FAA
Aviation Safety

SPECIAL AIRWORTHINESS INFORMATION BULLETIN

SAIB: AIR-21-08
SUBJ: Engine Fuel and Control – Operation with Contaminated Jet Fuel **Date:** April 20, 2021

This is information only. Recommendations aren't mandatory.

Introduction

This Special Airworthiness Information Bulletin advises airplane operators, fixed base operators (FBOs), FAA repair stations, Flight Standards District Offices (FSDOs), and foreign civil aviation authorities of the flight safety risk to airplanes that uplift jet fuel contaminated with diesel exhaust fluid (DEF), or uplift jet fuel using refueling equipment that was exposed to DEF. This SAIB also requests feedback regarding any service difficulties or operational anomalies of airplanes that uplift jet fuel contaminated with DEF and recommends that the owners of those airplanes consult with the original equipment manufacturers (OEMs) of their airplane, engine, and auxiliary power unit (APU) to determine the appropriate inspection and corrective maintenance actions on their airplane.

At this time, the airworthiness concern is not an unsafe condition that would warrant airworthiness directive (AD) action under Title 14 of the Code of Federal Regulations (14 CFR) part 39.

DEF Contamination Background

There have been five confirmed cases of DEF contamination affecting multiple turbine engine aircraft. Four of those cases occurred in the United States and one in Brazil. In all cases, aircraft experienced in-flight operational malfunctions, such as in-flight engine shutdowns or other engine operability problems resulting in in-flight diversions or emergency landings.

The documented cases are summarized as follows:

United States:

- November 2017: At Eppley Air Field Airport, Omaha NE (OMA), five aircraft made emergency landings.
- August 2018: At Miami-Opa Locka Executive Airport, FL (OPF), two aircraft made emergency landings.
- May 2019: At Punta Gorda Airport, FL (PGD), two aircraft made emergency landings, with one of the two making a dead stick landing after all engines failed.
- October 2020: At Savannah/Hilton Head International Airport (SAV), one aircraft made an in-flight diversion due to filter bypass warnings.

Brazil:

- October 2014: At Brasília International Airport, four aircraft had DEF directly injected into the jet fuel, and one aircraft had an air-turn back to the airport due to having filter bypass warnings.

In each of the first three U.S. cases and the Brazilian case, line personnel servicing the aircraft confused DEF with fuel system icing inhibitor (FSII). FBOs inadvertently put DEF into the FSII mixing tank on the aircraft refueling vehicles (fuel trucks). Because of DEF in the jet fuel, all of the aircraft involved in the in-flight incidents had documented cases of clogged fuel filters and fuel

nozzle deposits. The investigation was inconclusive as to the cause of the contamination in the fourth U.S. case.

DEF Background

DEF is a clear chemical comprised of 33% urea and 67% de-ionized water that is injected into the exhaust systems of diesel vehicles to break down and reduce nitrogen oxides (NOx) emissions into nitrogen and water. In 2007, the Environmental Protection Agency (EPA) required under the Clean Air Act that all on-road diesel vehicles manufactured from 2010 and later have reduced NOx emissions. Equipping on-road diesel vehicles with selective catalytic reduction (SCR) systems that require DEF is the most common approach to meeting this requirement. In 2014, the requirement expanded to newly purchased non-road vehicles, such as airport refueling trucks (fuel trucks). Since then, the number of SCR-equipped airport vehicles containing DEF reservoirs has been steadily increasing, and DEF has emerged as a threat to aviation safety. Vehicles and equipment that may require the use of DEF include:

- Fuel trucks
- Aircraft ground service equipment (ground power units, aircraft tugs/tractors, baggage loading/unloading equipment, forklifts, container and pallet loaders, aircraft air start units, potable water trucks and carts, lavatory service trucks and carts, passenger boarding stairs, conditioned air carts)
- Aircraft deice and anti-ice vehicles and equipment
- Facility snow removal vehicles and equipment (snow trucks, tractors, plows, blowers, scrapers, brooms, de-icers)
- Trucks and vehicles primarily used for aircraft maintenance
- Grounds maintenance equipment (lawn mowing tractors)
- Catering trucks
- Aircraft rescue and firefighting equipment

DEF is not a fuel additive and is not approved for use in jet fuel or any other type of transportation fuel. DEF should never come into contact with jet fuel, diesel, or any other fuel. To avoid contact, DEF is stored in a separate tank on vehicles where an SCR system has been installed. These tanks typically have a blue filler cap (see Figure 1). Nonetheless, DEF has been added to diesel truck tanks by mistake in on-road ground applications, resulting in fuel system and engine failures. When DEF is

mixed with diesel or jet fuel, it forms crystalline deposits in the fuel. These crystalline deposits can clog fuel filters and other fuel system components with potentially catastrophic consequences.

In the aviation community, DEF contamination events at small airports where FSII and DEF were mishandled and confused, resulting in FBOs adding DEF to the fuel tanks of aircraft, pose the largest threat.

Figure 1. DEF and Diesel Filler Caps

FSII's chemical name is DiEGME (diethylene glycol monomethyl ether) and includes popular or brand names PRIST, DICE, and Anti-Icing Fluid. FSII is a clear liquid injected (or mixed) into aviation fuel to prevent water in the fuel from freezing. FSII also inhibits microbial growth in the fuel. FSII is required on some smaller aircraft and is specified as an operating limitation if required to prevent ice formation in fuel. Transport aircraft are typically equipped with fuel heaters to negate the need for FSII.

FSII is mixed into aviation fuel in the following methods: 1) FSII is pre-blended at off-airport fuel terminals and shipped to the airport as pre-blended fuel; 2) FSII is mixed into jet fuel by being injected into the fueling hose during refueling operations; and 3) FSII is poured into aircraft fuel tanks by line service or flight crew. In the second and third methods, there is very little residence time in the fuel after FSII is injected before the fuel-FSII blend enters the aircraft fuel system and engines.

The confusion between FSII and DEF are due to the similarity of their properties, storage, labeling, and applications in the field. Both are clear liquids and are poured into the reservoirs on airport refueling trucks. As such, this is primarily a risk to General Aviation, charter and commuter operations, and small airports that utilize trucks to fuel aircraft, but not exclusively.

DEF Chemical Reaction with Fuel

When mixed with jet fuel, DEF reacts with certain jet fuel chemical components to form crystalline deposits (clathrates) in the fuel system (see Figure 2). These deposits 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.

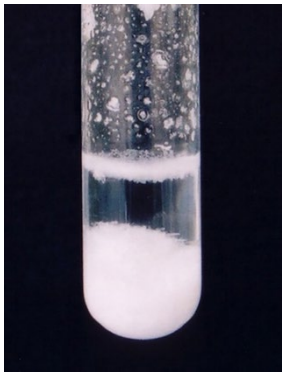

Figure 2. DEF Crystalline Deposits Formed when Mixed with Jet Fuel

Airplanes have experienced clogged fuel filters (see Figure 3), fuel nozzle deposits, and fuel tank contamination (see Figure 4) that led to service difficulties and unplanned diversions. Other airplanes were exposed to trace amounts of DEF from residual fuel remaining in the refueling hoses and equipment.

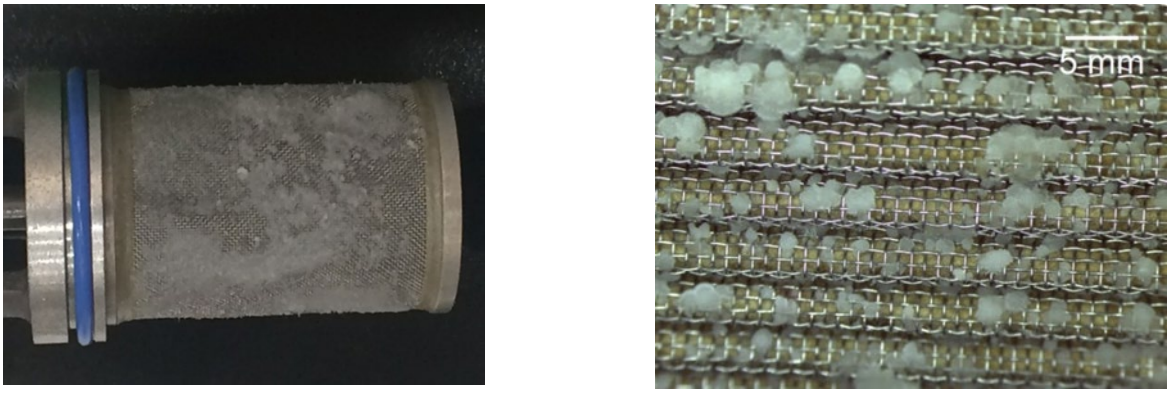

Figure 3. Aircraft Fuel Filters with DEF Contamination

Figure 4. DEF Deposits in Aircraft Fuel Tank

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

Jet fuel that has been contaminated with DEF no longer meets the aviation fuel operating limitations of airplanes certificated to operate on Jet A fuel, and therefore, cannot be used on those airplanes. Jet

fuel that has been removed from airplanes that contain even small amounts of DEF should be discarded and not used on airplanes or any other vehicles in the future.

DEF Mitigation Activities

FAA-Mitigating Actions
The following is a summary of FAA mitigating actions:

- The FAA is collaborating with the EPA to investigate possible actions that the EPA can take to reduce the DEF exposure at airports.
- In 2019, the FAA established an FAA Safety Risk Management (SRM) Team for DEF with representatives from both the FAA and aviation industry trade associations. The SRM team performed a safety risk assessment of the hazards associated with inadvertent contamination of jet fuel with DEF. The SRM team issued a report that consists of recommendations and requirements to mitigate this hazard. The SRM team met once in June 2019 and issued a final report in August 2019. The SRM team continues to work to address the team's recommendations.
    - The report is available on the NATA website: https://www.nata.aero/advocacy/def-awareness
    - As of the publication date of this SAIB, the direct link for this report is: https://www.nata.aero/assets/Site_18/files/DEF/2019-08-30_Safety_Risk_Assessment_Report_DEF-Final.pdf
- The FAA Flight Standards Division has written guidance and oversight methods for FSDOs and Certificate Management Offices (CMO's) to evaluate operators on their process of controlling DEF or other potential fuel contaminates. These can be found in Safety Alert for Operators (SAFO) 18015, "Jet Fuel Contamination with Diesel Exhaust Fluid (DEF)," dated November 13, 2018; Volume 6, Chapter 11 of FAA Order 8900.1, Flight Standards Information Management System; and Safety Assurance System (SAS) Data Collection Tool: 6.2.1 (AW) Fueling.

Additional information and recommended actions can be found in the following FAA reference documents:

- SAIB HQ-18-08R2, dated June 10, 2019.
- SAIB HQ-18-28, dated September 13, 2018.

Other Mitigation Actions
The following is a summary of other mitigating actions:

- The National Business Aviation Association (NBAA) established the Aircraft Diesel Exhaust Fluid Contamination Working Group in December 2018. FAA representatives from the Flight Standards (AFS), Aircraft Certification (AIR), and Airports (AAS) organizations teamed with 22 Industry Partners to collaborate and address the significant safety hazard of DEF contamination in aircraft. This collaborative effort provided a better understanding of the root cause of the events that have occurred to date and identified short- and long-term mitigation strategies to prevent such incidents from occurring again. The final report was issued in June 2019 and is entitled "Aircraft Diesel Exhaust Fluid Contamination Working Group: A

collaborative industry report on the hazard of Diesel Exhaust Fluid contamination of aircraft fuel." The report addressed the following issues:
    - Background on the issue
    - DEF Contamination Safety Hazard Analysis
    - Diesel Exhaust Fluid Contamination Mitigation Strategies
    - Short-term Mitigation Solutions for Operators and FBOs
    - Potential Long-term Mitigation Solutions
    - Resources for further research on this issue
    - Short and Long-Term Recommendations
    - Additional background, notices, and recommendations.
- A4A/NATA Bulletin 2018.4, Issued December 2018.
- National Transportation Safety Board Safety Alert 079, "Fuel Providers: Prevent DEF Jet Fuel Contamination," dated July 2019.
- Gammon Technical Products, Inc. Bulletin 181, "DEFKit® - DEF in FSII Test Kit," dated August 2020. This bulletin incorporates DEF in FSII Test Procedure, Emcee Electronics, February 2020.

Recommendations

The FAA recommends the following:

1. Owners or operators report any suspected instances of DEF contamination of aviation fuel to the FAA contacts identified in For Further Information Contact. The report should include information on affected aircraft and resulting 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.
2. Owners or operators of airplanes with suspected DEF contamination should contact their airplane, engine, and APU manufacturers to determine the appropriate inspection techniques and corrective maintenance actions to remove urea-based crystalline deposits from the fuel system. This may include removing and replacing fuel system parts or components affected by exposure to these deposits.
3. Jet fuel suspected of being contaminated with DEF, or jet fuel off-loaded from airplanes with suspected DEF contamination, should be discarded and not be used on airplanes or other vehicles.
4. Personnel responsible for refueling operations at airport FBOs and other refueling facilities consult NATA Operational Best Practice OBP-36, "Diesel Exhaust Fluid (DEF) Handling and Contamination Prevention" for guidance on handling and storage of DEF at airport facilities (available at https://www.nata.aero/assets/Site_18/files/DEF/OBP%2036%20-%20DEF%20Handling%20and%20Contamination%20Prevention.pdf). It is also recommended that these personnel attend the NATA's Misfueling and Prevention Program on-line training course at https://www.nata.aero/education-and-training/misfueling-prevention-program.aspx.

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provided, if any. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to: Information Collection Clearance Officer, Federal Aviation Administration, 10101 Hillwood Parkway, Fort Worth, TX 76177-1524.

For Further Information Contact

- Aircraft Maintenance Division (AFS-300), 950 L'Enfant Plaza SW, Washington, DC 20024; phone: (202) 267-1675; email: 9-AWA-AFS-300-Maintenance@faa.gov.
- Boston Aircraft Evaluation Division, 1200 District Avenue, Burlington, MA 01803; phone: (781) 238-7523; email: 9-AVS-AFS-150@faa.gov.
- Mark Rumizen, Senior Technical Specialist, FAA, 1200 District Avenue, Burlington, MA 01803; phone: (781) 238-7113; mobile: (781) 402-4609; fax: (781) 238-7199; e-mail: mark.rumizen@faa.gov.