



RESEARCH BRIEF

Research Request:

Diesel Exhaust Fluid (DEF) Contamination in Aviation Fuel

Research Response:

What is Diesel Exhaust Fluid (DEF) and what is it used for?

DEF is a clear liquid containing a mixture of urea and demineralized water that is used to reduce emissions in modern diesel engine vehicles. DEF is designed to be used only in 2010 or later year vehicles equipped with Selective Catalytic Reduction (SCR) systems.

What happens when DEF contaminated jet fuel is delivered to aircraft?

When mixed with jet fuel, DEF will react with certain jet fuel chemical components to form crystalline deposits in the fuel system. These deposits will flow through the aircraft fuel system and may accumulate on filters, fuel metering components, other fuel system components, or engine fuel nozzles. The deposits may also settle in the fuel tanks or other areas of the aircraft fuel system where they may potentially become dislodged over time and accumulate downstream in the fuel system as described above. This can lead to a very high likelihood of inflight engine failure, damage to aircraft fuel systems and engines, and represents a serious risk to flight safety.

Aircraft identified as having received the contaminated fuel have experienced clogged fuel filters and fuel nozzle deposits that led to service difficulties and unplanned diversions. Those aircraft serviced with the contaminated refueling equipment also were exposed to trace amounts of DEF from residual fuel in the refueling hoses and equipment.

The crystalline deposits are not soluble in fuel, so they cannot be removed by flushing the aircraft fuel system with jet fuel. Although the deposits are soluble in methanol and other polar solvents, use of these chemicals may have adverse consequences on aircraft and engine fuel system materials. Consequently, original equipment manufacturers (OEM) should be contacted to develop inspection techniques and corrective maintenance actions appropriate for each specific aircraft model type and its level of exposure.

Aircraft incidents where jet fuel was contaminated with DEF

There have been three incidents in less than two years where Diesel Exhaust Fluid, or DEF has contaminated the fuel supply of a jet fuel truck. In all three cases, multiple inflight engine failures occurred, with the possibility of significant damage to aircraft fuel systems and engines. Fortunately, none of these cases resulted in an aircraft crash.

◆ The first incident occurred between November 18 and November 21, 2017.

Seven aircraft were serviced with jet fuel containing DEF at Eppley Air Field Airport (OMA) in Omaha, Nebraska. During the same time period, an additional six aircraft were serviced using refueling equipment that had been exposed to DEF.

◆ The second incident occurred between August 12 and August 16, 2018.

Five aircraft were identified as being serviced with jet fuel containing DEF at Miami-Opa Locka Executive Airport (OPF) located in Opa-locka, Florida. Also during the same time period, nine other aircraft were identified as being serviced using refueling equipment that had been exposed to DEF.

◆ The third incident occurred on May 9, 2019.

Two Cessna Citation 550s operated by air-ambulance operator Air Trek lost power—in both jets' engines—due to fuel contamination by diesel exhaust fluid (DEF). The jets were both fueled by the FBO at Punta Gorda Airport (PGD) in Florida, which is operated by Charlotte Country Airport Authority.

One of the Air Trek Citations was flying to Niagara Falls, New York, and landed safely in Savannah, Georgia after the failure of both engines. On its way to Chicago, the other Citation “experienced an engine failure, and landed safely in Louisville, Kentucky.

In a preliminary accident report on the Citation that landed at Savannah, the NTSB said that the airplane flew to Naples, Florida after being fueled with 480 gallons of jet-A mixed with a fuel system icing inhibitor (FSII) additive. On the flight from Naples to Niagara Falls, at 35,000 feet and one hour, 20 minutes from takeoff, the left engine slowly started to spool down, and attempts to restore engine power proved futile. After requesting a lower altitude and descending, the pilot shut the left engine down after it showed no oil pressure.

At 8,000 feet while flying to Savannah, the right engine began losing power, and after declaring an emergency, the pilot was able to land on Runway 19. According to the NTSB, “The second-in-command noted that the left fuel filter bypass light did not illuminate but that the right fuel filter bypass light did illuminate.”

In all three incidents Diesel exhaust fluid was inadvertently used instead of fuel system icing inhibitor (FSII) on aircraft refueling trucks and injected into the fuel with each truck's FSII injection system. This affected both the aircraft receiving the contaminated

Aircraft incidents where jet fuel was contaminated with DEF Cont...

fuel and the aircraft that were serviced with the refueling equipment that had been exposed to DEF.

What can FBO's and other fuel providers do to reduce the risk of DEF contamination?

DEF has a similar appearance to FSII (fuel system icing inhibitor) additives, also known as Prist, so it is imperative that proper precautions are taken to ensure they are not mixed up.

Handling and Storage Precautions:

- ◆ DEF and Prist Containers should be clearly labeled in high detail.
- ◆ DEF and Prist containers should be different in shape and size.
- ◆ DEF & FSII should be stored in separate, locked locations with differently keyed locks. Keys should also be labeled and not kept on the same key ring.
- ◆ DEF shall not be purchased in the same or similar quantity of any product that is added to the aircraft.
- ◆ All staff should be properly trained on the dangers and risks involved with using DEF around aircraft and should receive recurrent training annually. They should also be trained on the locations of DEF and FSII and the differences between the packaging and labeling of the two products.
- ◆ Only trained and approved personnel should handle DEF or fill fuel truck DEF tanks.
- ◆ All FSII transfers from storage to refueling equipment FSII containers should be recorded in a dedicated log that includes
 - ⇒ Date
 - ⇒ Time
 - ⇒ Transfer to/from
 - ⇒ Name of individual who completed the transfer

What can aircraft owners and operators do to help ensure contaminated fuel is not added to their aircraft?

- ◆ Talk with your fuel providers and ask if they use DEF in ground equipment. If so, inquire about procedures to confirm correct additives are used for jet fuel. This should include separate storage, clear labeling, confirmation of correct additives at the time of insertion, and training for personnel.
- ◆ Pilots should stay with their aircraft during fueling to ensure they know what is being put into their aircraft, and not be afraid to ask questions. A couple of questions you could ask before fueling are:
 - ⇒ Do you have DEF equipment on base?
 - ⇒ Do you have a DEF policy?
 - ⇒ Are you aware of recent DEF incidences?

What should you do if you suspect the fuel may have been contaminated with DEF?

Currently there is no field test to check jet fuel for DEF contamination, although it has been reported the industry is working on such a test. NATA recommends that all FBO's and other aviation fuel providers work with their fuel distributor to develop a response protocol to aviation fuel contamination incidents. Such a protocol should include the training needs for FBO staff.

The FAA recommends that owners or operators of affected aircraft do the following:

1. Contact their aircraft, engine, and APU OEMs to determine the appropriate inspections and maintenance actions to remove urea-based crystalline deposits from the fuel system. This action may include removing and replacing fuel system parts or components affected by exposure to these deposits.
2. Report to the FAA any service difficulties (including fuel filter bypass and clogging incidents), fuel system repairs, and fuel system inspection results related to the presence of these urea-based crystalline deposits.
3. Discard any jet fuel that has been removed from an affected aircraft because it is suspected of being contaminated with DEF. The contaminated fuel should not be used on aircraft or other vehicles.
4. Discuss with your local fueling providers how best to determine if any of their diesel-powered airport service vehicles require the use of DEF. Also discuss with them what procedures they have put in place to prevent and test for jet fuel contamination.

What else is being done to prevent future incidents of DEF contamination in jet fuel?

A task force, which includes the FAA, industry groups, ground service operators, fuel providers, and operators, is working on a report to include a DEF safety hazard analysis, proposals for short- and long-term mitigations, and revisions of training priorities for personnel who handle and dispense fuel.

Richard McSpadden, executive director of the AOPA Air Safety Institute, noted that an in-depth examination is needed to identify issues associated with these dangerous errors, identify trends, and determine corrective action.

The industry groups' joint report is being finalized and will be released soon.