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July 27, 1998

Mr. Jean-Pierre Scarfo
National Transportation Safety Board
Washington, D.C. 20594

Subject: NTSB questions pertaining to Grumman F9F-2 accident on September 19, 1996 re: reports by ASI-ECD

Reference: Reports ECD422-AR82 dated November 14, 1996, ECD422-AR86 dated December 18, 1996, and Letter to David W. Dodson from Jean-Pierre Scarfo (NTSB) dated July 9, 1998.

Dear Mr. Scarfo:

AlliedSignal Aerospace Equipment Systems - South Bend has completed answering the questions you asked in your above referenced letter concerning the Grumman F9F-2 Panther accident on September 19, 1996. These answers are made as general statements of fact as recalled by the members of the investigative team using the test data and reports generated at the time of the investigation and operating and service manuals in our possession or obtained while responding to your questions. As noted, the information provided represents that found during testing and may not represent the actual condition of the components at the time of the accident. However, differences from standard or allowances made to account for the test conditions are not believed by AlliedSignal to indicate any degradation in the performance of the engine or its components at the time of the accident. Specific answers to your questions follows:

1. AlliedSignal Report No. ECD422-AR86 dated December 18, 1996

A. **What is the normal fuel flow schedule for testing the fuel pumps in the emergency and normal modes?**
There is not a fuel flow schedule for the entire fuel flow range of this pump. This pump is set for stall conditions, volumetric efficiency, maximum flow, governor setting and maximum discharge pressure per Handbook Overhaul Instructions for Fuel Pumps, Model JP-A5, JP-C2 Form 15-46. See attached JP-A Type Flow Inspection Sheet. Attachments A1 and A2.

B. **In exhibit AR86-F8, there are two (2) fuel flows, one labeled Wfm (pph) and the other EMG Wfm (pph). I assume the first Wfm is the fuel flow in the normal mode before switching on the emergency mode. If this is correct, then please explain the difference in the normal fuel flows in exhibit AR86-F8 and F7.**

AR86-F8
The pump emergency fuel flow is denoted by EMG Wfm pph. The pump fuel flow denoted by Wfm pph represents the pump fuel flow with simulated Servo Pressure psi. The servo pressure (Pg) is applied to the pump when the system is in the normal (or main) mode. In the emergency mode Ps is the same as Fuel Pump Discharge Pressure.

The difference between AR86-F7 and F8 normal fuel flows is AR86-F7 depicts the fuel pump in the normal mode without Ps being regulated to position the pump control piston. Pump control piston controls the cam plate angle for increasing or decreasing pump pistons. An increase in cam plate angle increases pump piston stroke and pump output.

AR86-F8 depicts the fuel pump in the main (normal) mode with Ps being simulated. Ps fuel flow and pressure is controlled by the Fuel Control Amplifier.

The two (2) data sheets depict three (3) pump fuel flow conditions. AR86-F8 demonstrates the fuel flows in the normal and emergency models and AR86-F7 denotes pump in normal mode without Ps regulation.

The pumps were checked in this manner to a portion of the pump Inspection Test Specification to verify that the pumps were functioning. The pumps were only tested because initial engine test raised the questions as to whether or not the pumps were discharging fuel flow.

C. **In exhibit AR86-F12, there are two (2) fuel flows, one labeled Wfm and the other wfm. Could you please explain the difference?**
AR86-F12
The WFM represents the pump fuel flow in the normal mode without Ps - Ps dumped overboard back to bench tank. The Wfm represents the pump fuel flow in the emergency mode- Pump Ps isolating valve shuts off Ps flow and Ps rises to become Pump Discharge Pressure.

This additional information denotes the pump fuel flow output at lower RPM input to pump and coincides with the emergency fuel flow starting at 700 RPM on AR86-F13 - column denoted by Emg. WFM PPH.

D. **In exhibit AR86-F13, there are two (2) fuel flows, one labeled Wfm (pph) and the other EMG Wfm (pph). I assume the first Wfm is the fuel flow in the normal mode before switching to the emergency mode. If this is correct, then please explain the difference in the normal fuel flows in exhibit AR86-F13 and F-12.**
AR86-F13
Fuel flow labeled WFM represents normal mode and Emg. WFM represents emergency mode.

Difference between normal fuel flow in exhibit AR86-F13 and F-12.
The normal fuel flow in AR86-F13 denotes pump fuel flow with Ps and AR86-F12 denotes pump fuel flow without Ps regulation. Thus three (3) extreme fuel flows were checked on the pump. The lowest fuel flow is exhibited when Ps is dumped overboard - simulates a wide open fuel control amplifier Ps halfball as far away from the Ps orifice as possible. (AR86-F12) The second condition (AR86-F13)represents the pump in normal mode with Ps simulated -as if the fuel control amplifier were in the system. The third condition represents the pump fuel flow in the emergency mode.

E. **At what pressures do the pressure switches normally open and close?**
The Grumman Hydrol pressure switches were not manufactured by AlliedSignal. AlliedSignal does not know the trip pressure.

The two (2) switches were checked upon NTSB request. Switch S/N 2612L at 485 psu had an open circuit and at 435 psu had a closed circuit. Switch S/N 2302L remained open at all pressure levels from 0 to 900 psu and was presumed to be non-functional.

2. AlliedSignal Report No. ECD422-AR82 dated November 14, 1996

A. **What does adjusting the minimum flow counterclockwise do?**
Counterclockwise on the control min flow adjustment decreases metered flow through the Governor Valve.

B. **What is the fuel flow suppose to be at idle and max power?**
Idle fuel flow is set at Test Points 5 and 6 per Test Specification AR-82-F32: 470-750 pph at T.P.5. and 385/635 pph at T.P.6.

Max power, wide open (W.O.) Throttle position, fuel flow is defined on T.S. AR82-F32 at Test Point 42 as 6800 to 7080 pph.

C. **Does adjusting the minimum flow stop effect engine/fuel pump RPM?**
No, if on a Fuel Control Test Stand. Adjusting the min flow stop positions Control Governor Valve to a fuel flow at a given Control RPM. Yes, if this adjustment is made while installed on the engine, then both engine and control RPM are affected. The manual stipulates that Min Fuel Flow adjustment is to be made on a Fuel Control Test Stand only.

D. **In exhibits AR82-F28, the nozzle flows for some of the test points (5,6,7) are outside the limits. Could you explain why that is acceptable or why this doesn't adversely effect engine performance?**
Exhibit AR82-F28 limit acceptability.
The Test Points 5, 6 on exhibit are field adjustable on engine (idle).

In order to simulate all the test conditions to comply with Test Specification exhibited on AR82-F28 either a Pressurizing Valve (FD-A), or a special fixture encompassing two (2) fixed orifices sized to simulate FD-A, to provide nozzle pressure or back-pressure to the Fuel Control.

An FD-A device was not with the Test Control, therefore a valve was installed as an alternate method to stimulate back pressure. This device was only set for the high flow section. This explains why some fuel flow test points are outside the Test Specification Limits and others are in the ball park.

The purpose of this test was not to verify that the Fuel Control ran to Test Specifications. It was to determine if the Fuel Control responded to throttle input, i.e. advance/decrease in Throttle position has a corresponding fuel flow change. Fuel Control wf changed in the correct direction and also responded to quick/rapid Throttle Inputs.

3. General Questions

A. **Does the fuel control sense the ram effect? How does it do it? Is it through an increase in engine RPM?**
Yes, Fuel Control can experience RAM effect due to the proportion of engine/control RPM and to the Density Aneroid.

The RAM effect on Aneroid compresses the Aneroid bellows and increases fuel flow - reference AR82-F28 Test Point 13.

Engine RPM is increased due to RAM effect on the compressor and due to the Control Fuel Flow increase change due to RAM effect on Aneroid.

B. **What inputs activate the fuel control emergency solenoid?**
The Fuel Control Pressure Switch activates the emergency solenoids. In the cockpit, the pilot can trigger the emergency switch.

C. **Is the amplifier in the fuel control used during the start sequence? If yes, what will a stuck amplifier halfball do?**
No.

D. **Is there a minimum fuel flow adjustment for the emergency mode? If yes, how is it adjusted?**
No. The emergency system has only two (2) items to adjust, the emergency throttling valve and emergency idle bleed. The emergency throttling valve is adjusted for max fuel flow at max throttle angle, 90 degrees. The emergency bleed is adjusted for altitude idle (15 degrees) reference emergency section test points 48 through 52 on the test specification AR82-F28.

The emergency fuel flow is controlled by and is directly proportional to the power lever angle.

Should you have any further questions concerning the above or our investigation of the subject fuel controls or pumps, please to not hesitate to contact us for additional information or clarification.

Sincerely,

[redacted]

David W. Dodson
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Attachments