Log 2128

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: July 17, 1989
In reply refer to: A-89-75 through -77

Honorable James B. Busey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Single-engine, low-wing airplanes manufactured by Socata, a subsidiary of Aerospatiale of France and imported into the United States under Title 14 CFR 21.29, "Issue of Type Certificate: Import Products," have recently been involved in three accidents following the loss of engine power in flight. The first accident, involving a Socata Trinidad TB 20, N31TB (serial No. 483), occurred at Omaha, Nebraska, on September 25, 1988, because of fuel starvation.1/ The second accident, involving a Socata Trinidad TB 21, N20GF (serial No. 646), occurred at Clinton, Iowa, on November 22, 1988, for undetermined reasons.2/ No injuries were sustained in either of these accidents. The third accident, involving a Socata Trinidad TB 21, N28LR (serial No. 812), occurred at Newhall, California, on June 22, 1989, and appears to have been precipitated by water in the fuel.3/ After losing engine power, The pilot of N28LR attempted an emergency landing but all four occupants aboard were killed when the airplane struck high-voltage electrical transmission wires. Also, pilots of several other Trinidad TB 20 airplanes have experienced engine surging in flight that necessitated precautionary landings, and several Service Difficulty Reports (SDR) have been submitted to the Federal Aviation Administration (FAA) regarding problems with the original (now obsolete) fuel systems in both TB 20 and TB 21 airplanes. Notable excerpts from the SDRs include:

> Following takeoff, the pilot turned off the electric fuel boost pump. At this time, the engine started to die. He made it back to the runway from 300 feet. On first inspection, fuel was noted running from the existing fuel filter bowl drain valve. The valve (closing) spring appears to be too weak. The bowl has been modified to accept a standard aircraft approved fuel drain valve. Submitter recommends changing the valve. (TB 20, SDR processed 04/28/86)

1/ For more detailed information, read Field Accident Brief No. 1545 (attached).
2/ For more detailed information, read Field Accident Brief No. 1935 (attached).
3/ Investigation in progress.

Pump gallons per hour output was 9 gph at 23 psi when tested following accident possibly caused by fuel starvation. Pump specification is 35 gph at 23 psi. Pump also tested 25 psi maximum when specification is 27.5 psi maximum. Unit had 99.37 hours operation since installed after repair by aircraft accessories. (TB 20, SDR processed 12/14/88)

Engine would not lock properly, rough and surgey. Flowed injector nozzles found flow in all nozzles to be pirated, cleaned nozzles. Engine run still showed roughness. Upon shutdown, noted fuel dripping from electric boost pump drain. Turned on pump, fuel poured from drain, but with engine running, no fuel dripped. Capped off drain line, engine ran smooth. Apparently sucking air through drain into fuel system, causing fuel interruption. This pump is at fuel bowl drain and is apparently drained at preflight. This pump is placarded "Never Operate Pump Dry." Submitter recommends redesign of system or don't drain sump at preflight. (TB 21, SDR processed 07/15/87)

Pilot reported engine surging in flight, accompanied by fuel flow oscillations. Inspection of fuel system revealed fuel leakage from boost pump seal drain. This condition could allow air to enter fuel system during relatively high power operation (cruise) with pump turned off and could partially cavitate pump, causing delayed recovery of fuel pressure when pump is turned on. Pump was removed, overhauled and reinstalled. Aircraft was ground run for leak and operational checks and judged safe for flight. Check flight of 1 hour duration was performed with no discrepancies noted. Submitter recommends that during preflight inspection, boost pump be operated and seal drain line be inspected for fuel leakage. (TE 20, SDR processed 06/13/88)

The National Transportation Safety Board suspects that the older, original design of the fuel system in the airplanes may have contributed to one or both of the accidents involving N31TB and N20GF, but a definite causal relationship could not be established. Nonetheless, the Safety Board's evaluation of the specific design and operating characteristics of these fuel systems prompts concern because they appear to be conducive to the induction of air in the system and the formation of vapor lock and do not appear to meet the intent of several of the fuel system requirements of Subpart E of 14 CFR Part 23 concerning fuel flow and fuel pressure, fuel pump systems, and fuel system operation in hot weather.

Socata's new improved fuel system, which appears to correct the problems of air in the system and vapor lock, had been installed in N28LR. However, because of a rough-running engine, both in flight and during engine runup on the ground, the pilot of N28LR took the airplane to a certificated maintenance facility for service and/or repair. After noting that the fuel injector servo mechanism had been contaminated with water, maintenance personnel, on the day of the accident, drained the fuel system (using the airplane's several drain valves) until no further water was observed in the fuel samples. Nonetheless, the Safety Board's examination of the wreckage of N28LR disclosed water to be present throughout the fuel system.

The fuel systems in Trinidad TB 20 and TB 21 airplanes are identical and include a fuel tank in each wing. The fuel tanks in the models manufactured before 1987 (prior to serial No. 731) are located at the fuel system low point and require the engine-driven and electric fuel pumps to lift the fuel against an adverse pressure gradient from the tanks to the engine. Fuel lines from the respective tanks are first routed up to the fuel selector near the top of the instrument panel (approximately 20 inches above the level of the fuel) and then through the firewall and down to the electric boost pump/filter assembly at the bottom left side of the firewall. From there, the fuel line is directed back upward to the engine-driven fuel pump and then to the engine. In summary, fuel must be drawn (sucked) uphill from the fuel tanks through a long serpentine arrangement of fuel lines, pumps, and valves, some of which are located in the very high-temperature environment of the engine. The Safety Board believes that, as a result of these design-operating conditions, the fuel system is vulnerable to vapor lock (fuel starvation), particularly at high altitudes, as well as other malfunctions.

To avoid damage to the electric fuel boost pump mechanism or seals, the manufacturer of the pump (Dukes, Incorporated) has placed a placard on the pump indicating that it must not be operated dry. However, because the original design of the TB 20 fuel system does not provide for a gravity fuel pressure head to any fuel system component, fuel in the lines and valves of the system tends to be siphoned back down to the fuel tanks when the engine-driven and electric boost pumps are inoperative. According to some TB 20 owners and operators, when they attempt to start the engine, the boost pump is sometimes unable to self-prime the empty lines and produce a flow of fuel (a green light on the instrument panel illuminates when fuel flow is established). As a result, the boost pump rotor shaft vane and bearing seal assemblies may sustain damage and allow air to enter the system. One operator of these airplanes has resolved this starting problem by having someone blow into the fuel tank vents, thereby slightly pressuring the tanks and forcing fuel up to the boost pump. Once this is accomplished, the engine starts and operates normally, unless the boost pump seal assembly has been damaged. In that case, fuel may leak from the boost pump drain assembly when the engine is off or is operated at low power settings; surging of the engine is likely to occur at higher in-flight engine power settings.

As a result of service and operating problems caused by dry operation of the fuel boost pump, Socata issued Service Kit No. 9128, "Installation of a Check Valve on the TB 20 Fuel System." The check valve, applicable to the original, obsolete fuel systems in TB 20 airplanes through serial No. 730, was intended to avoid dry operation of the boost pump by keeping the fuel inlet to the boost pump submersed in fuel. However, the Safety Board does not believe that the check valve is an effective solution to the problem. For example, each of the fuel lines from the fuel selector valve to the respective fuel tanks may still remain void of fuel and require a self-priming, dry operation of the pump. Moreover, the quantity of fuel above the boost pump filter assembly is diminished by the amount of fuel drawn from the assembly during preflight (fuel filter in airplanes though serial No. 730 is an integral part of the boost pump) and the problem is further complicated by leaky fuel filter drain valves, as reflected in several of the SDRs submitted to the FAA. (The maintenance manual for the TB 20 and TB 21--Chapter IX, Section 11.3, "Replacement of Bleeds on 'Sofrance' Filter"--refers to the installation of new, and presumably improved, fuel filter drain valves.)

Socata also attempted to alleviate fuel system problems by issuing Service Kits Nos. 9132 (TB 20) and 9133 (TB 21), "Fitting of New Weldon Electric Fuel Booster Pumps." These kits, applicable to airplanes through serial No. 730, provide for the installation of boost pumps supplied by a different manufacturer; Socata believed the Weldon pumps were better able to handle air or vapor and avoid cavitation. However, the Safety Board believes that the fundamental cause of the fuel system operating and service problems in these airplanes is inadequate design of the fuel system rather than specific operating characteristics or capabilities of individual fuel boost pumps. For example, both the old and new fuel boost pumps are positive displacement pumps, neither of which should be operated dry.

In 1987, Socata substantially redesigned the fuel systems in TB 20 and TB 21 airplanes, beginning with airplane serial No. 731, by relocating the electric fuel boost pumps and fuel selector valves. The boost pump is now mounted in the belly of the airplane below the level of the fuel in the wing tanks. Because of the gravity fuel pressure head assuring inlet fuel to the nearby pump at all times, there is no suction or adverse pressure gradient and the occurrence of cavitation or pump-induced fuel system malfunction is unlikely. The fuel selector valve was redesigned and relocated from the top of the instrument panel (where it was difficult to see) to a console near the floor of the airplane. The fuel selector outlet line is routed directly through the lower portion of the firewall. As a result of these changes, the fuel system now operates under the influence of a positive-pressure fuel flow, and the potential for vapor lock or fuel starvation appears to have been eliminated.

On March 17, 1989, the owner of a TB 20 airplane, N33AS (serial No. 533), advised the Safety Board that engine surging and erratic fuel flow were encountered in flight on several occasions and that subsequent ground-testing of the engine-fuel system, utilizing clear plastic tubing, confirmed the presence of air in the fuel lines. The air entry point was traced to the fuel boost pump (damaged seal). Additionally, because of recurring water in the fuel, as evidenced in fuel samples, the fuel tanks of N33AS were drained and the sealed access doors were removed to purge all fluid from the interior of the tanks. The mechanic who performed this operation told the Safety Board that a substantial quantity of fluid remained entrapped at two locations: (1) behind ribs separating the several fuel bays, and (2) in the area adjacent to the fuel sump. The fuel sump, according to the mechanic, did not appear to be at the low point of the tank. As a result of this report and the catastrophic accident involving N28LR, the Safety Board believes that tests of the TB 20 and TB 21 fuel tanks should be conducted as soon as possible to determine whether or not the fuel tank sump design complies with the fuel system requirements of 14 CFR Part 23, or their equivalent.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Require Socata to prepare a service bulletin ("Improved Fuel System Design, TB Series Airplanes") and a fuel system modification kit to retrofit all United States registered Trinidad TB 20 and TB 21 airplanes through serial No. 730 with a fuel system similar or equivalent to that installed in current production models of the airplanes. (Class II, Priority Action) (A-89-75)

> Issue an airworthiness directive applicable to Socata Trinidad TB 20 and TB 21 airplanes through serial No. 730 requiring, within the next 100 hours of flight, modification of the fuel system in accordance with Socata Service Bulletin, "Improved Fuel System Design, TB Series Airplanes," referenced in Safety Recommendation A-89-75. (Class II, Priority Action) (A-89-76)

> Conduct tests of the integral fuel tanks in Socata Trinidad TB 20 and TB 21 airplanes, with the airplane in its normal ground attitude, to determine whether any free water that may be present can be completely eliminated through the fuel tank sump drain valves. If water remains entrapped, the Federal Aviation Administration should require Socata to initiate appropriate remedial design action; issue an airworthiness directive outlining the action necessary to resolve this problem in existing airplanes;

and ensure that Socata TB 20 and TB 21 airplanes subsequently manufactured and imported into the United States comply with the provisions of 14 CFR 23.971,"Fuel Tank Sump," or their equivalent. (Class I, Urgent Action) (A-89-77)

KOLSTAD, Acting Chairman, BURNETT, LAUBER, NALL, and DICKINSON, Members, concurred in these recommendations.

By: James L. Kolstad
Acting Chairman

National Transport...on Safety Board
Washington, D.C. 20594

Brief of Accident

File No. - 1545 9/25/88 OMAHA,NE A/C Reg. No. N31TB Time (Lcl) - 1600 CDT

----Basic Information----

Type Operating Certificate-NONE (GENERAL AVIATION)

Type of Operation -PERSONAL
Flight Conducted Under -14 CFR 91
Accident Occurred During -LANDING

Aircraft Damage: SUBSTANTIAL
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	0	0	1
Pass	0	0	0	3

----Aircraft Information----

Make/Model - AEROSPATIALE TB-20
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 2943
No. of Seats - 4

Eng Make/Model - LYCOMING IO-540-C4D5D
Number Engines - 1
Engine Type - RECIP-FUEL INJECTED
Rated Power - 250 HP

ELT Installed/Activated - YES/YES
Stall Warning System - YES

----Environment/Operations Information----

Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - FULL
Basic Weather - VMC
Wind Dir/Speed- 170/013 KTS
Visibility - 15.0 SM
Lowest Sky/Clouds - 22000 FT SCATTERED
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
MOLINE,IL
Destination
OMAHA,NE

ATC/Airspace
Type of Flight Plan - IFR
Type of Clearance - IFR
Type Apch/Lndg - FORCED LANDING

Airport Proximity
ON AIRPORT

Airport Data
EPPLEY
Runway Ident - 17
Runway Lth/Wid - 8153/ 150
Runway Surface - ASPHALT
Runway Status - DRY

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
PRIVATE
SE LAND

Age - 21
Biennial Flight Review
Current - YES
Months Since - 4
Aircraft Type - TB-20

Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT

Flight Time (Hours)

Total -	241	Last 24 Hrs -	2
Make/Model-	23	Last 30 Days-	13
Instrument-	69	Last 90 Days-	62

Instrument Rating(s) - AIRPLANE

----Narrative----

THE PLT RPRTD THAT WHEN THE ACFT WAS AT APRX 150' TO 200' AGL ON FINAL APCH, THE ENG LOST PWR & WOULD NOT RESTART. UNABLE TO RCH THE RWY, HE LNDD ABOUT 50' SHORT ON SOFT TRRN, WHERE THE GEAR COLLAPSED & THE ACFT WAS DMGD. ONLY ABOUT 12 OUNCES OF FUEL WAS REMAINING IN THE LEFT TANK, BUT 13 GAL WAS FND IN THE RGT TANK. DRG POST-ACDNT CHECKS, 3 GAL OF FUEL WAS ADDED TO THE LEFT TANK. HOWEVER, THE ENG WOULD NOT START IRREGARDLESS OF THE FUEL SELECTOR PSN. WHEN AN INDEPENDENT FUEL SOURCE WAS CONNECTED TO THE INLET FUEL LINE, THE ENG STARTED & OPERATED NORMALLY. HOWEVER, WHEN THE ENG WAS RECONNECTED TO THE ACFT FUEL SYS, IT RAN ONLY BRIEFLY & WOULD NOT RESTART, EVEN THOUGH FUEL IN THE TANKS EXCEEDED THE UNUSABLE LVL OF 1.3 GAL/TANK. A TEST OF THE BOOST PUMP SHOWED THAT AT 23 PSI, ITS FLOW RATE WAS 9 GPH; THE PUMP SPECIFICATION WAS FOR 35 GPH AT 23 PSI.

File No. - 1545 9/25/88 OMAHA,NE A/C Reg. No. N31TB Time (Lcl) - 1600 CDT

Occurrence #1 LOSS OF ENGINE POWER(TOTAL) - NON-MECHANICAL
Phase of Operation APPROACH - VFR PATTERN - FINAL APPROACH

Finding(s)
1. FLUID,FUEL - LOW LEVEL
2. FLUID,FUEL - STARVATION
3. FUEL TANK SELECTOR POSITION - IMPROPER - PILOT IN COMMAND

Occurrence #2 FORCED LANDING
Phase of Operation DESCENT - EMERGENCY

Finding(s)
4. FUEL SYSTEM,ELECTRIC BOOST PUMP - OUTPUT LOW
5. STARTING PROCEDURE - NOT ATTAINED -

Occurrence #3 IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation LANDING

Finding(s)
6. TERRAIN CONDITION - SOFT

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 2,3

Factor(s) relating to this accident is/are finding(s) 1,4,6

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

File No. - 1935   11/22/88   CLINTON,IA   A/C Reg. No. N20GF   Time (Lcl) - 1430 CST

----Basic Information----

Type Operating Certificate-NONE (GENERAL AVIATION)

Type of Operation -PERSONAL
Flight Conducted Under -14 CFR 91
Accident Occurred During -LANDING

Aircraft Damage: SUBSTANTIAL
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	0	0	1
Pass	0	0	0	1

----Aircraft Information----

Make/Model - AEROSPATIALE TB-21
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 3083
No. of Seats - 4

Eng Make/Model - LYCOMING TIO-540-AB1AD
Number Engines - 1
Engine Type - RECIP-FUEL INJECTED
Rated Power - 250 HP

ELT Installed/Activated - YES/YES
Stall Warning System - YES

----Environment/Operations Information----

Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - FULL
Basic Weather - VMC
Wind Dir/Speed- 180/009 KTS
Visibility - 7.0 SM
Lowest Sky/Clouds - CLEAR
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
WAUKEGAN,IL
Destination
OMAHA,NE

ATC/Airspace
Type of Flight Plan - IFR
Type of Clearance - IFR
Type Apch/Lndg - FORCED LANDING

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
PRIVATE
SE LAND

Age - 43
Biennial Flight Review
Current - YES
Months Since - 4
Aircraft Type - UNK/NR

Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT

Flight Time (Hours)

Total -	158	Last 24 Hrs -	1
Make/Model-	32	Last 30 Days-	40
Instrument-	33	Last 90 Days-	94

Instrument Rating(s) - AIRPLANE

----Narrative----

THE PLT RPRTD THAT WHILE CRUISING AT 10,000' & MONITORING THE ENG INSTRUMENTS IN A NORMAL MANNER, POWER WAS SUDDENLY LOST AS IF BY FUEL STARVATION. HE STATED THAT EMERG PROCEDURES WERE PERFORMED, BUT HE WAS UNABLE TO RESTART THE ENG IN SPITE OF FUEL IN BOTH TANKS. HE TRIED TO GLIDE TO AN ARPT, BUT WAS UNABLE. DRG AN EMERG LANDING, THE NOSE & RGT MAIN GEAR COLLAPSED AFTER THE ACFT ROLLED ABOUT 20 TO 30 YDS IN SOFT TERRAIN. NO SPECIFIC MECHANICAL PROBLEM WAS FOUND THAT WOULD HAVE RESULTED IN A LOSS OF ENG POWER.

Brief of Accident (Continued)

File No. - 1935 11/22/88 CLINTON,IA A/C Reg. No. N20GF Time (Lcl) - 1430 CST

Occurrence #1 LOSS OF ENGINE POWER
Phase of Operation CRUISE - NORMAL

Finding(s)
1. MISCELLANEOUS - UNDETERMINED

Occurrence #2 FORCED LANDING
Phase of Operation DESCENT - EMERGENCY

Finding(s)
2. EMERGENCY PROCEDURE - INITIATED - PILOT IN COMMAND

Occurrence #3 GEAR COLLAPSED
Phase of Operation LANDING - ROLL

Finding(s)
3. TERRAIN CONDITION - SOFT
4. LANDING GEAR - OVERLOAD

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 1

Factor(s) relating to this accident is/are finding(s) 3