a foreign object that can be expressed in physical or economic terms, and may degrade the product’s required safety or performance characteristics. The acronym FOD is also used to represent the term ‘Foreign Object Debris’.

**FOD Control Area** – A FOD Control Area, also referred to as a FOD Designated Area, is 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. FOD Control areas are sometimes classified by risk level and divided into tiers such as FOD Awareness areas, FOD Sensitive areas, and FOD Critical areas.

- **FOD Awareness Area** – A FOD Awareness Area is any maintenance or fabrication area within the facility where manufacturing or maintenance requires specific actions.

- **FOD Sensitive Area** – A FOD Sensitive Area is any area where foreign objects could become entrapped or inaccessible within components where maintenance requires specific actions.

- **FOD Critical Area** – A FOD Critical Area is an area which contains an aircraft major assembly or in which the assembly or disassembly of engines or critical components occurs. Also includes flight lines and any area where aircraft are in place and exposure to foreign objects would potentially cause a system failure due to deterioration, malfunction, or damage.

**FOE (Foreign Object Elimination)** – Foreign Object Elimination is a program or process used to eliminate damage due to foreign objects. This is sometimes referred to as a FOD Prevention Program.

**Potential FOD** – Potential FOD is the condition where foreign objects may cause damage or failure should the product or aircraft be put into use.

**Critical FO** – Critical FOD is any foreign objects in an area from which migration is possible and will likely cause system or component malfunction should the product be put into use.
General Terms:

5-‘S’ Philosophy – A method adopted from Japanese culture for housekeeping and organization

Aircraft Operations Area – An Aircraft Operations Area is any ramp, flightline, or tarmac area where aircraft are taxied, or where aircraft engines are operated.

Chit System – A Chit system is a means of controlling tools using small non-metallic tags with an identification number assigned to a specific individual.

Clean As You Go – Clean As You Go is a FOD prevention housekeeping concept which is an ongoing process of removing work debris and keeping the work area clean while performing a task on a product.

Consolidated Tool Kit – A Consolidated Tool Kit is a tool box with a specific set of tools needs for a specific use. CTKs are normally shadowboxed for easy inventory and controlled through one of several sign in/sign out methods.

Consumables – Consumables are supplies provided to workers that are expendable such as issued apparel, safety glasses, glue, paint, sealant, rags, shop towels, brushes, and stock items like rivets, washers, fasteners, drill bits or other expendable tools.

Electronic Tool Accountability System – An Electronic Tool Accountability System is a tool control system that uses electronics devices, such as bar codes and laser scanners, to track and account for tools.

Electrostatic Discharge – An electrostatic discharge is the transfer of static electricity between objects with different electrical potentials.

FOD Bag – A FOD bag is a small canvas or non-metallic bags, usually with a Velcro closure, used to temporarily store work debris and other foreign objects while working in an aircraft.

FOD Barrier – A FOD Barrier is a device used to prevent foreign objects from entering any aircraft, component, or assembly and causing damage or contamination.

FOD Cans – FOD Cans, also called FOD Containers, are receptacles that are strategically placed to provide an easy point to dispose of foreign objects. FOD cans also serve a second purpose in that they serve as reminders to workers to take an active role in FOD prevention. FOD Cans are typically brightly colored for high visibility which increases employee awareness of FOD.

FOD Focal Point – The FOD Focal Point is a person who develops and implements plans and programs to prevent damage to aerospace products. The FOD Focal Point assures that FOD incidents are thoroughly investigated and that incident reports are completed and records are maintained.

FOD Incident Report – A FOD incident report is generated when damage occurs as a result of a foreign object, or when a foreign object is lost or found on an aircraft.
FOD Point of Contact (FOD POC) – A FOD Point of Contact, or FOD POC, is a person in charge of and in direct control of a FOD Controlled Area. The FOD POC is responsible for personnel entry, tool control logs, FOD audits, posting alerts, and initiating FOD Incident Reports.

FOD Walk / Sweep – A FOD Walk or FOD Sweep is a FOD prevention measures consisting of a physical inspection and cleaning of any area including ramp or tarmac areas around hangars, flight line areas, helipads, taxiways, or runways.

Hardware Accountability – Hardware Accountability is any formal system designed to assure that all hardware that goes onboard an aircraft or into a FOD critical area, is removed or accounted for.

Hardware Kit - A Hardware Kit is a pre-assembled kit of consumable hardware which contains the exact amount of hardware needed to perform a specific task.

Hazardous Materials – A substance or material capable of posing an unreasonable risk to health, safety, or property. Also referred to as ‘Dangerous Goods’ which is the international term for hazardous materials.

Housekeeping – Housekeeping is a FOD prevention technique which requires employees to maintain a clean and orderly work area with necessary tools, materials, and equipment in their places of orderly arrangement.

Material Handling – The common practices associated with packaging, shipping, inspecting, and protecting aircraft components and parts.

Material Safety Data Sheet – Documents relating to hazardous materials that contain information on health precautions, flammability, ventilation requirements, and information for health professionals in case of an accident. MSDS are furnished with all hazardous materials and are required by law to be available to all personnel working with the material.

Permanent Tooling – Any work area or facility where construction or work activity is being performed that may result in foreign objects entering a FOD Control Area.

Personal Tools – Personal Tools are any tools used in aircraft maintenance operations that are owned and controlled by an individual maintenance worker as opposed to being owned and controlled by the employer.

Shadowboard – A Shadowboard is a FOD prevention method that uses outlines in the shape of tools on a hanging tool storage board.

Shadowbox – Shadowboxing is a FOD prevention method where toolbox drawers, cabinets, and other tool storage areas are lined with foam and cutout in the shape of each tool creating specific, marked locations for each tool so that a missing tool will be readily noticeable.

Sponge Count – Sponge Count is a formal tool control method where tools are counted prior to entering a FOD Critical Area and when leaving a FOD Critical Area to ensure that no tools are left behind following the completion of a maintenance activity.
Tether – A tether is a lanyard of sufficient strength, attached to a tool and to the user or a fixed secure object. The tether should be of minimum length to prevent damage from a tethered tool’s “free swing.” A tether device, if not regularly examined and properly secured, may become a foreign object itself.

Tool Bag – A tool bag is a small zippered bag used to transport tools from an inventoried tool box onto an aircraft to perform a task.

Tool Control – Tool Control is any formal system designed to ensure that each tool carried onboard an aircraft, or used in a FOD critical area, is removed and accounted for.

Tool Inventory Sheet – A tool inventory sheet is a log used to document all tools, equipment, or personal items a person has in his or her possession when entering and leaving a FOD Controlled area.

Tote Tray – A tote tray is a device for storing, carrying, or transporting tools or equipment in a secure manner to prevent inadvertent dropping.
Part 2: Causes and Effects of Foreign Object Damage

Objective: Be able to identify the four categories in which foreign object damage occurs and determine which categories are most critical for a mechanic or technician. Be able to analyze an aircraft accident report and determine the way in which the FOD occurred.

Causes

Foreign object damage primarily occurs in one of four ways:

- Aircraft contacting foreign objects
- Aircraft ingesting foreign objects
- Foreign objects left inside aircraft
- Foreign objects migrating into aircraft

Aircraft contact with foreign object

A lot of people first think of foreign object damage being caused by aircraft coming in contact with a foreign object such as a bird strike or a tire being cut from running over debris on the runway. Although this is a common occurrence, maintenance operations have little effect on preventing this type of foreign object damage. Bird strikes are mainly avoided through pilot awareness and visual observation; removing debris from runways and taxiways is normally the responsibility of airport operations and managers. However, maintenance personnel need to be aware of this potential because sometimes the debris left on the runway or taxiway is a direct result of maintenance operations. For example, panels that are not secured can fall off or parts can separate from the aircraft and become foreign objects as a result of improper maintenance.

Elements of weather are also considered Foreign Objects. Snow, rain, hail, wind, and ice are foreign to the aircraft, and can cause damage. This form of damage can occur in-flight or on the ground. Hail can damage the wing surfaces of an aircraft which requires either resurfacing or replacing the wings. Severe wind and tornadoes destroys aircraft when it tosses small aircraft across parking ramps. Another foreign object which can cause damage to aircraft is volcanic ash which is extremely corrosive. Contact with volcanic ash can quickly deteriorate the leading edges of wings and other aircraft surfaces.

Case Studies:

1. Air France Flight 4590 (Concorde Crash), July 25, 2000 (Paris, France)
2. Piaggio P-180, 2011 (Grand Rapids, Michigan)

Foreign object ingested into critical area

The second form of foreign object damage is foreign objects being ingested into critical areas such as aircraft engine inlets. Just like the previous cause, foreign object debris left on a runway, taxiway, or ramp area can result in foreign object damage through ingestion. Volcanic ash is a concern again as it can cause serious damage to an aircraft engine.
While the main concern with FOD from ingestion is surface debris like broken pieces of concrete or small rock pebbles that migrate onto taxiways or ramp areas, the foreign object could also be part of an aircraft that has fallen off and now becomes a foreign object to another aircraft.

Case Studies:

2. British Airways Flight 9 “The Jakarta Incident” June 24, 1982 (Jakarta, Indonesia)

Article Review:

1. *The Many Faces of FOD* by Bob Baron (FOD News)
2. *Engine Inlet Barrier Filters* by Fred Polak (HeliMX, October 2011)

*Foreign object migrating into critical area*

In addition to foreign objects being left in critical areas, sometimes objects can migrate to a critical area inadvertently. For example, a piece of tape can stick to the bottom of a person’s shoe as they walk through an office area. It may then fall off when that person is walking out on the ramp area when aircraft are parked and operated. That foreign object could then be sucked into the intake of an engine and cause damage to the engine. Another example is when a technician sets an instrument panel screw on a glare shield or pedestal. The glare shield and pedestal are certainly not areas where a screw can cause damage, but the screw could roll down and fall into an area where control cables and pulleys are located. Now the foreign object is in a FOD critical area and could potentially cause damage.

Case Studies:

1. Beech 65, April 12, 1995 (Great Bend, North Dakota)
2. Ayres S2R-G10, June 13, 1997 (Biggers, Arkansas)
3. Stinson 108-1, October 22, 2008 (Concrete, Washington)

Article Review:

1. *You pick: Cheap Lesson or Expensive Mishap* by LCDR Chris Plummer, USN

*Foreign object left in critical area*

For maintenance operations, foreign objects left in critical areas is the biggest concern. This is also the most preventable cause of FOD if the right prevention measures are established and followed. Foreign objects that are commonly left in critical areas include tools, flashlights, pens, pencils, rags, shop towels, screws, nuts, washers, and even personal items like keys or sunglasses. Several examples of this type of foreign object damage are provided in upcoming case studies.

Case Studies:

1. UH-60 “Blackhawk over Iraq”, August 22, 2007 (Kirkuk, Iraq)
Effects

As a result of foreign objects, aircraft can be damaged, personnel can be injured, and FOD can also lead to loss of life. There are other effects from foreign object damage as well such as lost revenue when aircraft are grounded.

Most FOD incidents result in significant damage to aircraft. Sometimes an engine needs to be replaced or a piece of equipment needs to be repaired, but in many cases, multi-million dollar aircraft are destroyed as a result of foreign object damage. For example, U.S. Airways Flight 1549, the “Miracle on the Hudson”, resulted in a complete loss of a Boeing A320 aircraft valued at nearly $60 million dollars. Damage to aircraft and equipment can be quantified and the total damage can be defined as a dollar value. However, not all costs can be measured or defined. For example, a FOD incident resulting in a grounded aircraft could mean lost revenue for the aircraft owner or operator, insurance costs may increase for the shop where a FOD incident occurred and in the case of military aircraft, a grounded aircraft means degraded military readiness and strength. In many cases, contract pricing is increased to account for costs associated with FOD which affects profitability. For some shops, the costs resulting from a FOD incident can easily lead to the demise of the business.

The ultimate cost in FOD incidents is loss of human life, like when the Concorde crashed in Paris in 2000. Not only was the aircraft destroyed, which cost £23 Million (U.K. Pounds) in 1977, but 113 people died as well. A price cannot be placed on loss of life, the worst type of FOD incident.

The importance of being aware of the potential for FOD is critical in day-to-day maintenance operations. The smallest of foreign objects can cause substantial damage and lead to injury or loss of life if not caught in time. Consider the following examples of small foreign objects causing big problems...

Case Studies:

1. Piaggio P-180, December 13, 2010 (Columbus, Ohio)

Article Review:

1. Suit blames negligence for crash of Black hawk by Star-Bulletin Staff (August 12, 2008)

FOD Incidents

April 12, 1995: Great Bend, North Dakota. A Beech 65 twin engine aircraft experienced an in-flight loss of power and subsequently crashed into terrain killing the pilot and destroying the aircraft. The cause of the loss of engine power was small pieces of metal separating from the induction duct entering the engine and causing catastrophic failure.
June 13, 1997: Biggers, Arkansas. An Ayres S2R-G10 crop duster was destroyed when making an emergency landing following an in-flight loss of power. The cause of the loss of engine power was a blocked fuel line resulting from a small piece of silicone rubber in the fuel line. Luckily, no one was injured in the crash.

June 25, 2002: Ontario, California. An MD-369E helicopter experienced a catastrophic engine failure after take-off forcing the pilot to perform an emergency autorotation landing. The helicopter hit the ground hard and was consumed in a post-crash fire. Both the pilot and passenger were seriously injured. The cause of the engine failure was found to be the clipped end of a plastic tie wrap that somehow entered the engine during maintenance.

June 15, 2005: Anchorage, Alaska. An Aerospatiale ATR-42-300 was substantially damaged following a lightning strike during descent for landing. The aircraft’s electrical systems were knocked offline with only partial recovery prior to landing. The aircraft’s left aileron suffered damage from the lightning strike as well and had to be replaced. The pilot was able to safely land the aircraft without further incident.

June 20, 2007: Fergus Falls, Minnesota. An Air Tractor AT-301 was damaged as a result of a forced landing following a severe engine vibration. During landing, the aircraft flipped over and the pilot was able to escape with only minor injuries. Investigators found the propeller was missing a section of blade approximately 9-inch long. The propeller was further examined in a lab with the findings of the damage to be consistent with the impact of a foreign object.

October 22, 2008: Concrete, Washington. A Stinson 108-1 aircraft collided with trees and was destroyed during an emergency landing following a loss of engine power. The cause of the engine malfunction was determined to be a short section of rope that was inadvertently left in the engine compartment and migrated to the carburetor air intake which restricted the air flow into the carburetor.
Part 3: FOD Prevention

Objective: Be able to describe the various methods in which foreign object damage can be prevented. Be able to identify the FOD prevention method a specific practice is an example of.

In this section of the training, several methods of FOD prevention will be identified and explained in great detail. In many organizations, a combination of these methods will be used to create an effective FOD prevention program customized for that organization’s specific activity. However, many aviation maintenance facilities have not implemented any type of FOD prevention methods, practices, or processes. These organizations are at risk of FOD-related incidents and the effects that result from those incidents. If you work in a shop that does not practice FOD prevention, you will at least have the knowledge of the various FOD prevention methods and you will be able to follow these methods on your own to ensure that you are not the cause of a FOD incident.

The FOD prevention practices that will be covered in this training are Housekeeping, Tool Control, Hardware Accountability, Material Handling, Physical Entry and Personnel Control, and the most important and effective prevention measure… Attitude.

Housekeeping

Housekeeping is the responsibility of employees to maintain a clean and orderly work area with necessary tools, materials, and equipment in their places of orderly arrangement. In simpler terms, housekeeping is organization. If your tools are neatly arranged in a toolbox rather than scattered all over your work area, not only are you preventing foreign object damage, you are also making yourself a more efficient maintenance technician. You will no longer spend countless hours searching for things, or more accurately, searching for the last place you left something. Housekeeping, as it relates to foreign object elimination, incorporates some methods and philosophies that help you stay organized and introduces work practices that will help you keep your work area clean and orderly.

These methods, philosophies, and work practices are “Clean-As-You-Go”, the 5-S Philosophy, FOD Containers, FOD Bags, Permanent Tooling, and Aircraft Operations Areas.

Clean-As-You-Go

Clean-As-You-Go is an on-going process of removing work debris and keeping the work area clean while performing a task. The key points of the Clean-As-You-Go philosophy are:

- 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 or give the appearance of poor workmanship
- Clean the immediate area after work is completed and prior to inspection
- Clean the work area at the end of each shift
- And most importantly… If you drop something or hear something drop - pick it up!
Whether you work on a flight line, in a hangar, in a shop, or anywhere else around aircraft, your immediate work area should be kept clean. A messy area, littered with loose objects, creates a potential for FOD. Those loose objects can migrate into a FOD critical area in an aircraft. Remember, a FOD Critical Area is any area where foreign objects can cause a system failure. Keeping a work area clean includes sweeping or vacuuming periodically and storing tools and parts in their designated locations.

Clean-As-You-Go programs provide an ongoing process of removing work debris as it accumulates and keeps the work area clean while tasks are being performed. Paperwork is a necessary part of our jobs that is used to document work, look-up parts, make notes, or reference when performing a task. Items used to handle paperwork include office supplies such as paper, pens, pencils, staples, paperclips, and binders, all of which can become Foreign Objects themselves. Controlling loose office supplies is an important element of the Clean-As-You-Go philosophy.

The last element of Clean-As-You-Go is... “If you drop something, or hear something drop, pick it up.” Whether you dropped an item, you see something drop, or you hear something drop, take the time to search for it right away. You’re chances of finding a dropped item are greater immediately after it happens. If you keep working and plan on finding the item later, you may forget that you dropped something, forget where it dropped, or it may migrate somewhere other than where it dropped. If you can’t find your lost item, ask for help. Sometimes a second set of eyes is all it takes to spot something that is out of place. If you still can’t find it, don’t be afraid to report it to your FOD Point of Contact. It’s better to report the lost item than to release an aircraft only to have it crash.

5-S Philosophy

The 5-S Philosophy is a method adopted from Japanese culture for housekeeping and organization. The 5-S philosophy is used in many FOD programs because good housekeeping processes and habits have a significant positive impact on FOD prevention. The basic principle of a 5-S concept is organizing a work area by first sorting all the tools and equipment, then straightening them or establishing a logical grouping or location for each item. Shine means to keep all the tools and materials clean and free of foreign material like oils, grease, or adhesives. Standardize is to set up similar work areas with identical equipment and tool locations. This helps keep the work areas clean since each tool can be found and stored in an identical location when working at different work stations. Sustain means to place tools and equipment back in their proper location, keep tools clean, and keep the work area neat and orderly.

Sometimes, organizations use a sixth S which is added to stress the importance of Safety. The ‘Safety S’ is used to remind workers to take corrective action if something is potentially unsafe. For example, if a tool has a gouge with a sharp edge that could possibly cut someone’s hand, the tool should be repaired or replaced.

FOD Containers

FOD cans and containers are strategically placed in or around FOD designated areas and provide an easy means of discarding any foreign objects found or produced during aircraft maintenance activities. The containers are normally brightly colored and well-marked for easy identification, and should feature a spring-loaded, self-closing lid. These containers increase FOD awareness and help remind workers to properly discard foreign objects. The main point of using FOD cans or FOD containers is that this practice prevents foreign objects from migrating to
other areas, potentially causing foreign object damage. In a FOD prevention culture, it is everyone’s responsibility to use FOD cans and containers to discard foreign objects.

**FOD Bags**

A FOD bag is slightly different than a FOD can or FOD container in that a FOD bag is a small container, normally made of canvas with a Velcro cover, used to temporarily store foreign objects until they can be placed in a FOD can for permanent disposal. Some organizations also use FOD bags for special purposes like storing personal items such as keys, loose change, sunglasses, jewelry, or even security badges. Whether storing personal items, work residue, or other foreign objects, the main purpose of FOD bags is to provide an easy and convenient means of storing items until they can be properly taken care of. One purpose that FOD bags should not be used for is storing or transporting tools. You will learn the proper methods for transporting tools in the Tool Control section of this training course.

**Permanent Tooling**

Permanent tooling refers to construction or work activity of facilities or work areas. This could be in the form of converting a storage area into a battery shop or tool crib. It may also be in the form of making improvements such as painting the hangar or installing new lighting. When the construction or improvements are complete, the entire area should be cleared of foreign objects and potential FOD before the area is put into use. This is accomplished by inspecting, sweeping, cleaning, and inspecting again. This practice prevents foreign objects from migrating from these areas into FOD critical areas. Remember, workers who perform the construction tasks may not be thinking about their work residue or trash migrating into a FOD critical area, especially if their primary job is construction and not aircraft maintenance. In a FOD prevention culture, it is everyone’s responsibility to think of the potential of FOD and foreign objects.

**Aircraft Operations Areas**

The housekeeping principles you just learned primarily apply to your immediate work area. However, keep in mind that the ramp or aircraft operations area may also be your responsibility. The airport management team is responsible for ensuring that runways and taxiways are free of FOD, but each company or FBO operating on the airport is responsible for its own ramp or flightline area. Keeping your aircraft operating area free of FOD is part of the housekeeping principles. Remember that “Clean-As-You-Go” includes the philosophy, “if you drop something, or hear something drop, pick it up.” If you see a foreign object lying on the ramp or flightline, “stop and pick it up”.

In some cases, your company may also require periodic or daily FOD walks in which personnel walk along the entire aircraft operations area and pick up any foreign objects they find. These measures have a significant impact in reducing FOD. New ideas are modernizing this concept with efficient and effective products such as FOD sweepers that are pulled behind vehicles. The investment in this type of product allows one employee driving a vehicle to cover a large area in a shorter amount of time compared to numerous employees walking along an entire ramp or flightline.
Tool Control

Tool Control is any formal system designed to ensure that each tool carried onboard an aircraft, or used in a FOD critical area, is removed and accounted for. Tool control methods include: Sponge Count, Shadow Boards, Shadowboxes, Consolidated Tool Kits (CTK), Tool Inventory Sheets, Chit Systems, and Electronic Tool Inventory systems. In addition to these methods, there are several common work practices that help prevent FOD such as using tethers, inspection of tools, and handling disposable tools and consumables as inventoried items.

Sponge Count

Sponge Count refers to a process where tools are counted before and after a task is performed to make sure that the same number of tools is removed from a FOD critical area as entered a FOD critical area. Advanced sponge count processes also include identification of the tools that were used to make it easier to find a lost tool. This process has been adopted from the medical industry where the sponge count method is used in surgical rooms. The medical industry uses this procedure to ensure that all surgical materials that are taken into a surgical operation area are properly accounted for at the end of the surgical procedure, thereby preventing FOD, such as a sponge or surgical tool from accidentally being left inside a patient. In aviation, the sponge count method helps prevent tools from being left inside an aircraft.

Shadow Board

A Shadow Board is a storage board that features specific, marked locations, such as outlines in the shape of a tool, for each tool that belongs on the storage board. Using this method, a storage board can be inventoried in just a few seconds so a missing tool is readily noticeable. This method is primarily aimed at visually determining when a tool is missing. This method is often used in conjunction with a sign in/sign out method and a tool inventory method.

Shadow Box

A Shadow Box is typically a toolbox with specific, marked locations, such as foam cutouts, for each tool in each drawer of the tool box. Similar to shadow boards, this method allows you to visually inventory the tool box drawer in seconds and a missing tool will be readily noticeable. Using the shadow box method, an entire tool box can be inventoried in 60 seconds or less. Shadow boxing with foam cutouts is very popular and is used not only in large roll-around tool boxes, but also in small hand-carry tool boxes that are carried on board an aircraft.

Consolidated Tool Kits

Also known as “CTK”, Consolidated Tool Kits are specific tool boxes with all tools inside assigned to that specific tool box. The tools in the kit are typically marked with an identification that matches the tool box itself. The tool box is normally shadowboxed with foam cutouts for easy inventory. Consolidated tool kits can be large roll-around tool boxes or small hand-carry tool boxes. The main goal of using the CTK system is that a specific inventory of tools is always maintained because only the tools in the consolidated tool kits will be used in the shop. This is primarily used where employers provide technicians with the necessary tools needed to do their job. When using the CTK system, personal tools such as flashlights or multi-purpose tools, are not accounted for in the system and
therefore, should not be used. Consolidated Tool Kits are usually stored in a tool crib when not in use and signed out by a technician during the work shift or when needed.

**Tool Bags**

A tool pouch or tool bag is a canvas or non-metallic bag that is used to transport a small, inventoried set of tools into and out of a FOD critical area. Tool bags are often part of a consolidated tool kit and used for convenience by a technician. For example, let’s say a technician needs to climb into the tail of an aircraft to replace the ELT. It would not be practical or safe to bring an entire toolbox full of tools into the tail of the aircraft as this could present a major foreign object potential. Let’s say a technician only needs two wrenches, one screwdriver, safety wire, safety wire pliers, and a flashlight. He or she can remove those tools from the shadowed tool box, and place those tools in a tool bag. The tool bag should have a closure of some type, such as Velcro or a zipper, to prevent tools from falling out of the bag. When the technician climbs into the tail of the aircraft, he or she is of course going to also have a FOD bag to store work debris as learned about in housekeeping. When using a tool bag, the tools that are placed in the bag should be either inventoried or counted (Sponge Count method). The technician is now ready to perform the work, taking only the necessary tools and materials into the FOD critical area, and storing any work debris in the FOD bag. When finished, the tools are removed from the tool bag and either inventoried or counted, depending on the tool accountability method used. The tools are then replaced in their proper storage location which, if shadowboxed, will provide additional confirmation that no tool was left behind.

**Tool Inventory Log**

Written Tool Inventory Logs are lists of tools that are “checked in” when entering a FOD critical area, and “checked out” when leaving the FOD critical area. The lists used in this method are sometimes expanded to include personal items as well. This method is very effective but takes a little extra time to accomplish.

Let’s run through a scenario. You’ve been tasked to perform a periodic test on the emergency power supply of several helicopters. Before entering the first helicopter, you stop and fill out a tool inventory sheet. You enter your name and employee number, the registration number or aircraft serial number of the helicopter you are entering, then list every item you are taking into the helicopter with you. This includes anything in your pockets such as tools, pens, glasses, badges, and all other items not secured to your body. For the change in your pocket, you would list, one quarter, three dimes, and two pennies as separate line items. After listing all your tools and belongings, you can enter the helicopter and perform the test. When leaving the helicopter, you must check each line item on your tool inventory sheet, confirm that you still have the item in your possession, then check off the item on the sheet. After accounting for all items on the sheet, it is turned in to the FOD supervisor for that area for accountability. If any items are missing, you will know right away and can search for it immediately, before the helicopter is returned to an airworthiness condition. The FOD supervisor for each area is responsible for checking each tool inventory sheet and keeping them on file.

This method may seem like a tedious precaution, but imagine working without this method and performing maintenance on several helicopters before realizing at the end of your shift that you have lost your car keys. You would have to search all the helicopters you performed maintenance on instead of just one. Also, several helicopters would now be grounded instead of just one. Hopefully none of those helicopters had been returned to service and taken off with your car keys somewhere on board. The extra minute it takes to fill out the tool
inventory sheet when you enter and exit an aircraft is considerably less than the time you would spend searching for lost items, not to mention the risk of causing an aircraft to crash due to FOD.

**Chit System**

A chit is an assigned identification tag issued to a technician displaying a control number. The tag, or chit, is put in place of a tool when the technician removes the tool from its storage place. For example, a maintenance technician needs to use a torque wrench for a specific task. The technician will locate the torque wrench in the storage cabinet or large roll-around toolbox which is, of course, shadowboxed with foam cutouts. The technician will remove the torque wrench, and place a chit with his or her assigned number in place of the torque wrench. When the tool box is inventoried, such as at the end of the work shift, the missing tool will be easily noticed due to the foam cutouts, and... the chit will identify the technician who has the tool. Chits can also be used to designate that a tool is out for repair or calibration. When using a chit system, a technician is often assigned a specific number of chits which are treated as an inventoried tool itself. The chits must be accounted for to prevent the chits from becoming foreign objects themselves. It is the responsibility of every technician to control their chits, especially in FOD designated areas. To make a chit system effective, it is imperative that every technician follow the one-for-one policy of removing a tool and replacing the tool with a chit.

**Electronic Tool Accountability System**

Electronic Tool Accountability is a system where tools are signed in and signed out using a computer. This is typically accomplished using laser scanners and bar-coded labels affixed to each item much like at a grocery store. Advanced systems can also scan or swipe a technician’s ID or security badge to link the tool to the technician. This also method makes it easy to remove a tool from service for calibration or repair, and trace missing tools to the technician that last used the tool.

**FOD Prevention Practices**

**--Tether**

A Tether is a lanyard of sufficient length and strength that is secured to a technician, structural work stand, or other suitable location at one end, and is attached to a tool at the other end. The tether should be long enough to perform the necessary work, but short enough to prevent damage if the tool is inadvertently dropped and the tool swings on its tether. Tethering prevents the tool from being dropped into an area where it cannot be easily retrieved such as inside an engine nacelle. One caution when using tethers is that the tether and its related hardware can become FOD if it is not regularly examined for damage and wear, or if it is not properly secured.

**--Inspection**

Inspecting tools to make sure they are in serviceable condition is important in preventing FOD. Chrome flaking is a common occurrence that leads to the flaking pieces of metal becoming foreign objects and causing damage. Ratchets have many small moving internal parts and if the ratchet is not inspected regularly, the ratchet could break and those small parts can become foreign objects. A periodic visual inspection of your tools to make sure
they are not broken or worn will help tremendously in preventing FOD. Any damaged tools should be replaced or repaired immediately, before being used on an aircraft.

**--Disposable Tools**

Some tools used in aircraft maintenance are considered disposable and must be controlled more carefully because they are easily overlooked. This includes drill bits that become dull and apex bits that become worn or break. Some organizations even include safety wire spools and rags as tools with respect to accountability. In such a case, the roll of safety wire would be assigned to a technician and properly identified as belonging to that technician. The spool of safety wire would then be inventoried and controlled just like the rest of the technician’s tools. In the case of rags, a technician would have to sign out a rag or specific number of rags, and would be responsible for turning in the same number of rags after a job is complete or at the end of the shift, regardless if it’s clean or dirty.

**--Personal Tools**

In many organizations, the use of personal tools, such as multi-purpose tools or miniature flashlights, is strictly prohibited. This is because personal tools are not accounted for in the tool control systems. If you work in an organization that does not provide tools for you to use, your personal tools should be accounted for in a controlled manner using one of the methods you’ve just learned. Some companies may even require your personal tools, in your personal toolbox, to be shadowed with foam cutouts for ease of inventory. You may be required to mark each of your tools with a unique identification for traceability of the tool back to your toolbox. You may also be required to maintain an inventory sheet of all your tools and perform regular inspections for damage or other potential FOD hazards. Always make sure you are following the guidelines found in your company’s FOD Prevention Program.

**Summary**

All these tool control methods may seem like they are time-consuming and inefficient but the reality is that FOD is a serious risk to our industry and the only way to prevent FOD is if we all take proactive measures to eliminate the risks before incidents occur. Once you have effective tool control methods in place, the time it takes to maintain the tool control process is far less than the time you might spend looking for lost tools. The cost of maintaining your tool control program is significantly less than the cost of a single FOD incident involving an aircraft.

**Hardware Accountability**

Hardware Accountability is any formal system designed to assure that all hardware that goes onboard an aircraft or into a FOD critical area, is removed or accounted for. Hardware is a general term for all the small components such as nuts, bolts, screws, and washers used to assemble and maintain aircraft and their components. There are four main hardware accountability methods: ‘Kitted Hardware’, ‘Hardware Removal, Control, and Replacement’, ‘Hardware Storage’, and ‘Hardware Containers’.

**Kitted Hardware**

A Hardware Kit contains the exact amount of hardware needed to perform a specific task. For example, to install a mounting tray on an equipment shelf in an aircraft, the task may require 6 screws, 6 washers, 6 nuts, and the mounting tray itself. The hardware kit the technician is given will contain only 6 of each piece of hardware. The
common practice of having extra hardware “just in case” is going by the wayside because that practice is not conducive to preventing foreign object damage. Use of kitted hardware ensures the technician has no spare hardware, and must use all of the hardware that is provided in the kit to successfully complete the task. Leftover hardware is an indicator that hardware has been lost; it is readily noticeable because the task will be incomplete. Early recognition that hardware has been lost brings about early reporting of the lost hardware and immediate follow-up.

**Hardware Removal, Control and Replacement**

If hardware is removed during maintenance, alteration or other task, the removed hardware must be controlled and accounted for. Procedures used to control and account for removed hardware may differ from one organization to another, but established procedures must be followed to ensure the removed hardware does not migrate to a FOD critical area or cause foreign object damage. Failure to follow established procedures is often a major contributor in FOD incidents.

Let’s look at an example of when we might need to control hardware when it is removed from an aircraft. Let’s say you’re tasked to remove the wingtip of an aircraft so it can be repainted. To accomplish the task, you must remove thirty screws and washers, or 60 total pieces of hardware. During this task, you must account for and control all thirty screws and all thirty washers at the end of the removal process. Since the wingtip will be reinstalled at a later date, the hardware should be placed in some form of a hardware container or storage bag depending on the established procedures of your organization. Even if you plan to use new hardware when the wingtip is reinstalled, you must account for the old hardware and replace them with new items when you reinstall the wingtip. This procedure ensures that the removed hardware is controlled, and properly disposed of, to prevent it from causing FOD.

**Hardware Storage**

During the manufacture, maintenance, repair or alteration of an aerospace product, assembly or vehicle, it is critical to have hardware contained in a manner that does not promote migration to a FOD Critical Area. As hardware storage moves closer to FOD designated areas, greater preventive and control methods must be implemented. Hardware should remain in an isolated area and transported to a work area by methods established in the company’s FOD control program.

**Hardware Containers**

Hardware containers, such as Tote Trays, are covered containers used for storing, carrying, or transporting hardware in a secure manner. Hardware containers or tote trays normally feature spring loaded lids that prevent hardware from falling out inadvertently. Open containers or loosely held hardware increases the risk of the hardware becoming lost or causing FOD. Consider the time and effort that would be required if you had a container of 50 washers and that container was accidentally knocked over in the flight deck of an aircraft. Those washers would fall in every direction and find their way down inside the control cable area or other critical area of the flight deck. A spring-loaded lid on that hardware container would have prevented the wasted time and effort of finding all 50 washers.
Material Handling and Hazardous Waste

Not all foreign object damage occurs on the aircraft. Foreign objects can damage aircraft components before they are installed as a result of improper handling. Often, personnel that are responsible for handling parts, including packaging, shipping and storage of parts, are not necessarily aviation maintenance professionals trained in FOD prevention. This leaves the potential for mistakes to be made. The following guidelines will help prevent foreign object damage caused by improper handling.

Material Inspection

Aircraft maintenance professionals must be extra diligent in inspecting parts and components for foreign objects, contamination, or damage, before installing those parts on an aircraft. When parts are packaged, care should be taken to prevent parts from making contact with each other. This prevents damage to the parts which could produce foreign objects either internally or externally.

When unpackaging a part, it should be inspected for any nicks, dents, abrasions, scratches, or other evidence that a foreign object may have damaged the part. Sometimes, the packaging material itself can become FOD. For instance, cardboard boxes are secured with tape. When removing the tape, it should be properly disposed of to prevent it from becoming FOD. Other parts may be shipped in wooden crates or containers in which the container hardware, such as nails, screws, and plastic or metal strapping, can become foreign objects if not properly controlled and disposed of.

Material Storage

When storing parts, the most protective method is to keep the parts in their original shipping containers until they are to be installed in the aircraft. The problem is that this consumes extra storage space which is often undesirable in a warehouse or storage environment. If parts will be stored without their original shipping containers, care should be taken to ensure FOD barriers or other protective devices remain intact to prevent foreign objects from contaminating the part during storage.

If a part is removed from an aircraft temporarily while other maintenance is being performed, it should be protected in a similar manner such as storing the part in an area free of foreign objects and protecting the part from potential contaminants.

FOD Barriers

FOD Barriers, or other protective devices, should be used to cover any exposed opening where packaging material could enter the part or assembly and potentially cause damage. FOD barriers and other protective devices must be chosen carefully for proper design and fit. FOD Barriers which fit loosely may fall off the part or assembly, thereby losing their effectiveness. Loose FOD Barriers that separate from the part can also become foreign objects themselves.

When unpackaging a part in preparation of installing it in an aircraft, the part should be carefully inspected and all FOD Barriers should be removed just prior to the time of installation. Often, FOD barriers fit best inside fittings or
openings but may not be visible at first glance. If not carefully removed, the FOD barriers can cause a failure of the part or system as the FOD barrier has now become a foreign object.

FOD barriers are also selected for their “visibility,” meaning how noticeable the FOD barrier will be in contrast to the equipment it is protecting. FOD barriers will typically be a bright or highly visible color so they do not appear to be part of the component they are protecting.

FOD barriers should also be controlled and accounted for as if they were hardware. For example, if a part contained 5 FOD barriers when it was packaged, those 5 FOD barriers should be controlled and either discarded if they are not to be reused, or installed onto the part that is being removed from the aircraft. When possible and appropriate, the same packaging container should also be reused to package and ship the removed part.

**Aircraft Protection**

Another form of FOD barrier is used on aircraft to protect the aircraft itself from foreign objects. Common protection against FOD on an aircraft is foam pads over wings where work is being performed. This prevents tools from scratching or damaging the surface of the wing. Often, plastic is placed around aircraft entrances to protect high traffic areas from damage. Drop-clothes or runners are often placed inside aircraft to help protect the carpet from dirt and grease. These measures are all effective steps in preventing the aircraft from being damaged by foreign objects but care must be taken to ensure the protective materials do not become FOD.

**Electrostatic Discharge (ESD)**

Another FOD hazard related to material handling is electrostatic discharge, also referred to as ESD. Electrostatic discharge occurs when a static charge builds up on a part or structure then comes in close proximity to a charge of opposite potential. This is just like walking across carpet then touching a metal structure; a small spark is sometimes produced. These small sparks can damage electrical or electronic components. For this reason, electrostatic discharges are considered a foreign object which has the potential to cause damage.

While working on and around aircraft, ESD can be minimized by touching a grounding point to neutralize any built-up static charge prior to handling ESD sensitive parts. This is also a good practice to use prior to entering an aircraft to prevent damage to internal components. Another ESD preventive measure is to use FOD barriers. Often, FOD barriers are placed over electrical connectors on parts and assemblies, not only to prevent contamination of the electrical connections, but also to prevent ESD from damaging the internal electronic components of the part. In addition to using FOD barriers, some ESD sensitive parts may be packaged and stored in special ESD bags. Parts stored in an ESD bag should remain in the bag until it is to be used. This prevents damage to the part during storage and handling of the part.

**Hazardous Waste**

Hazardous materials must be properly handled to prevent damage to aircraft, equipment, and personnel. If not handled properly, hazardous materials can contaminate, damage, or destroy parts and assemblies, and can also result in injury or other health related issues to workers. Whenever working with hazardous materials, make sure all precautions listed on the Material Safety Data Sheet, or MSDS, are followed. Hazardous Materials must also be
disposed of properly to make sure they do not contaminate the environment. In addition to the guidelines found in the MSDS, also check local, state, and federal laws related to hazardous waste and disposal.

**Physical Entry and Personnel Control**

A FOD Designated Area is any area where foreign objects can potentially cause damage to aircraft or cause an aircraft system failure. For maintenance operations, this may include engine inlets and exhausts, fuel tanks, or may even include an entire hangar where aircraft are stored or maintained. Certain work areas such as engine overhaul areas, battery stations, or avionics shops may also be considered FOD designated areas.

Depending on the organization, FOD designated areas may be termed or classified as FOD Awareness areas, FOD Sensitive areas, FOD Critical areas, FOD Restricted areas, or FOD Controlled areas. Regardless of what term or classification is used, physical entry into these areas is typically limited to only the personnel that are essential to operations in that area. Access by non-essential personnel is normally restricted to limit the possible migration of foreign objects into these areas.

When physical entry is required into FOD designated areas, personnel should remove all badges, jewelry, and other loose items. Pocket-less or closed zippered-pocket coveralls should be worn to prevent foreign objects from falling out of pockets and into critical areas.

**Attitude**

The most important element of a FOD prevention program is attitude. The right attitude begins with understanding the causes and possible effects FOD can have on an aircraft, to a pilot, to the organization, and to yourself. The worst feeling a technician can have is being the root-cause of an aircraft crash that caused the deaths of hundreds of people. If you take the proper precautions to ensure you aren’t contributing to the FOD problem in the industry, you will be on the right path to a FOD-free environment. The right attitude also starts at the top of the organization. A company’s managers have to take a proactive attitude toward eliminating FOD within the company. Those managers must support those that are performing maintenance on aircraft, handling parts, and investigating incidents.

The right attitude is actively participating in FOD prevention such as picking up foreign objects on the hangar floor, taking a little extra time to control and account for hardware, and making sure you have all your tools before releasing an aircraft for flight. The right attitude is asking a coworker or inspector to check over an area before it is closed up. The inspection is not just for workmanship, it’s also to check for any foreign objects that might be left behind.
Part 4: Reporting and Investigating Lost Items and FOD Incidents

Objective: Identify the relationship of basic facts and state general principles of reporting missing, lost, or found items, the processes used to locate missing items, and follow-up requirements for missing items that are not found.

Lost Items

At the completion of a task, all tools, hardware, and personal items should be inventoried and accounted for. If any item is missing, a search for the missing item should begin immediately. The chances of finding a lost item are significantly greater the sooner the search begins. In most organizations, the search starts with the person who performed the work and was responsible for the item. If that person cannot find the lost item, the incident should immediately be reported to the shop supervisor and, if the item was lost in or near an aircraft, that aircraft should be grounded. The search then continues until the item is found or reasonable assurance is made that the aircraft is safe to release for flight. In addition to the typical visual inspection with flashlight and/or magnets, searching for the item may also include removing access panels or other aircraft components, or even inspections using borescope, X-ray, or other non-destructive testing.

Reporting & Investigating FOD Incidents

Typically there is a documented process of steps covering the reporting and investigation of a lost tool or FOD incident. At most facilities, there is NO disciplinary action for reporting a lost or missing tool or item even if the technician is at fault. Although established as a positive self-reporting method, repeat offenders may face disciplinary action. Also, disciplinary action can be taken against someone who fails to report a lost item, or when an item is found that should have been under that person’s control.

A FOD incident or lost tool report normally contains the following information:

- Date and time of the incident
- Name of the lost item
- Model number and serial number of the part if applicable
- Location of the incident which may be an aircraft or area of the shop
- Who discovered the incident and how
- Who reported the incident
- A narrative description of the incident
- Root cause; and,
- Corrective action

Investigating FOD incidents is normally the responsibility of the designated FOD Focal Point for the organization. That person will review the report, investigate the incident, and determine a root cause of how the FOD incident occurred. The next step is to properly document the cause and effect so it can be used as a “Lesson Learned” for all workers in the organization to learn from. The incident serves as a reminder of “what not to do.” Lessons Learned can also be used in future training and in FOD awareness newsletters.
Another type of Lesson Learned is a near mishap. A near mishap is an incident where damage would have occurred as a result of a foreign object, had the event remained undetected. The gravity of these types of situations is often realized when considering what the effects might have been as a result of the incident, and how close the organization came to a major at-fault incident.
Part 5: Case Studies

Objective: Understand the concept of FOD prevention through the study of real-world examples of foreign objects and foreign object damage.

FOD Case Study #1:

Scenario: Two avionics technicians are working on an installation in a Cessna Citation business jet. The installation involves modifications to the aircraft wiring behind both the pilot and copilot’s instrument panels and side panels below the armrests. One technician is sitting in the pilot’s seat, the other in the copilot’s seat. Each technician is working with their own sets of personal tools.

Dilemma: The technician seated in the pilot’s seat asks the other technician if he can borrow his penlight to be able to see the numbers on the electrical connector better. What is the best response the second technician can give, keeping in mind that the goal is to prevent FOD?

a. “No, you’ll have to go get your own flashlight out of your toolbox.”

b. Make up some excuse like “my batteries are dead” to avoid letting him borrow the flashlight.

c. “Sure, no problem. Just make sure I get it back when you’re done.”

d. Any of these answers are equally acceptable in preventing FOD.

The correct answer is D: Any of these answers are equally acceptable in preventing FOD. Your main concern is that you must account for all your tools at all times. If you refuse to let someone borrow your tools, or make up an excuse to prevent letting someone borrow your tools, you have maintained accountability and control of your tools. Although the first two responses may seem awkward from a social perspective, they are effective in preventing FOD. Answer C would also be acceptable because you are still maintaining accountability of your tools. You know who has your tool and where they are using it. It is also your responsibility to inventory your tools when you have finished your task so before you leave the work area, you will make sure you have retrieved your tool from your coworker.

So answer D is the best answer here. This doesn’t mean that this is the best practice to use though. Let’s see how the scenario plays out.

The technician in the copilot’s seat lets his coworker borrow the penlight saying, “Sure, no problem. Just make sure I get it back when you’re done.” Both technicians continue to work until break time. Both technicians exit the aircraft, join their coworkers in the break room, and have a cup of coffee. After break, they return to work and the first technician finishes his task just before lunch. He picks up his tools, takes them to his tool box and puts them away. He inventories each drawer and accounts for all his tools. He then moves on to another aircraft to work on more wiring installations. The second technician takes his lunch break and spends the rest of the day working on his task. At the end of the shift, he determines he has 15 minutes of work left to finish up, then clean up and go home. He finishes the work and as he begins to clean up, he gathers his tools and cleans his work area, following the clean-as-you-go philosophy. He then takes a few extra minutes to put his tools away even though he is ready to go home after a long day working in the aircraft. He inventories his toolbox and makes sure that everything is in its place in the shadowboxed drawers and nothing is missing. At home that night, he needs a flashlight and reaches
into his pocket for his penlight and it’s not there. He searches his other pockets and still cannot find it. He thinks back to the last place he used it and suddenly realizes that his coworker never returned it.

In this situation, what is the technician most likely to do?

a. Don’t worry about it; he’s already at home with his family; wait until morning to check on it.
b. Drive back to the shop and search for the penlight where the coworker was using it.
c. Call the coworker at home and ask him what happened to his penlight.
d. Call the shop and have the maintenance supervisor ground the aircraft he was working on for a possible foreign object.

In most situations, the technician would likely not worry about it since he is already at home, off-duty, and therefore, not his problem. This is not the right attitude to have in a FOD prevention culture. What would you do in this situation?

Answers B, C, and D are all good choices. You are taking a proactive approach to preventing FOD by initiating a search for the lost tool or grounding the aircraft until a search can be conducted. Perhaps the most important answer is D which grounds the aircraft to make sure it is not released for flight until the lost tool is found. The most effective action you can take is all three: B, C, and D. However; in this scenario, the technician has a nice dinner, watches some TV, then goes to sleep. Now let’s see what happens the next morning at work.

The technician asks his coworker the next morning if he still has the penlight he borrowed yesterday. The coworker says he gave it back while they were in the aircraft. The technician doesn’t remember him returning the penlight and they go back and forth, each insisting that the other one has the penlight. Finally, the technician storms off to search his toolbox and work area to verify that he doesn’t have it. He can’t find it anywhere. He then searches the cockpit of the airplane they were working in. It’s not lying around and it didn’t roll underneath either of the seats. The night shift crew has already reinstalled some the interior including the armrest panels where they were working. The instrument panels have been put together and the aircraft is scheduled to be delivered to the customer later that day.

At this point, the technician has searched his toolbox, his work area, and the aircraft. Still, there is no sign of the penlight. What do you think the technician is most likely to do?

a. Notify his supervisor that he lost a tool and that it could be on the aircraft scheduled for delivery today.
b. Submit a purchase requisition to have the company buy a new penlight to replace the one he lost.
c. Make a note to buy a new penlight; letting anyone else know about it might make him look bad and might affect his performance review.
d. Don’t worry about it… it’s just a penlight.

Many technicians might think that they will get in trouble for losing a tool or that it may make them look bad on their performance review. FOD prevention programs are not effective unless employees are not afraid to report missing items. In fact, they should even be recognized or rewarded for speaking up and doing the right thing. Although the technician in this case should notify his supervisor of the lost tool, he will most likely go buy a new flashlight and not say anything at all. The consequences of this action are that the technician is putting many
people at risk. First, releasing the aircraft with a lost penlight somewhere in the cockpit may cause a wiring short leading to an in-flight fire and subsequent crash, or could jam the flight control cables causing the pilot to lose control of the aircraft leading to a crash. The lives of the pilots and passengers are now in jeopardy along with potential victims on the ground wherever the aircraft crashes. Second, the technician is also putting himself at risk. In the unfortunate event of a crash of this aircraft, the investigation will reveal that work was recently performed and the investigators will interview everyone who had contact with the aircraft, including the coworker who remembers borrowing a penlight and returning it, only to be accused of not returning it. When the investigators determine that the crash was caused by FOD and name the technician who lost a tool during the recent maintenance activity, the technician is at risk of losing his job, being charged with manslaughter and serving time in prison, and being sued by the victim’s families. This would essentially end his career in aviation and most likely have a profound effect on his family.

So the technician didn’t notify his supervisor and the aircraft was delivered on-time to the customer. Everyone is happy. The technician bought a new penlight, but, he is not necessarily happy. Every day, he thinks about that aircraft he was working on when he lost his penlight. He still has no idea if the penlight is on that aircraft or not. He still doesn’t remember the coworker returning it and think he may still have it somewhere. The technician tries to focus on his work but he is continuously stressed about that aircraft. Even at home, he is short-tempered and doesn’t sleep well. He realizes that not reporting the lost penlight was the wrong decision but what can he do about it now. Well, he can’t do much about what happened, but he can take a look at what he did and learn from it. This is what we call a “Lesson Learned”. Which of the following preventive measures do you think the technician should implement to prevent this situation from happening again?

a. He should never loan out tools to coworkers ever again.
b. He should create a method of having coworkers “Sign Out” tools they borrow and require them to “Sign In” the tool when they return it.
c. He should improve his tool inventory process by doing a tool sponge count every 30 minutes while working inside an aircraft.
d. He should include his penlight in his inventoried set of tools.
e. He should start using a tool bag that is controlled through an inventoried list of the tools in the bag or by sponge count.

These are all good answers but one answer in particular identifies a mistake the technician made right from the start. Remember when he inventoried his tool box after he was done working and accounted for all his tools? Then at home that night, he needed a flashlight and went to get his penlight out of his pocket only to discover it wasn’t there? That’s right… he never had his penlight included in his inventory list or in his shadowboxed tool chest! He never had control and accountability of the penlight because he felt it was just a common tool he uses on every job and he uses it so much, how could he ever lose it? Besides, it’s just a penlight. It’s not a real tool that belongs in the tool box. You can see how this mistake was the root cause of the problem. After all, the technician did appear to be conscious of FOD. His tool chest is shadowboxed and even though he worked a little overtime and wanted to go home, he still took a few extra minutes to inventory his tools before going home.

Before we go on, let’s look at the rest of these answers to see how effective they would be. Answer A is he should never loan out his tools to his coworkers. This would certainly increase his control of his tools but he better make
sure he has every tool he ever needs because his coworkers will not likely let him borrow any of their tools as a result. Answer B is to have coworkers sign out and sign in tools they borrow. Another effective tool control solution but may come across as over-controlling to the coworkers. Answer C is to do a sponge count of his tools every 30 minutes while working in an aircraft. This is also an effective solution and may have prevented losing the tool by keeping better control of his tools while working away from his main tool chest. Answer D, include his penlight in his tool inventory process is a definite requirement to prevent this from happening again. And answer E, use an inventoried or sponge counted tool bag when working inside an aircraft, would also be effective and probably would have prevented losing the penlight, provided that the penlight was included in the inventory list or sponge count for the tool bag.

Now let’s see what happens next to our technician who lost his penlight.

Two months has gone by since the unreported lost tool incident. The technician has taken extra measures to ensure his tool accountability process is effective and has no loopholes. He still thinks back to the day he lost his penlight and is now questioning that maybe his coworker did return the penlight and maybe, just maybe, he was using it afterwards and dropped it himself on the copilot’s side where he was working. He remembers searching primarily on the pilot’s side since he was sure at the time that his coworker had lost the penlight. A sigh of relief escapes him as he shows up for work one morning and sees a familiar tail number up in the front of the hangar. The aircraft has returned and is scheduled for some short maintenance before departing again later in the day. The technician immediately lets the maintenance supervisor know that he needs to remove the copilot’s armrest panel to check for something, possibly a lost tool. The maintenance supervisor has no problem with the request so the technician jumps in and removes the armrest panel. Sure enough, he finds his penlight lying on a metal frame. He inspects the rest of the armrest area to make sure there are no other foreign objects before reinstalling the armrest panel. He notifies the maintenance supervisor that the aircraft is back together and he found the lost item. No harm done… this time.

Now here’s another problem. The maintenance supervisor has been trained that any foreign object found on an aircraft must be reported and investigated so he fills out a report. The FOD Focal Point starts investigating and interviews the technician who by now is so relieved that nothing happened to the aircraft, he explains the whole story. The FOD focal point has a responsibility to follow the processes and procedures, including any disciplinary action, as noted in the company’s FOD prevention policy. The policy states that disciplinary action will be taken against anyone who fails to report a lost item on an aircraft, but no disciplinary action will be taken if an employee reports a lost item prior to the aircraft being returned to service. Given the circumstances, what is the appropriate disciplinary action the FOD Focal Point should take?

a. The technician clearly failed to report the lost item so he should be fired.
b. The technician failed to report the lost item but the aircraft did not crash so he should only be reprimanded.
c. The technician found the item before damage occurred so he should only be given a warning.
d. The technician has demonstrated a positive attitude toward preventing FOD, has already taken corrective action on his own, and took the initiative to find the item when the opportunity presented itself so no disciplinary action should be taken and this event should be used as a “Lesson Learned.”
As with many disciplinary actions, several factors can be taken into account. Any of these answers could have been justified by the FOD Focal Point, but remember that one main goal of a FOD prevention program is to encourage employees to not be afraid to report lost items in fear of disciplinary actions. Answers A, B, and C all would have discouraged the technician from reporting a lost item in the future. Had another maintenance worker found the item and reported it, the technician would have been at least reprimanded, if not worse. Because the technician himself took the initiative to find the item and had demonstrated both a positive attitude toward FOD prevention, and incorporated several FOD prevention practices in his daily work routine, special consideration by the FOD Focal Point would be appropriate in this case.

As you can see, the incident has been used as a Lesson Learned and presented as a case study for you to learn from. This case study was based on actual events in which the outcome was identical. The lost penlight was found when the aircraft returned months after the initial incident. No one was hurt, no damage occurred, and no one was fired. Not every event has a happy ending like this one.
Summary

Throughout this training course, you’ve learned what FOD is and you’ve learned the definitions of key terms related to FOD. You’ve seen the causes and effects of foreign object damage in terms of costs, damage, and loss of life. You’ve learned the principles of Housekeeping like “Clean as you go”, the use of FOD bags and FOD containers, and you learned about the 5-S philosophy. You’ve seen various tool accountability methods such as shadow boxing, tethers, chits, and consolidated tool kits. You now know the procedures for reporting a lost tool and for entering FOD critical areas. You also learned how to properly handle, store, and ship items to prevent FOD. We finished up with a case study on the importance of reporting lost items. Most importantly, you now know that preventing FOD is all about having the right attitude.

Remember, FOD costs money and lives. Also remember, most FOD is preventable!