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DEPT OF TRANSPORTATION

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25 Jan. 2000
2358 Peach Parkway
Fort Valley, Georgia 31030

Department of Transportation, Dockets
Docket No. FAA 1999-6411 — 9
400 Seventh Street SW.
Room Plaza 401
Washington, DC 20590

Gentlemen,

Long before the Flight 800 disaster many of us have been concerned about the design of fuel systems in general, so we are excited about the opportunity to get something done about the . problem

In meetings with FAA Atlanta, Jerry C. Robernette Senior Engineer, Propulsion, David Crews, Senior Engineer, Flight Test; Robert Bosak, Aerospace Engineer.Propulsion , Paul C. Sconyers, Associate Manager, Atlanta Certification Office sat down with our team and went over our schematics in great detail. We have been encouraged by their help and interest and will continue to work with them. We have also received help from Mercer University Engineering Department(Proof of Concept Research) and Doctor Bill Nease, Economics Department joined our team. We received our Patent Pending about a year ago and are still working toward our final Patent.

We are excited about this project and are looking forward to hearing from you.

Please, accept our solution to this problem so that we can get started with the task of making flying safer for us all.

Sincerely,
L. Frank Smisson
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CEO SHN Fuel Systems

INTRODUCTION

Fuel tank explosions in airplanes have been of concern to aircrews, airlines, the military, aircraft manufacturers and their component suppliers, and government air safety oversight agencies for many years. Fuel tank explosions first became a significant issue during World War II when aircraft were exposed to enemy fire with the potential of "hits" in the fuel tanks. Since WWII, the potential for catastrophic fuel tank explosions has grown dramatically because of the tremendous increase in the numbers of aircraft in the sky, ever larger planes with additional and ever larger fuel tanks, and often without proper consideration given to deterioration of parts like wiring, insulation, rubber seals, motor bearings and other critical components necessary to safety of flight. Extrapolating these trends portends many more planes in the skies and more people flying more often over longer distances. Thus, the potential for catastrophic events due to fuel tank explosions also increases.

During WWII, (even as early as 1938) the Russians developed a system (used in their LN-7 and LN-8 Fighters) of pumping exhaust gases into and around fuel tanks to reduce this problem. Although the system was reasonably effective in warm temperatures, it failed in the lower temperatures of winter because in any internal combustion engine ten parts of the exhaust is water in the form of steam. This steam condensed into water and froze adding ice as another hazard.

On long missions during the War in the Pacific, when bomb bay tanks were used to extend range, bomber crews often used CO_2 from a hand held fire extinguisher to flush fuel fumes from the bombay tanks to reduce the probability of explosion in event of a tracer hit in an empty tank. One of the B-24 pilots that employed this system is also one of the inventors of SHN fuel system described in this response to Docket 64-11.

Because there is sufficient CO_2 plus and other inert gasses in the exhaust of jet engines to purge the tanks of fuel fumes as well as sufficient flow to drive an Air Cycle Unit the Smisson Hudson Nease Fuel System will provide constant purging of fuel fumes and excess CO_2 as well as provide temperature control of the in tank fuel. In view of the fact that ten parts of the exhaust is water in the form of steam, our system provides a water separator to dry the inert gases, chill and filter the gases before using them to provide a 2.7 pressure differential while providing a constant out flow of fuel fumes and excess CO_2 .

Some of the contaminants are carried off with the water, and the remaining will be filtered through a cotton sleeve before entering the tank, thereby allowing only inert, clean, dry, chilled air into the tanks. The outflow valves will be adjusted to maintain the desired differential pressure to provide a constant out flow of fuel fumes and excess CO_2. The out flow valves will be located in the vent surge tanks.

RESPONSE TO FAA DOCKET 1999 64-11

OBJECTIVES

To show:

1. How the SHN Fuel System eliminates all three sides of The Fire Triangle.

2. That SHN fuel system meets or exceeds all requirements contained in Docket 64-11.

3. The basis for SHN Fuel System STC.

4. That catastrophic failure conditions will not occur during life of fleet using SHN System

5. Design integrity and quality, including life limits, to ensure intended functions and prevent failures.

6 Redundancy or backup systems that provide system function after the first failure.

7. System independence, i.e. isolation of systems and components so that failure of one element will not cause failure of the other.

8. The mechanism for detection of failures or failure indication.

9. Functional verification (The capability to test or check the component's condition.).

10. Proven reliability and integrity to ensure that multiple component or system failures will not occur in the same flight.

11. Damage tolerance that limits the safety impact or effect of the failure.

12. Designed failure path that controls and directs the failure, by design to limit the safety impact.

13. Flightcrew procedures following failure designed to assure continued safe flight by specific crew actions.

14. Error tolerant design that considers probable human error in the operation, maintenance, and fabrication of the airplane.

15. Margins of safety that allow for undefined and unforeseeable and adverse flight conditions.

OBJECTIVE # 1
THE FIRE TRIANGLE

For fire to occur three things must be present:

1. Combustible material	In this case, fuel fumes.
2. O2	Contained in air in fuel tank.
3. Ignition	From a spark due to build up of static electricity, a hot motor bearing or even a dropped metal tool striking another piece of metal or a lightening strike.

COMBUSTIBLE MATERIALS

The SHN fuel system continuously removes all combustabl materials from the fuel tanks by scooping CO_2 plus other inert gases from the tail pipe, using this high pressure gas flow to operate the air cycle unit which provides pressurized, chilled flow of filtered inert gases through the fuel tanks removing all fuel fumes from the tanks along with excess inert gases.
The outflow valves are set to maintain 2.7 pressure differential (the same as in the cabin differential) The outflow valves are installed in the vent surge tanks. For ground operation the exhaust of the APU is used to operate the Air Cycle Unit. The temperature of the fuel is controlled by an aquastat in the fuel tank that modulates the mixing valve maintaining the fuel temperature at desired levels. Note: From page 5 of FAA Docket 1999 64-11,"Vapors from Jet A fuel (the typical commercial turbo engine fuel) at temperatures below approximately 100 degrees F, are too lean to be flammable at sea level, at higher altitudes the fuel vapors become flammable at 45 degrees F, (at 40,000 feet altitude) "Please remember that on a standard day the outside temperature is minus 55 Degrees plus or minus ISA. So it will never approach 45 degrees F." However, the regulatory authorities and aviation industry have always presumed that a flammable fuel air mixture exists in the fuel tanks at all times and have adopted the philosophy that the best way to ensure aircraft fuel tank safety is to preclude ignition sources within fuel tanks".Because. this philosophy takes into consideration only one side of the "Fire Triangle", this philosophy must be changed.

OXYGEN

By continuous purging the tank of all fuel fumes and excess CO_2 and other inert gases the level of O_2 never reaches a point where combustion can be supported.

OBJECTIVE # 2

SHN FUEL SYSTEM MEETS OR EXCEEDS ALL REQUIREMENTS CONTAINED IN FAA DOCKET 1999 64-11.

After reviewing all 15 Objectives in this response, and Docket 64-11, we are certain that SHN Fuel System will meet or exceed all requirements set forth by FAA and prevent any and all fuel tank accidents.

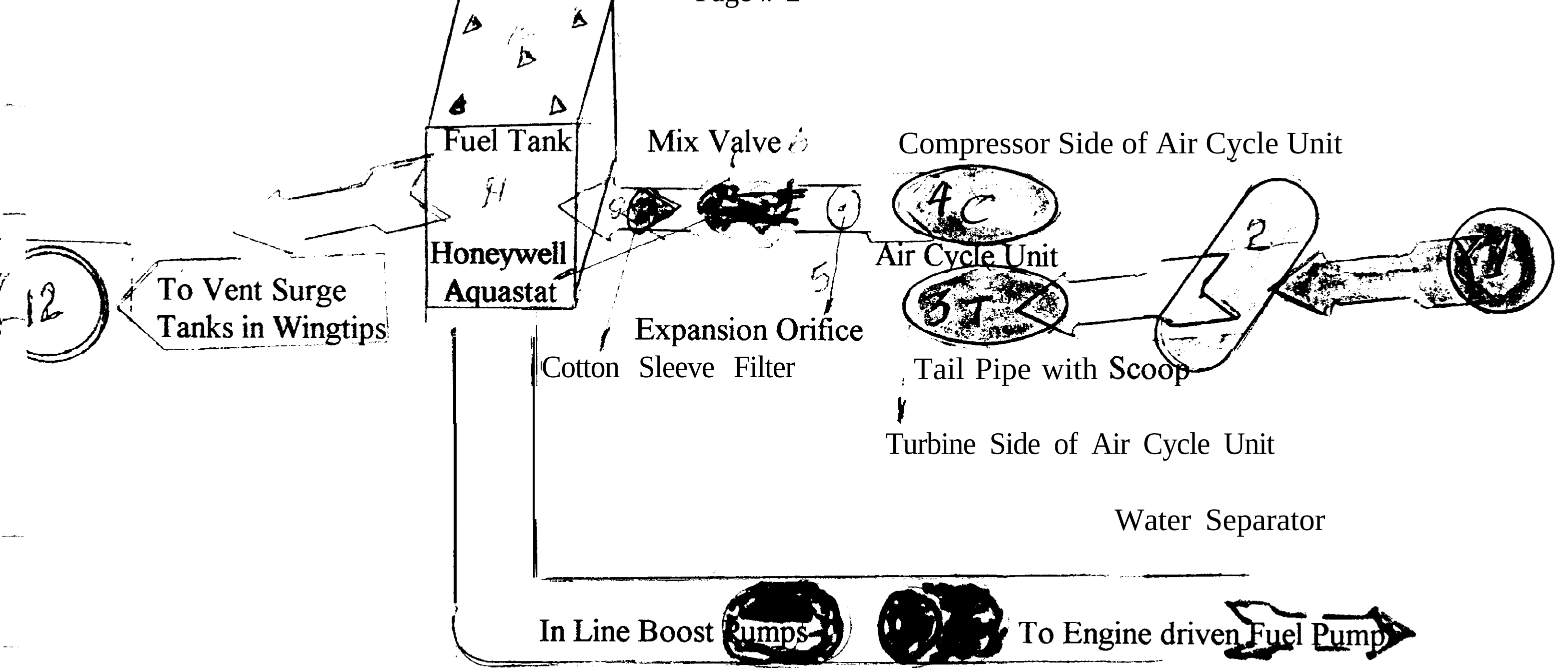
BASIS FOR STC

After several meetings with FAA in Atlanta, Georgia, we were advised to get an STC. We also feel that an STC is the way to proceed, and if our response to this docket meets with your approval we shall go for the STC.

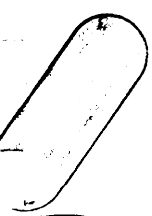
Even though we know we have a valid approach to this problem and it will save a lot of lives, we know that it is going to be very costly and time consuming. This is a fix that is long over due and we would like to get started.

Any suggestions, advice or words of wisdom will be greatly appreciated.

OBJECTIVE #
Page # 1

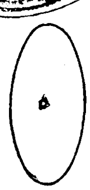



1. Scoop in Tailpipe picks up flow from engine exhaust and directs it through duct work to:


2. Water Separator where steam is condensed into water carrying some contaminates with it overboard. Since the Outside Air Temperature at cruise altitude is minus 55 degrees C., the Water Separator must be heated to keep the water from freezing. Ten parts of the exhaust is water in the form of steam. The dried CO_2 is routed through duct work to:


3. The Turbine Side of the Air Cycle Unit and the exhaust coming out of Turbine side of the Air Cycle Unit is routed to:


4. The Compressor side of the Air Cycle Unit where it is compressed and routed through:


5. The Expansion Orifice where it expands and chilled to a very low temperature and routed to:

6. The Mixing Valve that is modulated by:

7. The Honeywell aquastat located in the Fuel Tank to control the Fuel Temperature by mixing hot air from the Turbine side of Air Cycle Unit with the chilled and dried CO_2 (plus any other inert gases). From the Mixing Valve the gases that have been adjusted to the required temperature are routed through duct work that contains a:

8. Cotton sleeve which filters out any remaining contaminates before reaching the:

9. Fuel Tank with:

10. Five Ultra Sonic Fuel Level sensors located in top of tank with one in each comer and one in center. An average of the five readings will give a very accurate Fuel in any aircraft attitude.

11. From the Fuel Tank, Duct Work routs the fuel fumes and excess CO_2 to the Outflow Valves located in the Vent Surge Tanks located in each wing tip. The Outflow Valves are adjusted to maintain small differential pressure is maintained in the tanks so that we will maintain a constant outflow of fuel fumes and excess CO_2.

12.. The Outflow valves are located. There are three Outflow Valves in each Vent Surge Tank that are adjusted to maintain a slight positive pressure and to allow a minimum of 22.5 Cubic Feet of gas fumes and excess inert gases to escape. (Since the 767 bums an average of 10,000 pounds an hour, which is 22.5 Cubic Feet per hour we will adjust the Outflow valves to provide a constant out flow. . :

DESIGN INTEGRITY AND QUALITY, INCLUDING LIFE LIMITS, TO ENSURE INTENDED FUNCTIONS AND PREVENT FAILURES.

The same components have been in use over the past sixty years to pressurize and air condition the cabins of jet aircraft. Very few problems have occurred, and when they did occur fixes were adopted that improved the system. One problem that happened from time to time after many hours of operation, was a sticking shaft on the outflow valves. The gum from nicotine caused the valves to stick, and the passengers would feel a bump in air pressure when they came unstuck. The fix of the time was to inspect and clean the shaft more often. Since smoking has been banned on passenger flights, this is no longer a problem.

The normal inspection cycles that apply to the environmental system will also apply to the SHN Fuel System. The Water Separator and the Duct Work are the exception, and should be inspected during routine inspections for any cracks and/or chafing.

The Ultrasonic Fuel Level Units should be checked on each pre flight by turning four off in each tank, check the reading on the fifth, then using the same procedure check each of the other four in each tank to ensure that each reading on the same tank is reading the same. These units are designed to be "quick change" items. Nevertheless, the loss of one of these units during flight will make little difference in the accuracy of the total fuel remaining reading, since there will still be the average of four readings instead of the average of five readings.

Life limits of the individual components of the SHN Fuel System, with the exceptions as outlined above, will be the same as the components in the aircrafts environmental system and inspection cycles and life limits will be the same.

OBJECTIVE # 6

REDUNDANCY OR BACKUP SYSTEMS THAT PROVIDE SYSTEM FUNCTION AFTER THE FIRST FAILURE

As mentioned in Objective # 4,. Built in redundancy on the 757/767 could have primary system plus two back up systems. However, this sound be an overkill excessive considering the reliability of the SHN Fuel System based on the many hours in service of the different components used in the system.

Our recommendation; is to use either engine to power the primary system and the APU to provide cooling and filtering while refueling, or in the unlikely event that there is a failure of the main system, use the APU powered system. If our recommendation is followed it would be a saving in cost and weight.

Quite a few years ago aircraft flying into New York International were lost due to main tank explosions during single point refueling. Gulf Oil Company investigated and ran a detailed study that revealed the problem to be, first mixing Jet A and JP-4 and the fact that when single point refueling (aprox 1,000 gallons in 12 minutes) six to eight inch spark gaps were occurring in the fuel tanks. Jet A would not explode because it was too lean, and JP-4 would not explode because it was too rich. But when mixed there was a point where the mixture was just right for ignition and the spark gaps set the stage for an explosion. In Canada they were using JP-4 at that time. In the States Jet A had already become the standard for civilian carriers.

Getting rid of fuel fumes during refueling can add to the safety of the refueling process.

There are Outflow valves in each Vent Surge Tank. In the unlikely event of a stuck valve there are two spares in each tank.

In the event of a stuck mixing valve , causing an overheat situation, an overheat sensor will activate a mechanical drive that will drive the mixing valve to the full cold position.

In the event of an over pressure situation a pressure sensor will open a by pass gate that will by pass the tank until the pressure is reduced to normal, at which time the bypass will be driven back to normal.

In event the water separator freezes, the Water Separator heater will turn on automatically.

There are five Ultra Sonic Fuel Level Sensors in each tank. They are mounted in the top of the tank. One in the center top and one in each comer of the top of the tank. The average of all the sensors will give a very accurate reading of fuel remaining regardless of the attitude of the aircraft. In the event one sensor fails the average of the remaining four will still give a good reading. If four fail, which is extremely unlikely, an accurate fuel remaining can still be obtained at straight and level flight.

In the event of failure of one of the In Line Boost Pump, a drop in fuel pressure will automatically turn on the Stand By Boost Pump.

OBJECTIVE # 7
Page 1

SYSTEM INDEPENDENCE, ISOLATION OF SYSTEMS AND COMPONENTS SO THAT FAILURE OF ONE ELEMENT WILL NOT CAUSE FAILURE OF THE OTHER.

Reference Objective # 5, and the 11 components of the SHN Fuel System. We will take each of the eleven components and isolate their functions and look at the results of failure of that particular component.

Loss of:	Effect on #:			Maintenance
#1. Tail Pipe & Scoop	2 - 11.	Inoperative	No effect	Normal Preflight
#2. Water Separator	1		X	
	3		X	
	4		X	
	5		X	
	6			
	7			
	8			
	9			
	10			
	11			
# 3 Turbine Side of Air Cycle Unit	1			
	2			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
	11			
#4 .Compressor Side of Air Cycle Unit	1			
	2			
	3			
	5			
	6			
	7			
	8			
	9			
	10			

#5 Expansion Orifice #1
2
3
4
X
6
7
8
9
10
11

6 Mixing Valve #1
2
3
4
5
7
8
9
10
11

7 Cotton Sleeve 1
2
3
4
5
6
8
9
10
11

8 Fuel Tank
2
3
4
5
6
7
9
10

9 Honeywell Aquastat

1
2
3
4
5
6
7
8
10
11

10. Out Flow Valves

1
2
3
4
5
6
7
8
9
11

DETECTION OF FAILURES, OR FAILURE INDICATION

As mentioned before, the reliability of the components in the SHN Fuel System have a sixty year record of proven, almost maintenance free service in all environments. And as indicated in Objective # 7, some failures will require action by the crew, and some failures will be taken care of by automatic switch over to an alternate system. For example, a drop in fuel pressure will activate a switch to the Stand by Fuel Boost Pump. Since decisions of whether to continue on to the next leg of the flight or stop for a Quick Change replacement would be based on the knowledge that you are operating without a stand by pump.

Since automatic "switch over" may go unnoticed by the Flight Crew, the Fuel System Panel will also contain an Annunciator Panel that will be color coded to reflect in Red Lights those systems that must be fixed before the next flight. Amber Lights will indicate those items that should be changed out as soon as practical and offer no detriment to safe flight and green lights will indicate action that can be taken in flight to fix the problem, i.e. reset a circuit breaker, etc. Green and Amber Lights can be reset, red lights can be dimmed but not reset to off.

The SHN Fuel System will be designed so to allow for quick change out of components, that will enhance Safety of Flight and reduce cost of Maintenance.

Failure Indications, such as a drop in Oil Pressure, a Fluctuation in Fuel Pressure, an Engine quits are still good Indicators and should not be ignored, however a well designed system that has a well designed Annunciator

Annunciator lights will also indicate a by pass gate position (light on, either open or closed, either normal position or not in the correct position). Some light switches can also reset a circuit breaker.

OBJECTIVE # 9

FUNCTIONAL VERIFICATION (The capability to test or check the components condition)

Reference Objective # 8. To check the function of the Annunciator Panel the Fuel Panel light test switch should be pressed, which will light all lights on the Fuel System Lights including the Annunciator Panel Lights. Pushing each of the Annunciator Lights in turn, will check the circuits to the particular component. Once the engines are started, the function of other components can be checked by turning power to that particular unit off then on and watching for change of reading.

Fuel Boost Pumps can be tested with the Fuel Boost Pump Test Switch which simulates a drop in Fuel Pressure. Watch for a momentary drop in fuel pressure and an indication on the Fuel System Panel that the Standby Fuel Boost Pump is operating.

To test the Ultrasonic Fuel Level units, turn off one unit at a time and check that all the units read the same. A five unit system will give a very accurate indication in any attitude with ample redundancy since any three units will cover the attitude error.

OBJECTIVE # 10

PROVEN RELIABILITY AND INTEGRITY TO ENSURE THAT MULTIPLE COMPONENT OR SYSTEM FAILURES WILL NOT OCCUR IN THE SAME FLIGHT

The different components of the SHN Fuel System have been in use for over sixty years as components in the Pressurization and Air Conditioning Systems on jet aircraft. They have been practically Maintenance free.

Reference OBJECTIVE # 7,. "Effects of one component failure on another. In the event of a failure occurs that would shut down the system, (such as an engine failure), a complete independent stand by system, powered by the exhaust of the on board APU is available."

In event of failure of Stand By System, the aircraft will still fly normally.

OBJECTIVE # 11

DAMAGE TOLERANCE THAT LIMITS THE SAFETY IMPACT OR EFFECT OF THE FAILURE

All components of the SHN Fuel System are rigidly mounted in locations that offer the least exposure to damage. Each unit is constructed to standards that can withstand damage from impact as well as extremes in temperatures.

SHN Fuel System components will be manufactured to standards that will improve the safety factor of each unit. For example, the In Line Fuel Boost Pump is an axial flow, permanent magnet armature with the field coils as part of the structure, mounted exterior to the pump barrel..

The Turbine side of the Air Cycle Unit's housing is made of heavier reinforced material to protect the surrounding units in the unlikely event of a turbine failure.

Every consideration will be given to use of materials that will withstand the greatest impact and continue to operate.

OBJECTIVE # 12

DESIGNED FAILURE PATH THAT CONTROLS AND DIRECTS THE FAILURE, BY DESIGN, TO LIMIT THE SAFETY IMPACT.

Since the aircraft will continue to fly safely with most components of the SHN Fuel System inoperative, the best procedure is to shut down the failed component. The exception to this would be a stuck mixing valve in the "hot" position. First try opening the fuel tank by pass valve. If all efforts to unstick the mixing valve fail and the crew cannot open the bypass valve the crew can shut down the engine to prevent an overheat situation. If the aircraft is at cruise altitude, it is likely that the OAT (outside air temperature) may keep the fuel temperature within limits. If this is the situation, monitor the fuel temperature and continue on to destination.

Built in redundancy will take care of most failures, however, understanding the system and good common sense will ensure a safe flight.

OBJECTIVE # 13

FLIGHT CREW PROCEDURES FOLLOWING FAILURE DESIGNED TO ASSURE CONTINUE SAFE FLIGHT BY SPECIFIC CREW ACTIONS

In event of failure of the complete primary system, i.e. the SHN Fuel System, the pilot can switch to the Secondary system which is powered from the exhaust of the on board APU. In the event the APU is not running, it will be necessary to start the APU. Use normal Check list for starting APU in flight.

Check List will be provided with installation of the SHN Fuel System.

Along with the new check list, modified to the particular aircraft a check list and instructions for operation of the newly installed SHN Fuel System Panel is provided which will include the Fuel Panel Annunciator.

The SHN Fuel System has been automated as far as practical, and in most cases, the system will take care of itself Switching to an alternate system, repositioning valves to normal operation position will be accomplished automatically when a pressure or heat sensor senses the need.

The SHN Fuel System panel will include override switches, pro viding the Pilot with final control. From a practical approach, we have reviewed every possible situation, with Murphy's law firmly in mind." If anything can go wrong. ..it will."

OBJECTIVE # 14

ERROR TOLERANT DESIGN THAT CONSIDERS PROBABLE HUMAN ERROR IN THE OPERATION, MAINTENANCE, AND FABRICATION OF THE AIRPLANE.

Only components that have been in service for many years and proven to be practical maintenance free were used in the design of the SHN Fuel System. The aircraft will continue to fly safely with the loss of any or all of the components of the SHN Fuel System.

One example, the in line axial flow, Fuel Boost Pump are designed with ample space between the impeller vanes so that adequate fuel can continue to flow through the pump in event of failure. More than ten thousand pounds or twenty two and one half cubic feet per hour can continue to flow in event of failure of either pump. In the unlikely event that p\both pumps fail the engine driven fuel pumps will supply the necessary fuel for safe flight to destination.

The pumps are designed, taking into consideration Murphy's Law.. . It will be impossible to install the pump backwards. The intake end of the pump will have left hand threads while the pressure or outlet end of the pump will have right hand threads. In addition, color coding with arrows indicating direction of flow will be used along with a circuit diagram of the wiring on the barrel of the pump, so that a mechanic will not need to go look it up in the manual. Since these are A/C pumps we have simplified things for longer TBOs and or replacements for considerable savings in maintenance cost.

All components and installed units will be color coded with date of installation and scheduled date of next inspection and date/hours replacement is due.

In event of failure that could affect safety of flight all valves will be driven to normal flight position, unless overridden by the Pilot.

OBJECTIVE # 15

MARGINS OF SAFETY THAT ALLOW FOR UNDEFINED AND UNFORESEEABLE AND ADVERSE FLIGHT CONDITIONS

Flight Condition	Affect on SHN Fuel System	Affect on Safety of Flight
CAT	None	Normal
Lighting Strike	All Components well bonded	Normal
Icing	Water Separator Heater Turns On	Normal
Negative "G" Forces	None unless extended inverted flight	Do Not Exceed Aircraft Published Limitations
Positive "G" Forces	None (do not exceed published limits)	Stay within Published Limits

The SHN Fuel System is designed to with stand much greater stresses than the aircraft in which it is installed and no limitations will be reduced because of the installation of our system.

Department of Transportation, Dockets
Docket No. FAA 1999-64 11
400 Seventh Street SW.
Room Plaza 401
Washington, DC 20590

Gentlemen,

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We are excited about this project and are looking forward to hearing from you.

Please accept our solution to this problem so that we can get started with the task of making flying safer for us all.

Sincerely,

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CEO SHN Fuel Systems

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