

FOD Forensics



By Alex Lusk

CSI Miami, CSI NY and CSI (Crime Scene Investigator) are popular television shows, but have you heard about CSI FOD? It's a term that many use for FOD forensics. An ongoing effort to find the root causes of FOD incidents.

The crime scene: a multi-million dollar aircraft unable to perform its mission. The criminal, in this case, is foreign object debris—a.k.a. FOD. The innocent victim is a very expensive aircraft engine that has been damaged by an unknown or unidentified assailant—a foreign object. The FOD CSI team needs to identify the suspect and eliminate the source, so another expensive aircraft engine doesn't fall prey to this indiscriminate criminal.

The victim may have suffered only a small nick to a blade, requiring just a minimal amount of blending, or it could lead to a Class A mishap or any category between. FOD endangers the aircraft, the crew, and even people or property on the ground.

FOD or foreign object debris causes a lot of damage each year to engines. In fact, about 400 engine repairs are done each year because of FOD. This number doesn't include those mysterious "compressor internal failures."

FOD costs Naval aviation about \$90 million each year, and that amount only includes the engine repair costs, not organizational labor hours to remove and replace the engines, labor for conditional inspections usually required as a result of an engine change, cost of readiness or labor hours spent cannibalizing parts from a down aircraft to make another one RFT (ready for tasking).

Other victims include maintainers, QA and safety personnel, who spend hours filling out reports and doing investigations. The list of reports involved: engine FOD incident reports (mandatory report...regardless of other reports submitted), hazardous material reports, engineering investigations, BASH reports, hazard reports, safety incident report's, mishap data reports, and JAG investigations. On the maintenance side, more paperwork and time is required: VIDS/MAFs or work-orders to remove and replace the engines, conditional inspections required as a result of the engine change, and man-hours expended to replace and repair the engine. Squadron readiness suffers with the aircraft down for an unscheduled engine change, along with the impact unscheduled maintenance will have on your scheduled maintenance plan and operational commitments.



Naval aviation FOD-prevention efforts include: Daily flight line or deck FOD walk-downs, monthly or quarterly air station base-wide FOD walk-downs, tool-control programs, fastener awareness/integrity programs, piece-part-and-rag accountability programs, clean-bird inspections, FOD squads, vacuum and sweeper trucks, and some commands and stations have purchased the FOD BOSS. Yet with all that we do, the assailant that causes FOD often goes unidentified and can continue to inflict damage.

FOD forensics can help our FOD detectives identify these culprits. Historically 70-to-75 percent of FOD reports are reported as “cause/source unknown.” The problem is obvious: If we don’t know the source, how can we eliminate it?

One company, FAST—Failure Analysis Service Technology, Inc., has been working with NAVAIR to identify the offending criminals that cause FOD damage. The company has perfected a non-destructive method to identify the source material. The procedure uses a DNA sample or fingerprint, of sorts, that the offending debris leaves behind as it travels through the engine. The FAST FOD procedure looks at the microscopic bits left at the impact site. It exploits the chemical differences between various materials. For example, engine materials are different than aircraft materials, which are different than non-aircraft materials.

Just as in the CSI television shows, we start with pictures of the crime scene. We get the “big picture” photos of the damaged area and then move in for the close-ups. A ruler or other measuring tool is used to establish the scale of the damage for the photos. We then start looking for the most forward damage to the engine. This part can be tricky because that damage may not be obvious or even possible to see looking down the intake. Depending on the size of the engine

or extent of the damage, the first impacts may not be accessible or even visible until the victim is examined and disassembled at the intermediate maintenance activity or Fleet Readiness Center. The first visible impact may actually be on the aft side or pressure face (concave side) of the blade. Using a special replicating tape supplied with the FAST FOD sample kit, a control sample is taken from an undamaged area. Samples, called replicas, then are taken from the most forward damaged areas. Usually about four samples from the damaged areas are sufficient. The replicating sample will remove microscopic particles that the offending object leaves in the damaged area. The most forward area of damage is important because as the foreign object or objects travel down the engine, bits of blade and/or vane material also will travel down the engine, causing more damage and leaving secondary trace particles. After the sample replicas are taken, they are sent to FAST for intensive analysis, using a scanning electron microscope to identify the chemical properties or forensic evidence of the FOD. Photographic evidence then is used to evaluate the geometric characteristics of the physical damage, which reflects the geometry or shape of the FOD at the time of contact. FAST will then provide analysis results, usually in about five working days. The crime lab (FAST) identifies the suspect; however, our FOD CSI team must do the detective work to determine the source.

NAVAIR’s propulsion and power engineering group (AIR 4.4) is funding a fleet FOD forensics demonstration program, in coordination with CNAF N422, to evaluate the effectiveness of the FAST procedure in identifying the source of unknown FOD.

Although this technology sounds new, it actually has been around for almost 15 years. FOD forensics provides another tool in our FOD prevention toolbox and a scientific approach to fight the FOD problem. ✦

Alex Lusk works at NAVAIR (AIR 4.4.7.2) at Patuxent River, MD.

Useful FOD links:

www.safetycenter.navy.mil/aviation/default.htm

www.safetycenter.navy.mil/media/mech/vault/categories/FOD.htm

www.fod.com/FAST

www.nafpi.com National Aerospace FOD Prevention, Inc. (non-profit)

www.fodcontrol.com/

www.fodnews.com/

(This listing doesn’t reflect endorsement of any company or product.)