Presentation Notes
DEF Fuel Contamination Prevention
2020/01/06-181(I)PP

This outreach guidance is provided to all FAA and aviation industry groups that are participating in outreach efforts sponsored by the General Aviation Joint Steering Committee (GAJSC). It is important that all outreach on a given topic is coordinated and is free of conflicts. Therefore, all outreach products should be in alignment with the outline and concepts listed below for this topic.

Outreach Quarter: Second Quarter, FY '20

Topic: DEF Fuel Contamination Prevention

The FAA and industry will conduct a public education campaign emphasizing the safety benefits of Preventing Aircraft Jet Fuel Contamination with Diesel Exhaust Fluid (DEF)

Background:

The Aircraft Diesel Exhaust Fluid Contamination Working Group is a working group made up of several industry representatives along with the FAA. They were chartered to discover the reason Diesel Exhaust Fluid (DEF) was mistakenly added to Jet fuel at 3 airports, to discover the risks of DEF mixing with Jet fuel and the potential hazards that would result. They also researched mitigation actions that would prevent DEF from being inserted into Jet Fuel and made recommendations thereof.

Urea has been used by farmers for many years as a fertilizer, it is a non-petroleum based chemical that is clear and has an ammonia type odor. It is never to be mixed with Diesel fuel as it will harm the pumps, clog filters and fuel injectors in trucks and any other equipment. Urea will crystallize when mixed with Kerosene, Diesel Fuel and any other similar chemicals.

The EPA Tier 4 mandates that all diesel powered equipment, (Heavy Duty Trucks, Pickups, etc., Stationary Equipment, Farm Equipment, Construction Equipment, etc.) with a horsepower rating over 75 horsepower are required to have the Selective Catalytic Reduction system. This system injects Urea into the exhaust stream and uses the ammonia with the materials in the Catalytic Converter to reduce NOx emissions.

Teaching Points:

- Discuss the composition and uses of Diesel Exhaust Fluid (DEF) and Fuel System Icing Inhibitor (FSII)
- Discuss the hazards of mixing the storage containers and also the chemical reactions of DEF in the Jet Fuel system.
- Discuss the "Best Practices" of handling of DEF and FSII and suggested training of company personnel

References:

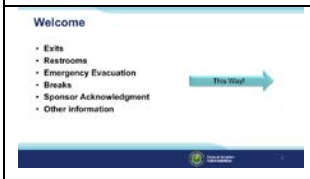
- ***Aircraft Diesel Exhaust Fluid Contamination Working Group Report*** *https://download.aopa.org/advocacy/2019/2019_06_11_Aircraft_DEF_Contamination_Working_Group_Report_FINAL.pdf*
- ***AVWEB working group report (https://www.avweb.com/news/working-group-how-to-avoid-def-in-jet-a/)***
- *AOPA News Report (**http://aopa.org/news-and-media/all-news/2019/june/11/recommendations-to-prevent-jet-fuel-contamination-released**)*
- *SAIB HQ-18-08R1, SAIB HQ-18-28, SAFO 18015*

Abstract: Lasting 10 to 20 Minutes, this presentation acquaints the audience with the hazards of mixing DEF into Jet Fuel and how to avoid this condition.

Format: Information Briefing – Power Point presentation

Required Personnel: FAASTeam Program Manager or designated FAASTeam Rep (s)

AFS 850 Support: In addition to this document, a Power Point presentation that supports the program is provided. FPMs and presentaers are encouraged to customize this presentation to reflect each individual program.

Slides	Script
	**Slide 1** **2020/01/06-181(I)PP** Original Author: G. Knaggs December 2019; POC G Minor, AFS-850 Airworthiness, Office (707) 704-3530; revised by **Presentation Note**: *This is the title slide for **DEF Fuel Contamination Prevention*** Presentation notes *(stage direction and presentation suggestions) will be preceded by a* **Bold header**: *the notes themselves will be in Italic fonts.* **Program control instructions** *will be in bold fonts and look like this:* **(Click)** *for building information within a slide; or this:* **(Next Slide)** *for slide advance.* *Some slides may contain background information that supports the concepts presented in the program.* *Background information will always appear last and will be preceded by a bold* **Background:** *identification.* *We have included a script of suggested dialog with each slide. Presenters may read the script or modify it to suit their own presentation style.* *The production team hope you and your audience will enjoy the show. Break a leg!* **(Next Slide)**
	**Slide 2** Presentation Note: *Here's where you can discuss venue logistics, acknowledge sponsors, and deliver other information you want your audience to know in the beginning.*

	You can add slides after this one to fit your situation **(Next Slide)**

	**Slide 3**
	In the advent of recent EPA regulations, Large and Medium sized Diesel powered engines, produced after 2014, installed in any equipment will need Selective Catalytic Reduction (SCR) systems installed. This includes a device (Catalytic Converter using different technologies than our gasoline powered cars/trucks) and Diesel Exhaust Fluid (DEF) injected into the catalytic converter. There have been at least 3 events, which several aircraft (at least 9) that included DEF being mixed into Jet Fuel and the aircraft operated. Fortunately. Due to proper training and reactions of the involved flight crews, no aircraft accidents occurred, although that potential was immanent.
	• ***What is the Problem?***
	  • *We now have 2 chemicals that can appear on airports that may be packaged very similarly, yet are very different chemically.*
	  1. *Diesel Exhaust Fluid (DEF)*
	  2. *Fuel System Ice Inhibitor (FSII) Trade names include: Prist, DICE Flash 190, and ICE-5*
	  • *They are both clear fluids with similar viscosities*
	• ***What Happened?***
	  • *There have been at least 9 civilian aircraft and several military aircraft that were fueled with contaminated fuels, three of those aircraft had engine failures in flight, two had dual engine flameouts (one Falcon 50 with 3 engines, the other was a Cessna Citation 550 with 2 engines). Fortunately all of the aircraft involved landed safely on airports with no further damage or any injuries.*

	• ***How do we Mitigate?***
	  • *The key will be careful labeling, segregation of the fluids and training*
	• ***Where do we find help?***
	  • *NBAA, AOPA, FAA SAFO's and a Joint Committee have produced reports and suggestions to eliminate this problem. These publications will be made available at the end of the presentation.*
	
	Presentation Note: *If you'll be discussing additional items, add them to this list*
	
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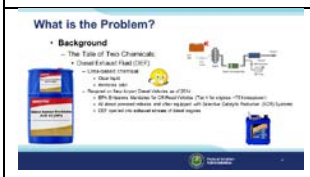
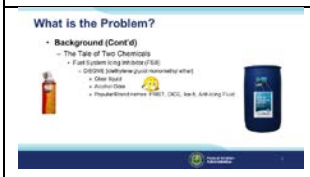
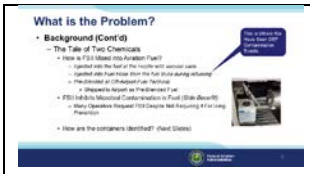
	**<u>Slide 4</u>**
	• **The Tale of Two Chemicals**
	  • Diesel Exhaust Fluid (DEF) is a mix of Urea and Water (35% to 65%). Urea has been used by farmers for many years as a fertilizer, it is a non-petroleum based chemical that is clear and has an ammonia type odor.
	  • Required on New Airport Diesel Vehicles as of 2014:
	  ➢ Beginning in 2014, EPA Tier 4 mandates that all newly manufactured diesel powered equipment, (Heavy Duty Trucks, Pickups, etc., Stationary Equipment, Farm Equipment, Construction Equipment, etc.) with a horsepower rating over 75 horsepower are required to have the Selective Catalytic Reduction system (SCR). This system injects Urea into the exhaust stream (never into the engine) and uses the

	ammonia with the materials in the Catalytic Converter to reduce Nitrous Oxide (NOx) emissions. ➢ DEF is never to be mixed with Diesel fuel as it will harm the pumps, clog filters and fuel injectors in trucks and any other equipment. Urea will crystallize when mixed with Kerosene, Diesel Fuel and any other similar chemicals. **(Next Slide)**
	**<u>Slide 5</u>** Fuel System Icing Inhibitor (FSII): -Also is a clear liquid, but with a very different odor (more like alcohol) from DEF. It is mixed **into** the Jet fuel and has 2 purposes. First it is a de-icing fluid, second it is a microbial contamination eliminator. -Injected (or mixed) into Aviation Fuel to Prevent Water (in fuel) from Freezing -Typically required on smaller turbine engine powered aircraft FSII is not often used among the Air Carriers as they have fuel heating systems in their fuel systems on their aircraft and enough fuel flows through the system to combat the microbial contamination risk. **(Next Slide)**



Slide 6

-How is FSII Mixed into Aviation Fuel?

- FSII can be injected into the fuel at the nozzle with aerosol cans
- FSII can be injected in the fuel delivery hose from the truck to the aircraft, there will be a reservoir for the FSII on the truck that is refilled periodically.
- Jet Fuel can be ordered with FSII pre-mixed before delivery to the local fuel farm

-The side benefit to FSII is that it inhibits microbial growth in the jet fuel. Many operators ask for FSII year round for this purpose.

So far, the contamination events involved fuel trucks that use the system that injects the FSII into the fueling hose from a reservoir mounted on the truck.

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Slide 7

As you can see from the samples shown, there are several container types for DEF, most are either blue or white/translucent containers. They will not typically have markings/specifications on them as we would be used to seeing in the Aviation Field.
You will almost never see DEF shipped or stored in a steel or other metal drum due to its corrosive nature.

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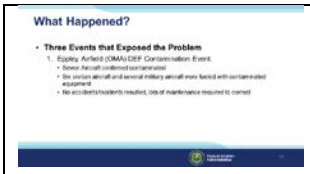
Slide 8

As seen in the slide, there are several container types in which FSII is shipped. It can be shipped and stored in anything from aerosol cans with

	self dispensing tubes and nozzles to 55 gallon drums. Those who use the aerosol cans are much less likely to have a contamination issue than those who buy the fluid in bulk and rely on a tank and injection pump on their trucks for mixing. **Any of the blue or clear barrels need special handling to ensure that DEF is not used instead of FSII in aviation fuel dispensing.** **(Next Slide)**
	**<u>Slide 9</u>** **Often, both fluids are delivered, from the vendors, in white or clear plastic drums or other containers. They are appropriately marked, but the overall visual ques can be confusing or at least non-descript.** **-It is becoming more prevalent at airports with newer truck and other equipment using the SCR systems** **-Both DEF and FSII are clear liquids with very similar viscosities** **-If purchased in large containers, both are poured into smaller containers and added to reservoirs in the fuel trucks** **-With these similarities, we have had 3 contamination events that affected several aircraft, mostly from line personnel pouring the wrong fluid into the FSII tanks mounted on fueling trucks.** **-The primary risk is to general aviation, turbine powered aircraft. The risk has been felt in Military aircraft as they can purchase fuels from local FBO's** **(Next Slide)**



Slide 10

Nov 17, 2017 Truck #1 FSII tank was topped off with 3.5 gallons of DEF

Nov 18, 2017 A discrepancy was identified by an operator that was fueled on Nov 17. The FBO immediately performed all industry quality control checks on truck #1 and the fuel farm. No discrepancies were found

Nov 18, 2017 The FSII container was removed from the truck and replaced with a fresh, undiluted FSII container.

Nov 19, 2017 The FSII container removed from Truck #1 was installed on Truck #2. The fluid left in the container was 1/3 full with 60% DEF. It was topped off with 3.5 gallons of FSII.

Nov 20, 2017 Another operator identified a fueling discrepancy.

The FBO drained all fuel from all truck and refilled with new fuel.

All FSII containers were removed from all trucks, emptied into separate containers, flushed and refilled with fresh FSII. New containers were ordered and installed on Nov 27.

All operators fueled between Nov 17 and Nov 21.

During this event, in all 7 aircraft were identified with contaminated Jet fuel, and 6 additional civilian aircraft and several military aircraft were impacted with this event.

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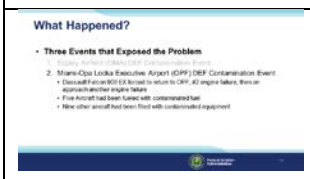


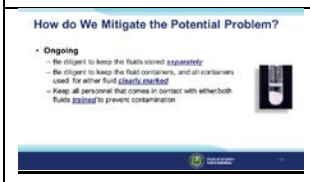
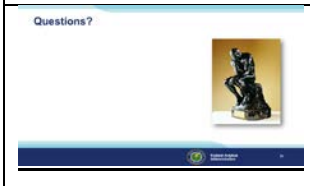
Slide 11

Aug 14, 2018 Dassault Falcon 900EX was forced to return to OPF, the flight crew received multiple clogged fuel filter warnings on departure, followed by

	#2 engine failure. Another engine became nonresponsive to power inputs. Testing revealed fuel contamination consistent with DEF contamination. The issue was traced back to a FSII tank that had been removed from a fuel truck for repairs, then accidently filled with DEF for leak check purposes. Prior to reinstallation. The FBO had procedures in place to avoid cross-contamination including a hose on the DEF that wouldn't reach the FSII tank on the truck. However the tank wasn't on the truck when the DEF was pumped in. The DEF supply has been moved to a different location. Additional research revealed that 5 aircraft uplifted jet fuel contaminated with DEF, and an additional 9 aircraft were uplifted with jet fuel using refueling equipment that was exposed to DEF. **(Next Slide)**
	**Slide 12** May 9, 2019 Two Cessna Citation 550's, both operated by the same 14 CFR 135 operator, received 480 and 440 gallons of jet fuel at Punta Gorda Airport (PGD). An Eclipse Jet was also fueled that morning with FSII from the same truck. It has been confirmed that a pail of 2.5 gallons of unmarked DEF was mixed with a container of FSII prior to servicing the FSII reservoir on the refueler truck. Both Citations flew from PGD to Naples (APF) that morning. They received another 195 and 168 gallons respectively, picked up their passengers and departed on separate flight to different destinations. One aircraft was headed to Chicago Executive Airport (PWK), the other to Niagara Falls International Airport (IAG). The aircraft Enroute to IAG experienced an engine flameout at 35,000 feet, descended, then at 8,000

	feet on approach to Savannah/Hilton Head Airport (SAV), experienced the second engine flameout, then landed without either engine, fortunately without damage or injuries. The aircraft Enroute to PWK experienced an engine flameout at 36,000 feet, descended and landed with one engine operative at Louisville International Airport (SDF) without damage or injuries. The FBO at APF placed their refueler and storage tank out of service until it was determined that the fuel was not contaminated with DEF. There were no reports of operational or maintenance issues with the Eclipse Jet at this time. **(Next Slide)**
	**Slide 13** **DEF (remember the 35% Urea and 65% Water?) does not mix (emulsify) into the fuel, but will crystallize in the fuel and leave deposits in the fuel tank and get caught in the filters.** **(Next Slide)**
	**Slide 14** These filters were fully plugged when removed from their respective aircraft. **(Next Slide)**
	**Slide 15** **Notice the white crystallized DEF deposits in the fuel tank. The aircraft manufacturer needs to be informed of the contamination to provide the maintenance personnel with an adequate cleaning regime. A quick flush will not do.** **(Next Slide)**

	**Slide 16** **Diesel-powered airport trucks manufactured after 2014 are required by EPA to have the DEF systems installed and working. The reservoirs on the truck are separated from the FSII tanks. They will have a BLUE tank cap and often are near the truck's diesel fuel supply tank.** **Typically the DEF fluid is purchased and stored in larger containers (Barrels) then transported in smaller containers to the truck DEF tank.** **(Next Slide)**
	**Slide 17** **It appears that in each of the contamination cases, FSII and DEF were stored in the same room/shed/building area.** **It also appears that the line crew was responsible for the mix up by putting DEF into a tank on the truck that should only have had FSII** **The markings on the containers were inadequate to bring the contents to the attention of the line crews. They may have had markings, but were they did not get the attention of the crew.** **DEF MUST be thoroughly cleaned from any FSII equipment to remove all traces.** **Typically the FSII fluid is purchased and stored in larger containers (Barrels) then transported in smaller containers to the truck FSII dispensing tank.** **(Next Slide)**
	**Slide 18** Plan initialization will take a bit of work, follow the information on the slides to get started, also look for the *Aircraft Diesel Exhaust Fluid Contamination Working Group* report for suggestions. Never cross utilize storage or carrying containers from DEF to FSII, trace amounts of DEF can cause problems Clearly Label the storage and carrying containers

	Give training to any and all persons who might (even with the remotest possibility) have any contact with these fluids. The resources are coming. **(Next Slide)**
	**Slide 19** Keeping the fluids stored in a manner that reduces the possibility of mistake is vital to preventing contamination Keeping the containers marked clearly, so that anyone who might use them, even in a stressful time will recognize what they are using is also vital to preventing contamination. Training employees that are new to handling the fluids is essential, even if the employee has been with your organization for many years. Retraining reminds the employees of the dangers and the proper handling of the fluids. Plan retraining is essential to maintain an acceptable level of safety, follow the information on the slides to get started on your training plan, also look for the Aircraft Diesel Exhaust Fluid Contamination Working Group report for suggestions. **(Next Slide)**
	**Slide 20** These are four really good resources that will help you understand the problem and affix a solution to your company **(Next Slide)**
	**Slide 21** **Presentation Note:** *You may wish to provide your contact information and main FSDO phone number here. Modify with*

	Your information or leave blank. **(Next Slide)**
	**<u>Slide 22</u>** The AMT Awards program encourages AMTs and employers to take advantage of initial and recurrent training by issuing awards based on training received in one calendar year. The program has several levels, or phases, of recognition for both you and your employer. You can obtain an FAA Certificate of Training upon successful completion of the program requirements. Employers can obtain a Gold or Diamond Award of Excellence yearly depending on the percentage of their employees receiving awards. Training earned toward an AMT Award falls into one of two categories; Mandatory Core Training and Eligible Training. Mandatory Core Training is one or more on-line training courses, depending on FAA evaluation of training needs. The Core Training course(s) can be located and completed in the Aviation Learning Center at FAASafety.gov. Eligible Training is the hourly training that can be credited toward an individual AMT Certificate of Training. This training must be aviation maintenance career related training. Be sure to document your achievement in the AMT Awards Program. It's a great way to stay on top of your game and keep stay proficient. **(Next Slide)**
	**<u>Slide 23</u>** Your presence here shows that you are vital members of our General Aviation Safety Community. The high standards you keep and the examples you set are a great credit to you and to GA. Thank you for attending. **(Next Slide)**

	**Slide 24** **(The End)**

Appendix I – Equipment and Staging

Equipment:

- Projection Screen & Video Projector suitable for expected audience
    - Remote computer/projector control available at lectern or presenter location
        - In lieu of remote – detail a Rep to computer/projector control.
- Presentation Computer
    - **Note:** It is strongly suggested that the entire program reside on this computer.
- Back up Projector/Computer/Media as available.
- PA system suitable for expected audience
    - Microphones for Moderator and Panel
        - Optional Microphone (s) for audience
- Lectern (optional)

Staging:

- Arrange the projection screen for maximum visibility from the audience.
- Equip with PA microphones
- Place Lectern to one side of screen. This will be used by presenters and moderator
- **IMPORTANT** – Once you have completed outreach on this topic, please help us track the outreach you have done by entering a PTRS record.

Rev 0 Dec 2019

NPP41: GAJSC Safety Outreach "Airworthiness Topic of the Quarter"

PTRS Activity Code	National Use	Primary Area	Keyword	Description	Performance Target	Date Due	LDR **12XXFAFAAST**
3931 or 5931	NPP41	K	065	Promote "Airworthiness Topic of the Quarter" within the FSDO area	1 per FSDO, per Quarter	09/15/20	OR0010

RESOURCES:

- Airworthiness Topics of the Quarter materials are available at the National FAASTeam KSN site under - Approved Resources.

COMMENTS:

- GAJSC Airworthiness Topic of the Quarter:
  - Industry and the FAASTeam will nationally promote each quarterly topic.

NOTES:

- 1 PTRS entry at the conclusion of each GAJSC Airworthiness Topic of the Quarter outreach.
- Record the type of outreach conducted in the comment section of the PTRS (provide link to the outreach that was developed, when possible).