



Aviation Investigation Final Report

Location:	Glendale, Arizona	Accident Number:	WPR22FA094
Date & Time:	February 10, 2022, 11:05 Local	Registration:	N633AX
Aircraft:	DASSAULT AVIATION MIRAGE F1 CR	Aircraft Damage:	Destroyed
Defining Event:	Fuel exhaustion	Injuries:	1 Minor
Flight Conducted Under:	Public aircraft		

Analysis

A turbo-jet airplane was being operated as a public-use aircraft in support of the United States Air Force's simulated combat flight training at the time of the accident. The airplane took off and proceeded to the Military Operating Area (MOA) and, near the completion of the flight the pilot reported a discrepancy between the two fuel quantity indications in the cockpit. Shortly thereafter, the pilot headed back to the airport once the airplane reached its briefed minimum fuel status. While en route to the airport, the pilot reported a loss of fuel pressure and shortly afterward the engine flamed out.

The pilot attempted to restart the engine but was unsuccessful. When the pilot determined that he could not make the runway at his destination, he turned toward an uninhabited area and successfully ejected from the airplane. Subsequently, the airplane impacted terrain.

Postaccident interviews revealed that the airplane was not fueled with the correct amount of fuel for the flight by maintenance personnel before the flight. Although the refueling forms accurately reflected the shorted amount of fuel, the error was not detected by maintenance personnel or the pilot before the airplane took off. During the flight, the pilot failed to notice that his fuel load was incorrect. The pilot relied on a fuel remaining totalizer that had been manually set to the expected full fuel load, not to the actual fuel load, and did not appropriately reference the individual fuel quantity tapes.

Postaccident examination of the airplane wreckage revealed that the airplane's fuel tanks had loose sealant globules inside the main feeder fuel tanks and an additional piece of Foreign Object Debris (FOD) present. Additionally, the operator discovered that several of their F-1 airplanes were found with varies type of FOD in the fuel tanks, including loose pieces of fuel tank sealant, which led to fuel anomalies including issues that caused false full tank fuel

indications during refueling. Once the FOD was removed, the airplanes’ fuel system anomalies that were experienced were virtually eliminated. It is possible that the FOD caused anomalies during refueling of the accident airplane and presented a false full tank indication, which contributed to the airplane not being serviced to the correct fuel load.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

A loss of engine power due to fuel exhaustion as result of the failure of maintenance personnel to ensure the airplane was serviced with the correct amount of fuel, the failure of maintenance personnel and the pilot to adequately check the airplane’s paperwork to ensure the correct amount of fuel was present for the flight, and the failure of the pilot to adequately monitor the airplane’s fuel status during the flight.

Findings	
Aircraft	(general) - Incorrect service/maintenance
Personnel issues	Aircraft/maintenance logs - Maintenance personnel
Personnel issues	Aircraft/maintenance logs - Pilot
Personnel issues	Use of equip/system - Pilot
Personnel issues	Monitoring equip/instruments - Pilot
Aircraft	Fuel - Fluid level
Aircraft	(general) - Not specified

Factual Information

History of Flight

Enroute-descent	Fuel exhaustion (Defining event)
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On February 10, 2022, about 1105 mountain standard time, an experimental Dassault Aviation Mirage F-1 CR Turbo-jet, N633AX, was destroyed when it was involved in an accident near Luke Air Force Base, (LUF), Glendale, Arizona. The pilot sustained minor injuries. The airplane was operated as a public-use aircraft in support of the United States Air Force’s simulated combat flight training.

According to the accident pilot, he flew in the number two position in a flight of two aggressor jets. The formation took off and proceeded to the MOA, where the two airplanes split up into separate areas. Near the completion of the area work, the pilot reported a discrepancy between the two fuel quantity indications in the cockpit. Shortly thereafter, he recovered before the lead airplane since his airplane reached its briefed minimum fuel status first. While exiting the MOA, and en route on the recovery, the pilot reported a loss of fuel pressure and shortly afterward the engine flamed out.

The pilot attempted to restart the engine but was unsuccessful. When the pilot determined that he could not make it back to the runway at LUF, he executed a left turn to an uninhabited area and successfully ejected from the airplane. Subsequently, the airplane struck desert terrain about 16 miles northwest of LUF.

Postaccident interviews revealed that the airplane was not fueled with the correct amount of fuel for the flight by maintenance personnel before the flight. Although the refueling forms accurately reflected the shorted amount of fuel, the error was not detected by maintenance personnel or the pilot before the airplane took off. During the flight, the pilot failed to notice that his fuel load was incorrect. A high throttle setting (with frequent afterburner use) basic fighter maneuver flight engagement for the pilot, made him rely on the fuel remaining totalizer, without appropriately referencing the individual fuel quantity tapes. The fuel remaining totalizer that the pilot relied on had been manually set to the expected full fuel load, not to the actual fuel load. Subsequently, the low fuel light illuminated in the MOA and during the return to LUF, the fuel quantity tapes indicated zero, while the fuel totalizer read about 1,300 liters. Shortly afterwards, the engine flamed out consistent with fuel exhaustion.

Pilot Information

Certificate:	Airline transport; Flight engineer; Flight instructor	Age:	54, Male
Airplane Rating(s):	Single-engine land; Multi-engine land	Seat Occupied:	Single
Other Aircraft Rating(s):	None	Restraint Used:	5-point
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	Toxicology Performed:	
Medical Certification:	Class 1 Without waivers/limitations	Last FAA Medical Exam:	July 20, 2021
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	November 18, 2021
Flight Time:	(Estimated) 4859 hours (Total, all aircraft), 240 hours (Total, this make and model), 3634 hours (Pilot In Command, all aircraft), 93 hours (Last 90 days, all aircraft), 36 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft)		

The pilot held an airline pilot certificate with a flight instructor airplane single-engine and multi-engine land and airplane instrument ratings. He also held an experimental aircraft authorization for the DA-F1. The pilot was issued a Federal Aviation Administration (FAA) first-class medical certificate on July 20, 2021, without limitations. The pilot reported about 4,859 total hours of flight experience and about 240 hours in the F-1 aircraft. He was a former military fighter pilot in the F-16 and F-18 aircraft and an airline pilot.

According to the pilot of the lead aircraft and maintenance personnel that launched the airplane, the accident pilot appeared to be in a normal good mood the day of the accident. The accident pilot stated that he had normal sleep the 3 days before the accident and had no personal issues to report.

Aircraft and Owner/Operator Information

Aircraft Make:	DASSAULT AVIATION	Registration:	N633AX
Model/Series:	MIRAGE F1 CR	Aircraft Category:	Airplane
Year of Manufacture:	1985	Amateur Built:	
Airworthiness Certificate:	Experimental (Special)	Serial Number:	653
Landing Gear Type:	Retractable - Tricycle	Seats:	1
Date/Type of Last Inspection:	November 2, 2021 100 hour	Certified Max Gross Wt.:	35700 lbs
Time Since Last Inspection:		Engines:	1 Turbo jet
Airframe Total Time:	6333.3 Hrs as of last inspection	Engine Manufacturer:	SNECMA
ELT:	Not installed	Engine Model/Series:	ATAR 09K50 SER
Registered Owner:	AIRBORNE TACTICAL ADVANTAGE COMPANY LLC	Rated Power:	15355 Lbs thrust
Operator:	AIRBORNE TACTICAL ADVANTAGE COMPANY LLC	Operating Certificate(s) Held:	None

The F-1 Mirage was a French fighter and attack aircraft that was imported into the United States and registered under the experimental category. It is a single-engine, swept-wing, supersonic airplane capable of Mach 2.1. The airplane had a maximum takeoff weight of over 35,000 lbs.

The airplane's fuel system is comprised of a left and right fuel system. Normally, the left and right fuel systems are isolated from each other but can be connected to each other through a crossfeed valve. Refueling is normally carried out by pressurized single point refueling. The total quantity of usable fuel was about 4,100 liters. This total does not include the use of the optional external centerline fuel tank, which increased the fuel capacity by about 1,180 liters.

The airplane was equipped with 9 internal fuel tanks (including the 2 feeder tanks), 2 internal wing tanks, and 2 negative-g flight accumulators. Engine air pressure moves the fuel to the feeder tanks and from there it flows directly to the engine by 2 low pressure pumps.

The F-1 refueling checklist indicated for a clean airplane the following fuel capacity (in liters):

FEEDER TANKS	FRONT FUSELAGE	REAR FUSELAGE	NEGATIVE G ACCUMULATORS	WINGS	TOTAL USABLE
1 090	1 560	1 070	60	380	4,100

The airplane fuel gauges consisted of 2 vertical tapes that indicated the fuel quantity on the left and right side. The wing tanks and optional external tanks are not gauged. The fuel tapes only indicate about a maximum of about 2,000 liters of fuel on each side and, therefore, the

tape indications would only start to decrease when the airplane had less than about 4,000 liters of total fuel. The fuel transfer sequence is designed so that the optional external fuel tanks are consumed first, then the wing tanks, and then the gauged internal fuel tanks. Usually, once the airplane's external centerline and wing tanks are empty, the tape indications should reflect what the fuel remaining indicator (a 4-figure counter measured in liters) indicated. With more than 2,000 liters of fuel in each tank, the tapes would indicate near the full indication. In addition, the fuel remaining indicator (totalizer) would be manually preset to the total quantity of fuel onboard before flight and would decrease according to how much fuel the airplane used.

The accident airplane was refueled the day before the accident. During the start of the refueling the nozzle pressure was kept at 20 psi to ensure that the airplane took fuel and did not overpressure and vent fuel. About three minutes into the refueling, the fuel truck driver observed a significant amount of fuel venting from the airplane and was instructed to stop refueling by the operator's maintenance personnel. The driver said it was the most venting he had seen during his one year of refueling the F-1.

After having stopped for a couple of minutes, the operator's maintenance personnel checked the airplane and placed the collection container back to collect fuel that vented overboard and the refueling was resumed. Subsequently, about 7 minutes later, a total of about 456 gallons (about 1,726 liters) was added to the airplane and then the refueling driver observed a spike in back pressure that was a characteristic of the jet being fully loaded with fuel and stopped refueling. In addition, the operator's refueling personnel monitoring the refueling thought the refueling was complete as well. However, the fuel added was not to the full fuel load amount that was normally serviced.

Given, that the airplane's shutdown fuel from the previous flight was 2,320 liters and the fuel serviced was 1,726 liters, the airplane's fuel load for the accident flight after refueling was about 4,046 liters, which was less the normal full fuel load of about 5,280 liters with the external center fuel tank that was installed. Additionally, an engine run of about 10 minutes for maintenance took place on the airplane before takeoff and no fuel was added afterward. Therefore, the fuel load for takeoff was slightly lower than 4,046 liters. Maintenance personnel and the pilot then reviewed the aircraft forms, which indicated the amount of fuel serviced, but did not detect the shorted amount of fuel added.

Additionally, during the ground refueling process, the refueling lights flash on and then go out when the corresponding tanks are full. The last step of the checklist was to manually set the fuel remaining quantity indicator (totalizer) to display the amount of fuel in the airplane. The fuel remaining quantity indicator was as if the airplane was fully fueled with 5,280 liters of fuel.

On the airplane's warning and caution panel, the FUEL PRES red light would illuminate when the engine inlet fuel pressure was < 700 mb (10.15 psi). The LOW FUEL red light would illuminate when either feeder fuel tank was < 250 liters. A red warning light illumination called for immediate action by the pilot.

The emergency procedure for a FUEL PRES red warning light, which indicated that the dry engine fuel pressure was less than 700 mb while airborne, was to shut down use of AB and reduce rpm, check LP pumps on, check left and right LP caution lights out, and land as soon as possible while monitoring the fuel totalizer and both fuel gauges for indications of a fuel leak.

The emergency procedure for LOW FUEL warning light was to select the emergency transfer switch forward or aft as required, which connected the left and right forward or aft tanks (depending on selection) and allowed transfer of both tanks to the same feed tank. If the quantity of both feed tanks was below 250 liters and transfer sequence was normal, with or without tank 3 illuminated, the procedures were:

- RPM reduce.
- Descend to below 20,000 ft, heading to nearest field.
- RPM – set 8,000 for 30 seconds (maximum) and check the feed tank quantity.
- If the feed tank transfer does not increase – use emergency transfer.
- If the feed tank quantity increases – if necessary, continue flight at no higher than current altitude (< 20,000 ft).
- Land as soon as possible.

The operator performed a daily inspection on the accident airplane before its flight. Additionally, the airplane's last 100-hour inspection was accomplished on November 2, 2021, at an airframe total time of 6,333.3 hours.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	KLUF, 1085 ft msl	Distance from Accident Site:	16 Nautical Miles
Observation Time:	10:58 Local	Direction from Accident Site:	125°
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	10 knots / None	Turbulence Type Forecast/Actual:	None /
Wind Direction:	30°	Turbulence Severity Forecast/Actual:	N/A /
Altimeter Setting:	30.11 inches Hg	Temperature/Dew Point:	24°C / -5°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Glendale, AZ (LUF)	Type of Flight Plan Filed:	IFR
Destination:	Glendale, AZ (LUF)	Type of Clearance:	VFR
Departure Time:	10:32 Local	Type of Airspace:	Special

Airport Information

Airport:	LUKE AFB LUF	Runway Surface Type:	Asphalt; Concrete
Airport Elevation:	1084 ft msl	Runway Surface Condition:	Dry
Runway Used:	03R	IFR Approach:	None
Runway Length/Width:	9912 ft / 150 ft	VFR Approach/Landing:	None

LUF is a United States Air Force owned, towered airport, with a reported field elevation of 1,083 ft. The airport was equipped with two concrete runways, runway 03L/21R (10,000 ft long by 150 ft wide) and runway 03R/21L (9,912 ft long by 150 ft wide).

Wreckage and Impact Information

Crew Injuries:	1 Minor	Aircraft Damage:	Destroyed
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:		Aircraft Explosion:	None
Total Injuries:	1 Minor	Latitude, Longitude:	33.708728, -112.62649(est)

Examination of the accident site revealed that the jet airplane impacted flat desert terrain in an unoccupied area between residential areas. All major components of the airplane were found at the main wreckage site. The wreckage site was at an elevation of about 1,622 ft msl. There was no postimpact fire.

There was a large ground disturbance that led to the area where most of the major sections of the airplane were located. The initial point of impact was orientated on a heading of about 060° magnetic. The aft portion of the fuselage (the largest portion of fuselage that remained relatively intact) came to rest inverted. Small fragments of aircraft debris were scattered about several hundred ft from the accident site. The large portions of the remaining forward section of the fuselage and wings were found nearby.

The ejection seat and parachute were found about a half mile from the main accident site.

A postaccident examination of the airplane wreckage revealed that the airplane's fuel tanks had some loose excess sealant globules inside the main feeder fuel tanks; a loose screw was also found.

No additional evidence of any preimpact mechanical failures or malfunctions that would have precluded normal operation of the airplane were observed.

Flight recorders

The airplane was equipped with an Enertec PE6010-5A flight data recorder (FDR). The tape-based recorder was developed for use in early Dassault Mirage F-1 aircraft. The recording medium is a 1/2-inch magnetic tape, 63 meters in length, capable of storing up to 16 hours of flight data. The National Transportation Safety Board (NTSB) was unaware of any 1/2-inch tape-based recorders in commercial service in the United States and does not maintain equipment for the readout of 1/2 inch magnetic tape. The Bureau of Enquiry and Analysis for state owned aircraft (BEA-E) in France reported that they have some experience with the Enertec recorder, and that a specific readout bench is required to recover data from it. The BEA-E also reported that the recorder requires regular maintenance, and unless the tape is regularly changed recovery is unlikely.

It was determined that due to the age of the recorder and the lack of documented continued airworthiness maintenance on the recorder, the likelihood of recovering valid data was low.

Because of the low probability of recovery, it was determined that no further attempts to recover the FDR data would be made.

Medical and Pathological Information

The operator coordinated to have toxicological testing accomplished on the pilot and the results were negative.

Survival Aspects

The canopy, ejection seat, harness, and parachute were examined by the NTSB investigator-in-charge, the FAA, and a representative of the operator. Examination revealed that the ejection equipment functioned normally.

Organizational and Management Information

Airborne Tactical Advantage Company (ATAC) operated the airplane and, according to their web site, is the world's largest outsourced civilian tactical airborne training organization. ATAC is a business unit of Textron Systems that operates a variety of ex-military aircraft consisting of the F-1 Mirage, the F-21 KIFR, the L-39 Albatros, and the MK-58 Hawker Hunter. The accident airplane was part of their operating location at LUF.

ATAC accomplished both the maintenance of its aircraft and provided initial and recurrent ground and flight training to its F-1 pilots. Additionally, the organization had a safety department that was managed by their Vice President of Safety. Their safety department had a safety representative stationed at LUF.

The F-1 lead pilot of the formation stated that his F-1 ground school training was challenging and he was surprised by the length and depth of the ground school. Additionally, the accident pilot stated that the F-1 instructors do a good job in systems knowledge and instruction in the jet.

Additional Information

Due to the accident and other fuel anomalies experienced in some of their other F-1 airplanes, the operator accomplished a one-time inspection of their F-1 fleet's fuel tanks and discovered that 5 airplanes (out of a fleet size of about 8 aircraft) at the LUF location were found with various type of Foreign Object Debris (FOD). The main source of FOD in the tanks was the fuel tank sealant remnants. Fuel system anomalies, including false full tank fuel indications during refueling and issues affecting the fuel transfer valves, were experienced consistent with the FOD present in the fuel tanks. Once the FOD was removed from the fuel tanks, few additional anomalies related to the airplane's fuel systems were experienced.

Administrative Information

Investigator In Charge (IIC):	Nixon, Albert
Additional Participating Persons:	Frank Waterhouse; FAA; Scottsdale, AZ Ronald Sloma; Airborne Tactical Advantage Company (ATAC); Luke AFB, AZ Randolph Rushmore; USAF-HAF-AFSEC/SEF; Albuquerque, NM Jeremy Ulman; Airborne Tactical Advantage Company (ATAC); Ft Worth, TX Rob Modderman; Airborne Tactical Advantage Company (ATAC); Newport News, VA
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