

## What is FOD?

Foreign Object Debris (FOD) can be as simple as a nut, a piece of concrete, a piece of paper, a stone, a suitcase handle, a screwdriver or a passenger. Throwaway items are inherently dangerous. In the working environment of an apron, they contribute to the damage or potential damage to aircraft, ground equipment and perhaps even endanger life.

Foreign Object Debris can lead to Foreign Object Damage.

## Examples of FOD

- Aircraft parts, rocks, broken pavement, ramp equipment, and vehicle parts: Damage usually occurs when the aircraft is taking off or landing. The intake suction from a jet engine is powerful enough to suck up loose material lying on the runway, and the winds created by a helicopter or prop-driven aircraft's rotors or by a jet blast can send such objects airborne, creating hazards to nearby personnel.
- Parts from ground vehicles
- Garbage, maintenance tools, etc. mistakenly or purposely deposited on tarmac and/or runway surfaces.
- Hail can break windshields and damage or stop engines.
- Ice on the wings, propellers, or engine intakes
- Dust or ash clogging the air intakes (as in sandstorms in desert operating conditions or ash clouds in volcanic eruptions).
- Tools, bolts, metal shavings, lock wire, etc. mistakenly left behind inside aircraft during the manufacturing process or maintenance.

Generally speaking, bird strikes (when an aero plane flies into a bird, the impact can cause severe damage from a bird striking the fuselage, engine, etc) are not considered to be FOD strikes, unless the bird or wildlife was already dead and lying on the operating surface when the strike occurred. Bird strikes are treated separately.

All aircraft occasionally lose small metal or carbon parts during takeoff and landing. These parts remain on the runway and can cause damage to tires of other aircraft, hit the fuselage or windshield/canopy, or get sucked up into an engine. Although airport ground crews regularly clean up runways, the crash of Air France Flight 4590 demonstrated that accidents can still occur: in that case, the crash was said to have been caused by debris left by a flight that had departed only four minutes earlier.

On aircraft carriers, as well as military and some civilian airfields, sweeps are conducted before flight operations begin. A line of crewmen walk shoulder to shoulder along the flight operations surfaces, searching for and removing any foreign objects. The objects removed are often also referred to as "FOD" although they haven't caused any damage. In this context a more appropriate translation of the acronym would be "foreign objects and debris".

**In the case of the downed Air France Concorde in 2000, the source of FOD was from another aircraft.**

**Air France sues over Concorde**

"Air France today launched legal action against Continental Airlines for sparking the tragic chain of events that caused its Concorde crash, in which 113 people died.

French accident investigators believe a 16-inch-long shard of metal that fell from a Continental DC-10 jet on the runway of Paris's Charles de Gaulle airport was at the origin of the July 25 disaster.

The suit was based on an article in the civil aviation code that "makes a carrier fully responsible for objects which fall from its planes", an airline spokeswoman said.

Preliminary results of the official enquiry by France's BEA air accident investigators suggest the crash was caused by a metal strip left on the runway, which then caused a tyre blow-out and a chain reaction leading to a fire engulfing the plane's left side.

The plane spun out of control as the pilot tried to land at a nearby airfield, crashing into a hotel in the airport town of Gonesse.

BEA investigators also discovered a piece similar to the strip was missing from a DC-10 belonging to Continental Airlines flight COA55, which took off from Charles de Gaulle airport for Newark, New Jersey, shortly before Concorde.

In a statement earlier this month, Continental admitted French and US experts inspecting the DC-10 had found that a piece "of a similar shape" to one found on the runway was missing from the plane.

Continental Airlines has not issued a statement concerning the Air France or German legal actions."

*(Source: Associated Newspapers, Ltd., Sept. 28, 2000)*



## Foreign Object Debris and Damage Prevention

Foreign object debris (FOD) at airports can cause damage that costs airlines, airports, and airport tenants millions of dollars every year. FOD is any object that does not belong in or near airplanes and, as a result, can injure airport or airline personnel and damage airplanes. A FOD-prevention program of training, facility inspection, maintenance, and coordination between all affected parties can minimize FOD and its effects.

Foreign object debris (FOD) at airports includes any object found in an inappropriate location that -- as a result of being in that location -- can damage equipment, airplane or injure airport personnel. The resulting damage is estimated to cost the aerospace industry \$4 billion a year. Airports, airlines, and airport tenants can reduce this cost by taking steps to prevent airport FOD. FOD includes a wide range of material, including loose hardware, pavement fragments, catering supplies, building materials, rocks, sand, pieces of luggage, and even wildlife. FOD is found at terminal gates, cargo aprons, taxiways, runways, and run-up pads. It causes damage through direct contact with airplanes, such as by cutting airplane tires or being ingested into engines, or as a result of being thrown by jet blast and damaging airplanes or injuring people. A program to control airport FOD is most effective when it addresses four main areas:

### **(i) TRAINING**

All airport personnel should receive training in the identification and elimination of FOD, including the potential consequences of ignoring it.

Effective training should stress employee and passenger safety, the hazards to equipment, the direct costs associated with FOD damage, and the indirect costs associated with flight delays and rescheduling. It should also include procedures for removing and eliminating FOD at its source, and should be reinforced through the use of posters and signs. Recurrent training is necessary to help maintain an awareness of FOD.

Training is a tremendous awareness tool that is not always given the priority and forethought it deserves. It is an opportunity to highlight areas needing improvement, reinforce some of the rules that are not always being adhered to, introduce new initiatives, and applaud accomplishments.

For instance, elements of new employee training should include:

- The definition of FOD. Don't assume everyone knows what Foreign Object Damage is. Show photos of FOD and pass around samples of debris found at your facility.
- Identify the FOD SOP (Standard Operating Procedure) and provide a copy of the FOD procedure to each new employee.
- Emphasize the importance of "Clean-As-You-Go" and define the rules that apply to daily work routines.
- Review tool and hardware rules, to include tool crib issued items.
- Review the Missing Item Report, when to use it and how to submit it.
- Identify FOD control areas. Show examples of typical FOD charts/metrics.
- If a borescope is available at your site, discuss who may use it, and general safety rules.
- Also identify other specialized tools used to locate or remove foreign objects.
- Explain the role of the FOD department and how to contact a representative if needed. Put out the Welcome Mat.

Formal certification in FOD elimination covers knowledge of the following areas:

- Basic Terms & definitions
- Housekeeping
- Tool Accountability
- Hardware Accountability
- Lost Items
- Physical Entry & Personnel Control
- Reporting & Investigating
- Material Handling
- Parts Protections
- Hazardous Materials
- Wildlife / Environment
- FOD Effects.

### **(ii)INSPECTION**

Airline personnel, when feasible, should join the airport staff in daily airside inspections. This practice helps increase familiarity with local airfield conditions, and promotes effective communication between the airport and airlines.

The International Civil Aviation Organization (ICAO) require a daily, daylight inspection of airplane maneuvering areas and removal of FOD. In addition to performing these inspections at the beginning of the day or shift, personnel on the airside should look for FOD during their normal shifts.

Ongoing construction requires more frequent inspections. It may even be necessary to assign dedicated personnel to continually inspect for FOD during major construction activities. Flight crews should report to air traffic control and station operations any FOD they observe on runways and taxiways. Airlines and airplane handling agents should designate individuals to inspect gate areas prior to airplane movement to and from the gate.

### **(iii) MAINTENANCE**

The control of FOD includes using several methods:

Sweeping: Sweeping may be done manually or with the airfield sweeper, which is the most effective equipment for removing FOD from airside. The sweeper removes debris from cracks and pavement joints, and should be used in all areas except for those that can be reached only with a hand broom. All airside areas, including aircraft maneuvering areas, aprons and gates and the areas adjacent to them, should be swept routinely. The areas in which ground support equipment (GSE) is staged should be swept periodically.

Magnetic bars: These bars can be suspended beneath tugs and trucks to pick up metallic material. However, the bars should be cleaned regularly to prevent them from dropping the collected debris. Vehicles operating on the airside should be inspected periodically to ensure that they have no loose items that can fall off.

Rumble strips: Driving over rumble strips dislodges FOD from vehicle undercarriages. The strips, which are 10 to 15 ft long, can be moved and used at transitions from the landside to the airside, or adjacent to airside construction areas.

FOD containers: These containers should be placed at all gates for the collection of debris. The containers should be emptied frequently to prevent them from overflowing and becoming a source of FOD themselves. In addition, airport personnel can wear waist pouches to collect debris.

Evaluating the debris collected in containers and pouches can reveal its sources and indicate where personnel and equipment should be deployed for more effective control.

Other means for preventing FOD damage include wind barriers and netting to restrict the movement of airborne FOD, fencing to prevent animals from entering the airfield, and well-maintained paved surfaces. If damaged pavement cannot be repaired immediately, airplanes should take an alternate route.

**(iv)COORDINATION**

Airports with an Airside committee of airport representatives tend to control FOD more successfully than those without such a committee because the representatives can address local conditions and specific problems. At airports served by multiple airlines, the airlines should have these representatives as well as an airport user's committee to coordinate FOD control efforts among themselves.

Both airside and landside construction activities, as well as scheduled maintenance, should be communicated to airport users as early as possible. Airport preconstruction planning should include a means for controlling and containing FOD generated by the construction. This is especially true in high-wind environments where debris is more likely to become airborne. Access to and from construction sites should avoid areas of aircraft operation. Contractors must fully understand the requirements and penalties incorporated in their contracts regarding the control and removal of FOD.

**FOD and Maintenance Costs**

FOD AND MAINTENANCE COSTS	
<p>The effect of Foreign Object Debris (FOD) on maintenance costs can be significant. For example, the cost to repair a FOD-damaged engine can easily exceed \$1 million. FOD can also incur extensive indirect costs, including:</p> <ul style="list-style-type: none"> <li>• Flight delays and cancellations, leading to a loss of customers.</li> <li>• Schedule disruptions caused by the need to reposition airplanes and crews.</li> <li>• Potential liability because of injury.</li> <li>• Additional work for airline management and staff.</li> </ul> <p>The cost of repairing FOD damage to an engine can easily exceed 20 percent of its original purchase price.</p>	
Purchase cost of MD-11 engine	\$8-10 million
Purchase cost of MD-80 engine	\$3-4 million
MD-11 engine overhaul to correct FOD damage	\$500,000-1.6 million
MD-80 engine overhaul to correct FOD damage	\$250,000-1.0 million
MD-11 fan blades (per set*)	\$25,000
MD-80 fan blades (per set*)	\$7,000
*Fan blades are balanced and replaced as a set.	

## **RESPONSIBILITY FOR PREVENTING FOD**

The two main parties with a role in preventing foreign object debris (FOD) and the potential resulting damage are airports and airlines.

**ICAO Annex 14 Recommendation**, Pavements-paragraph 9.4.2 states, "The surface of pavements (runways, taxiways, aprons, etc.) should be kept clear of any loose stones or other objects that might cause damage to airplane structures or engines, or impair the operation of airplane systems." The regulatory agencies of many countries have adopted this statement by ICAO as a requirement.

**SOURCES OF FOD:** foreign object debris (FOD) comes from many sources. The most common are: Airport infrastructure, Normal airplane operations and Personal belongings.

**Airport infrastructure:** The deterioration, maintenance, and construction of the airport infrastructure can contribute to FOD. For example, pieces of concrete can break loose from holes in pavement or from fatigue corner cracks, and building materials can fall from construction vehicles or be blown from gate areas onto airplane maneuvering areas. Broken pieces of pavement can collect at the edge of the gate area and be carried onto the airplane maneuvering area by the tires of vehicular ground support equipment (GSE). Service roads that cross taxiways should be monitored closely to prevent the vehicles using these roads from moving FOD onto the taxiways.

**Normal aircraft operations:** Refueling, catering, cabin cleaning, and baggage and cargo handling can produce broken materials. Baggage pieces, including bag tags and wheels, can break off luggage and either fall onto the apron or collect in the door sill. Items collected in the door sill can damage the door or prevent it from fully sealing. They can also be knocked out of the sills and onto the apron at the next station. Other areas where FOD is likely to collect include the ground at both ends of the conveyor, and the area between the baggage cart and the conveyor belt.

Maintenance activities at the gate require a variety of small objects, such as rivets, safety wire, and bolts that become FOD when they are inadvertently left behind. An effective tool control program will reduce the number of missing hand tools.

Aft galley catering operations through the aft main deck door can be a potential FOD hazard to a rear-mounted engine not protected by an inlet cover. Without the cover, catering supplies can be set down in the engine intake, where they can be inadvertently left behind. These supplies can also fall or spill their contents into an unprotected engine.

FOD can collect both on and below ground support equipment stored or staged adjacent to the gate area. Jet blast can then blow FOD onto personnel or an airplane. It can also create runway FOD when an airplane transitions from the runway onto a taxiway. Outboard engines blow any loose dirt and materials from the shoulder and infield areas back onto the runway. Also, the outboard engines of four-engine airplanes can move debris from the runway edge and shoulder areas, where it tends to accumulate, back toward the center of the runway or taxiway.

Helicopters that maneuver over freshly mowed or loose-dirt infield areas can also move FOD onto runways, taxiways, and ramps. In addition, the rotor wash from a helicopter can propel lightweight GSE or materials staged nearby.

**Personal belongings:** Pens, coins, identification badges, hats, soda cans, paperwork, and any other object that airport or airline personnel carry can become FOD if inadvertently left in an inappropriate location.

### **Wildlife Hazard**

Many bird populations are increasing, and air travel is on the upswing. With more birds and airplanes in the air, strike hazard remains significant. A new report analyzing 14 years of data involving more than 9,000 airplane-damaging bird strikes documents the annual toll: some 118,000 hours of aircraft downtime and \$100 million in monetary costs. The actual cost could be far higher, given that only 20 percent of bird strikes are reported. The toll might well amount to nearly 600,000 hours annually of aircraft downtime and \$500 million in costs.

More than 90 percent of the strikes occur at altitudes below 3,000 feet. Bigger birds inflict a disproportionate amount of damage on aircraft. Canadian geese, weighing between 8-10 pounds, are involved in 5 percent of all reported bird strikes but represent nearly 20 percent of the strikes causing damage.

Significant problems occur with airports where the grounds were or have become nesting areas for birds. While fences can prevent a cows or goats from wandering onto a runway, birds are more difficult to control. Often airports employ a type of bird scaring equipment that operates on propane to cause a loud enough noise to scare away any birds that might be in the vicinity. Airport managers use any means available (including trained falcons) to reduce bird populations

Airport managers need to minimize habitat on their grounds that are attractive to birds, and which tend to act as "bird magnets." It is recommended that land-use beyond the airport perimeter fence should be incorporated into a local wildlife management program



Wetlands, waste-disposal facilities and wildlife refuges can attract hazardous wildlife. Such land uses are often incompatible with aviation safety and should either be prohibited near airports or designed and operated in a manner that minimizes the attraction of wildlife.

### **FOD Prevention Programs**

The Ultimate FOD Prevention campaign should include:

- FOD-themed posters, signs and large banners and other visual aids displayed in critical work areas and places where employees are likely to gather;
- Jackets, caps, coffee mugs, water bottles and other usable items with [FOD] logos affixed, which can be given away as “prizes” for good FOD-prevention performance;
- FOD Walks, in which personnel walk shoulder-to-shoulder, working together to pick up FOD.
- “FOD Awareness Week”, a week-long schedule of events – such as training sessions and FOD control equipment displays – targeted to get the workforce involved and increase their knowledge of the FOD Program.