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# Service News



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# FROM THE EDITOR'S

# DESK

Welcome to 2005 and our first Service News issue of the year. Numerous requests have been received over the last few months for information about SFAR 88. The article, **SFAR 88 — Fuel Tank System — Fault Tolerance Evaluation**, provides a synopsis of the background, analysis of the issues, and the resulting Lockheed Martin recommendations.

Safety, in general, is something that must be a constant part of our operating routine. The Hercules aircraft we operate, and in many cases the environment we operate in, can be quite hazardous to us and/or to our equipment. Constant vigilance must be maintained as we go about our daily routines. **Aviation Safety Management — Pay Now or Pay Later**, is an excerpt from a well-received presentation on Safety and is both thought provoking and entertaining.

In light of the recent USAF press release and given the significant interest and concern over the **C-130 Wing Service Life**, a copy of our recent memorandum is included in this publication. More details will follow in upcoming issues.

This publication is produced for **you . . . the Hercules community**. Your suggestions for topics or ways to improve the relevance or content of the Service News are always encouraged. We try to include interesting photographs of the Hercules at work. So, if you have comments, suggestions or photographs to share with others in the Hercules community, please forward them to us.



Image Courtesy of the US Air National Guard



# AVIATION SAFETY MANAGEMENT

*Excerpts of a Presentation by Al DeCastro, Lockheed Martin Aeronautics*

**PAY NOW OR PAY LATER**

The dictionary defines safe as being “free from harm or risk”, certainly one of the principal goals of any endeavor, particularly this business of building and flying airplanes. But how many of you really fly, drive, operate, maintain, or otherwise use anything that really fits this definition? If any of you raise your hand, be prepared to have your bubble burst. Let me instead suggest to you that this principle of “safe” is not a measurable absolute, and also tell you that it is virtually impossible to attain. It is instead a relative abstraction, meaningful only in comparison to something else. You want safe? Compared to what? Well, if we can’t guarantee freedom from harm or risk, how do we operate? We survive and succeed by changing our focus to what we’re really after—an acceptable degree of risk, thus ending up with something we can manage, for it’s really not safety we’re looking for, except in the abstract, but rather a level of risk we can tolerate and attempt to control. The “operational risk management” (ORM) discipline is an outgrowth of this way of thinking and has become a formal part of many aviation programs over the last decade in recognition of the distinction. ORM attempts to analyze an operation beforehand to make it relatively, and I emphasize relatively, safer than it would otherwise be—not to make it safe, but rather make the risks of the operation acceptable. ORM doesn’t replace safety; it merely refines the concept by analyzing the relationship between a hazardous condition or operation and its probability of occurring. In short, you don’t manage safety but you can and do manage risk. Keep this in mind as we talk about how safe something is and always be prepared to ask, “compared to what?”

## **How Safe Do You Want To Be?**

Much like the law, safety is concerned with achieving and maintaining equity, or balance between often competing forces. But there are varying degrees of this balance that help us decide just how “safe” we want to be. Let’s look at some examples.

It’s fairly common to hear someone use “99.9%” to signify high quality or confidence. Bearing that in mind, what if things in your lives were 99.9% good or right; you’d be happy as a clam, correct? Let’s see. A few years back someone calculated that in the US, 99.9% right would mean:

- One hour of unsafe drinking water each month.
- 16,000 lost pieces of mail per hour.
- 500 incorrect surgical procedures each week.
- 50 newborns dropped by doctors every day.
- 20,000 children suffering complications from whooping cough vaccinations each year.

Not so good, huh? Okay, let’s re-engineer things to be an order of magnitude better; surely 99.99% would be acceptable, don’t you think? If you do, you would have to be willing to accept:

- 2,000 incorrect drug prescriptions per year.
- 3,200 times per year your heart would fail to beat.
- Five children would suffer permanent brain damage from vaccinations.
- 370,000 checks would be deducted from the wrong accounts each week.

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Satisfied? Didn't think so. So how do we decide what is safe enough? One determinant is cost, which then begs the question of just how much safety can you afford? So let's talk about . . .

### ***The Economics of Safety***

In a perfect world, safety engineers never worry about money, and don't consider how much a safety improvement will cost. Safety enhancements, by their very nature, are supposed to be immune to the vagaries of economics; conceptually, they inhabit a plane where right and good always prevail. Being safe is good, its verity unassailable, and therefore not subject to question. However, in many cases, Safety is nothing more than an economic issue. As Professor Dick Wood, noted Safety author and teacher, says, "it's not a moral, not an ethical, not a pain and suffering problem—it's simply a matter of money."

Here's a little test. What is the almost universal first response of program management when the safety engineer proposes a safety improvement? "How much will it cost?" Not whether it's moral or ethical or smart—it's first and foremost about how much money. Some managers are smart enough to ask instead, "What will it cost if we don't do this?" Marginally more rational reasoning, but money is still the driving force.

In his book, *Aviation Safety Programs — A Management Handbook*, Professor Wood goes on to explain that business costs of risk are divided into two categories—insured or uninsured. The cost of risk is never less than your minimum insurance premium, one of the fixed costs of doing business. Have an accident, however, and watch what happens. The lost time, inconvenience, and aggravation that follow any accident have value; so do the higher insurance premiums that usually result. These and other uninsured costs mount up, generally to two or three times insured costs. In 1995, the average insurance payout for a major commercial aircraft accident was from \$120-200 million for the hull loss and \$2.8 million average liability payment per passenger. One operator suffered a \$35 million hull loss and a total liability of \$375 million, after which its premiums rose to twice the industry average. That's a powerful incentive if ever there was one.

Ground accidents can be prohibitively expensive too. The best estimate in the US aviation industry is that these cost nearly a billion dollars per year, even more incentive if you need one. When we report accident costs, we typically account for the cost of insurance and worker's compensation if injuries occur, but we rarely calculate or report uninsured costs. Some typical ones are:

- Insurance deductibles.
- Lost time and overtime.
- Investigation/corrective action costs.
- Loss of spares and specialized equipment.
- Higher costs of operating remaining equipment.
- Cost of hiring and training replacement workers.
- Loss of productivity of injured workers.
- Costs of cleanup and restoration of order.
- Loss of equipment use.
- Costs to rent/lease replacement equipment.
- Fines, citations, legal fees.
- Increased insurance premiums and excess liability claims.
- Costs of lost business and damage to reputation.

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# SFAR 88 FUEL TANK SYSTEM

*Terry Gooch—Senior Staff Safety, Test and Verification Engineer*

On July 17, 1996, a 25-year old Boeing Model 747-100 series airplane was involved in an in-flight breakup after takeoff from Kennedy International Airport in New York, resulting in 230 fatalities. The accident investigation conducted by the National Transportation Safety Board (NTSB) indicated the center wing fuel tank exploded due to an unknown ignition source. The NTSB issued recommendations intended to:

- Reduce heating of the fuel in the center wing fuel tanks on the existing fleet of transport airplanes.
- Reduce or eliminate operation with flammable vapors in the fuel tanks of new type-certificated airplanes.
- Re-evaluate the fuel system design and maintenance practices on the fleet of transport airplanes.

The accident investigation focused on mechanical failure as providing the energy source that ignited the fuel vapors inside the tank.

The NTSB announced their official findings of the TWA 800 accident at a public meeting held August 22 through 23, 2000, in Washington, D.C. The NTSB determined the probable cause of the explosion was ignition of the flammable fuel/air mixture in the center wing fuel tank. Although the ignition source could not be determined with certainty, the NTSB determined the most likely source was a short circuit outside of the center wing tank allowing excessive voltage to enter the tank through electrical wiring associated with the fuel quantity indication system (FQIS). Opening remarks at the hearing also indicated:

“. . . This investigation and several others have brought to light some broader issues regarding aircraft certification. For example, there are questions about the adequacy of the risk analyses that are used as the basis for demonstrating compliance with many certification requirements.”

This accident prompted the FAA to examine the underlying safety issues surrounding fuel tank explosions, the adequacy of the existing regulations, the service history of airplanes certificated to these regulations, and existing maintenance practices relative to the fuel tank system. FAA, NTSB, and Boeing undertook a program to examine aircraft in permanent storage to see what the condition of the components of the fuel system were. The accompanying photographs document some of the items found on these stored aircraft.

On October 26, 1999, the FAA issued Notice of Proposed Rulemaking (NPRM) 99-18, which was published in the Federal Register on October 29, 1999 (64 FR 58644). Three separate requirements were proposed in that notice:

1. Design approval holders of certain transport category airplanes to conduct a safety review of the airplane fuel tank system and to develop specific fuel tank system maintenance and inspection instructions for any items determined to require repetitive inspections or maintenance.

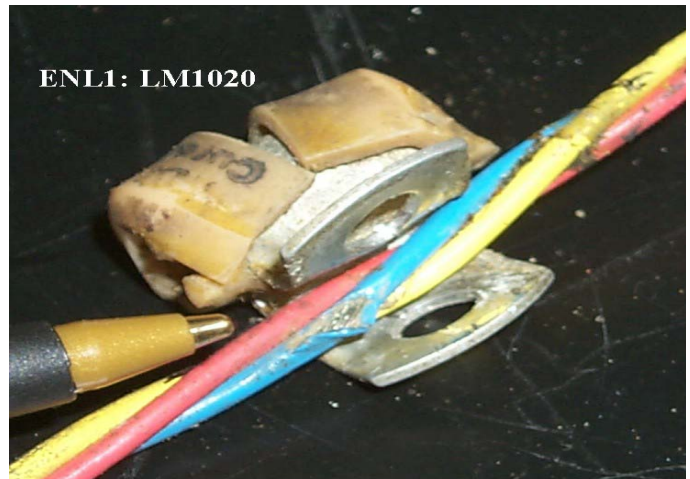
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## CONTINUATION OF SFAR 88—FUEL TANK SYSTEM FAULT TOLERANCE EVALUATION

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2. Prohibit the operation of those airplanes beyond a specified time, unless the operators of those airplanes incorporated instructions for maintenance and inspection of the fuel tank system into their inspection programs.

3. For new designs, a requirement for minimizing the flammability of fuel tanks, a requirement concerning detailed failure analysis to preclude the presence of ignition sources in the fuel tanks and including mandatory fuel system maintenance in the limitations section of the Instructions for Continued Airworthiness.



The Lockheed Martin Aeronautics Company 382/L-100 aircraft were required to meet requirements of SFAR 88 Transport Airplane Fuel Tank System Design Review, Flammability Reduction, and Maintenance Requirements. To ensure the design principles applied to each system are sufficient to achieve the required level of safety, and consequently comply with the requirement, extensive analysis was conducted on the entire fuel system.

Lockheed Martin Aeronautics Company assembled a team of certification/safety analysts to conduct the review of the fuel system of the 382 series aircraft. These personnel were supplemented by other specialists as required.

### **The Plan**

Lockheed Martin Aeronautics Company determined that to document the System Safety Assessment (SSA) which met the requirements of SFAR 88, 14 Code of Federal Regulations (CFR) 25.981 and Advisory Circular (AC) 25.981-1C (draft), the following would have to be developed:

- System Functional Hazard Assessment
- Zonal Safety Inspection
- Particular Risk Assessment
  - Electro Magnetic Interference (EMI) Assessment
  - High Intensity Radiated Fields (HIRF) Assessment
  - Lightning Assessment
- Thermal Analysis
- Flammability Exposure Time Monte Risk Assessment

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### **Scope**

The scope of the analysis was to document those design features that preclude a fire and explosion in the 382B, C, E, F, and G model aircraft fuel tanks. In conducting the safety analysis, the fuel tanks, the fuel system up to the nacelle, and the surrounding dry bay areas that might be subject to fuel that has leaked from the tanks or fuel fumes, were investigated. The intent of the System Safety Assessment was to demonstrate that ignition sources are non-existent; exist at an acceptable level; or are unacceptable but can be made acceptable if recommended design changes and continued airworthiness requirements are implemented.

The components included in this analysis were the fuel pumps (boost and dump), fuel level control valves, fuel quantity probes, plumbing tubes, equipment wire harnesses, conduits, filler caps, the fuel tank construction, equipment in surrounding dry bays, venting systems, fuel dump systems, and drain systems. Effects of adjacent systems (e.g., bleed air, other wires in the same wire bundles, etc.) on these components were considered. Lightning, HIRF, EMI and their effects on the fuel tank system were considered. All potential latent failures were considered to be possible and the effects of another failure combined with the latent failure were analyzed. The heating phenomenon from environmental, equipment failure, and equipment malfunction was considered in relation to the auto-ignition temperature of the fuel. Cascading failures were analyzed, and those that did not meet extremely improbable levels were addressed.

The major components in the fuel tanks were subjected to Failure Modes and Effects Analysis (FMEA) and quantitative Fault Tree Analysis (FTA). These were the Fuel Quantity Indicating System (FQIS), the Refuel System (including the Single Point Refueling (SPR) System and Fuel Level Control Valves), and the Fuel Transfer System (Fuel Boost Pumps, Dump/Transfer Pumps, and Dump Valves).

The SSA identified potential failures and addressed what events must occur for the potential failure condition to materialize, as well as discussions concerning their likelihood.

### **System Functional Hazard Assessment (SFHA)**

SAE ARP 4761 and 4754 methodologies were used to conduct this System Safety Assessment (SSA). The initial task was completion of a SHFA that addressed SFAR 88 concerns.

### **Zonal Safety Analysis**

A Zonal Safety Analysis was conducted to address the requirements of SFAR 88. The Model 382 design features were reviewed to verify compliance with FAR 25.1309 System Design and Analysis requirements and 25.901 Installation. The Electrical System, Conduit, Fuel Lines, Wiggins Fittings, Lightning Protection, Bleed Air, Structural and Non-Electrical Bonding, Electromagnetic Compatibility, Fuel Systems, Tanks, Flame Arrestors, Drains, Vents, Hydraulic Systems and Fuel Quantity Indicator System wiring were all evaluated.

### **Electro Magnetic Interference (EMI) Analysis**

There were two mechanisms identified that could potentially result in fuel vapor ignition:

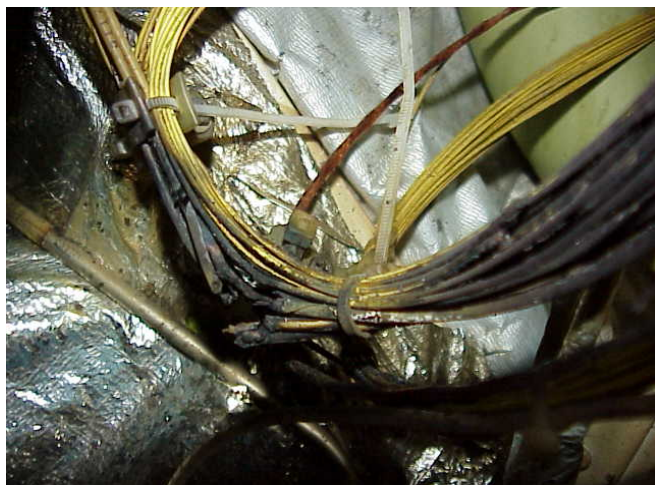
- A single point failure inside the Tank-in-Unit (TIU) in combination with EMI could potentially cause the units to introduce 115 VAC on the Tank Unit wiring. This could result in fuel vapor ignition if there is FOD or a short circuit between the Tank Units or the associated wiring inside the tank.

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- EMI coupling between high current wiring and Tank Unit wiring, in combination with a latent failure of FOD or a short circuit between the Tank Units or the associated wiring inside the tank, could cause arcing inside the fuel tanks with subsequent fuel vapor ignition.



Addition of Transient Suppression Devices (TSD) near the fuel tank connectors will prevent dangerous levels of voltage/current from entering the tanks.

### **High Intensity Radiated Fields (HIRF) Analysis**

The assessment addressed the threat of HIRF-induced fuel tank ignition on the 382/L-100. The most probable mechanism identified is excessive voltage/current FQIS wiring running to Tank Units. Addition of Transient Suppression Devices (TSD) near the fuel tank connectors will prevent dangerous levels of voltage/current from entering the tanks.

### **Lightning Analysis**

The assessment addressed the lightning induced fuel tank ignition threat on the 382/L-100. Several areas of investigation were identified. Additional testing was carried out to verify effects regarding skin thickness and the effectiveness of the suggested mitigations. That testing took place in July 2004 at Lightning Technologies Incorporated Laboratory in Pittsfield, Massachusetts. The testing validated the 0.080 thickness of the fuel tank skin with three applications of paint being the minimum requirement. External tank nose and tail cones and any area over the main tanks less than 0.080 thickness will be addressed by a Service Bulletin (SB).

### **Electrical Bonding Analysis**

The Electrical Bonding Report assessed the electrical bonding design of the 382/L-100 as it pertains to fault current protection and static electricity protections against fuel tank ignition. There were several areas of investigation identified, and mitigations were suggested for all of these areas.



### **Validation and Verification**

Individual parts of the fuel system were reevaluated to ensure they met the intent of SFAR 88 and 14 CFR 25.981. These included such things as the fuel filler caps, dump masts, etc.

### **SSA Conclusions**

The final task was a detailed SSA assessment of each SFHA Failure Condition performed using all appropriate FAA requirement, and guidance information, Lockheed Martin drawings and analyses, as well as vendor drawings and analyses. The goal of this assessment was to identify those failure conditions that required no further action, those that required an inspection, and those that required a design enhancement to meet SFAR 88 requirements.

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The analysis was formalized and presented to the Federal Aviation Administration (FAA) local Aircraft Certification Office (ACO) in Atlanta, Georgia, 6 December 2002. Lockheed Martin Aeronautics Company then provided a brief to the Aircraft Certification Office and The Airplane Directorate (TAD) out of Seattle, Washington, in May 2003.



### **Installation of Ground Fault Interrupters (GFIs) on 382/L-100**

The installation of GFIs in 382/L-100 fuel tank fuel pump and FLCV wiring as a means to mitigate the threat from any short circuit on wiring inside of fuel tank conduits, have also assessed, as requested by the FAA. The GFIs were determined to meet the FAA requirements and to provide an enhanced level of safety.

### **Recommendations**

In order to maintain the Lockheed Martin Hercules Model 382 aircraft in compliance with the SFAR 88 guidance, the recommended actions were as follows:

- Provide inspection requirements to assure the aircraft in the field adhere to existing appropriate design features and maintain continued airworthiness. These inspection requirements are provided in the form of Service Bulletins. (SB 382-28-19 (82-770) Fuel – SFAR 88 – Dry Bay Zonal Inspection and Inspection/Repair of Static Ground Terminal of Fuel System Plumbing)
- Provide design improvements and issue to the operators as Service Bulletins distributed as ADs so as to maintain continued airworthiness.
  - Add Transient Suppression Devices (TSDs). (SB 382-28-20 (82-772) Fuel – SFAR 88 – Installation of Ground Fault Interrupter (GFI), Transient Suppression Device (TSD), and Flame Arrestor for Protection of Fuel System)
  - Add Additional Bonding. (SB 382-28-21 (82-773) Fuel – SFAR 88 – Lightning Bonding Jumper Installation)
  - Add Ground Fault Interrupters (GFIs). (SB 382-28-20 (82-772) Fuel – SFAR 88 – Installation of Ground Fault Interrupter (GFI), Transient Suppression Device (TSD), and Flame Arrestor for Protection of Fuel System)
  - Define remedial action for fuel tank skin panels based on lightning strike test results. (Service Bulletin pending)
  - Add Flame Arrestors for Fuel Vents in Lightning Zone 2A. ). (SB 382-28-20 (82-772) Fuel – SFAR 88 – Installation of Ground Fault Interrupter (GFI), Transient Suppression Device (TSD), and Flame Arrestor for Protection of Fuel System)

# C-130 WING SERVICE LIFE

UPDATE

Lockheed Martin recently distributed the memorandum shown below. This memorandum was distributed due to the extensive interest in C-130 Wing Service Life, following the USAF aircraft groundings and flight restrictions. As stated in the memorandum, Lockheed Martin will issue a Service Bulletin addressing wing fatigue cracking and service life in the near future. This SB will affect International Military and Commercial C-130/L-100 operators. More detail will also be included in the next issue of the Service News.

Lockheed Martin Aeronautics Company  
86 South Cobb Drive Marietta, GA 30063



14 February 2005

## C-130/L-100 WING FATIGUE CRACKING AND SERVICE LIFE CONCERNS

Many C-130 operators are aware the United States Air Force issued a Press Release on Friday, February 11, 2005, regarding C-130 aircraft groundings and flight restrictions due to center wing fatigue cracking concerns. Over the past two years, Lockheed Martin Aeronautics has been providing analytical support and technical expertise to the USAF to assist them in evaluating the center wing service life. Lockheed Martin will continue to provide support to the USAF, and other operators, as requested in the months ahead.

In parallel with the USAF support activities, Lockheed Martin has also been assessing C-130/L-100 service life issues, related to both the center wing and outer wing, for International and Commercial operators. Wing fatigue cracking, wing service life, and aircraft operational usage have been specifically addressed during the 2002, 2003, and 2004 Hercules Operators Conferences (HOCs).

Lockheed Martin intends to issue a Service Bulletin (SB) addressing wing fatigue cracking and service life in the near future. This SB will affect International Military and Commercial C-130/L-100 operators. All analysis efforts regarding wing service life will be evaluated in terms of Equivalent Baseline Hours (EBH). EBH is not the same as aircraft flight hours. Both the actual wing flight hours, which may be different than the aircraft flight hours if the center wing has previously been replaced, and the past aircraft mission usage severity must be considered in order to determine EBH.

The SB will necessarily take a phased approach, where the first phase is determining the EBH of an individual operators C-130 fleet. The need for an operator usage evaluation was emphasized in Lockheed Martin presentations made during the 2003 and 2004 HOCs. Once an operator's usage is evaluated, their EBH will be used to determine if further actions are required. Lockheed Martin can assist operators in evaluating their aircraft usage and in determining the EBH for their fleet.

The second phase of the SB will define structural inspection requirements beyond the normal inspection program, and the urgency of these inspections, tailored to varying EBH limits. Some aircraft with high EBH levels could require flight restrictions or aircraft grounding until structural inspections can be implemented to determine what remedial action is appropriate.

Lockheed Martin is committed to supporting all of our C-130/L-100 customers in assessing the wing service life issue and recommending prudent and necessary remedial actions to ensure continued safe operations of C-130/L-100 aircraft while minimizing the potential impact on the operator's fleet. Lockheed Martin looks forward to working together with operators and their Service Centers as usage evaluations are conducted and structural inspection requirements are implemented.

# CERTIFIED PARTS

## AN UPDATE

In the world of C-130 spares it is often assumed that a part is high quality if it looks good, fits, and has a Certificate of Conformance. The fact of the matter is that this is often not true. Some of the most critical qualities of a part may be overlooked in a general inspection because they cannot be seen or measured. The most significant of these are special processes and materials.



Special processes range from those as common as painting to more exotic processes such as chemical plating, heat treating, and bonding. These processes increase strength, prevent corrosion, and assure flight safety. Combine this with a wide variety of materials such as castings and forgings and you have a whole world of unseen but critical qualities.

The Certified Parts program is designed to ensure that you get parts that not only fit, but use the right materials and processes. The source inspectors at

each licensed manufacturer's facility know where and how special processes should be applied and what materials that should be used. "We support the source inspectors and the manufacturers with the most up to date data. This is necessary because the data tells you what processes to use. No one else can do this. If a manufacturer is using old data, they may have no idea where or how to process a structural item. This is extremely important in flight critical items where strength and resistance to corrosion are a must," said Cole Blumer, Certified Parts program manager.

Blumer continues, "One of our biggest concerns is that without knowing it an operator may install a substandard and potentially dangerous part on their aircraft. We make Certified Parts widely available in the C-130 B-H marketplace to prevent this from happening. All of the part resellers who support the industry have access to high quality spares. By simply requesting Certified Parts, operators assure themselves that the parts they receive are made correctly."

It is advised that even when a request for Certified Parts is made, the parts should be checked upon delivery. Look for the Hologram (holographic sticker) on the part or part packaging to assure you have received the correct parts. Well into its second year the Certified Parts program has issued more than 120,000 holograms. Many of the large parts providers in the industry are carrying substantial inventories of Certified Parts. For more information on Certified Parts, as well as other "Hologram" programs please visit [www.LMHologram.com](http://www.LMHologram.com).



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Management today is largely an exercise in cost containment, with two general types of costs — fixed and variable — to control. About the first, we can do little or nothing, like that minimum insurance premium from before, or fuel, spare parts, and the like. Control of the variable costs—things like personnel, training, safety, marketing, advertisement, PR—in addition to excess premiums and other uninsured costs, is where managers get to manage.

Typically, the ratio between fixed and variable costs is about 80/20. In aviation, excess insurance premiums and uninsured costs are about 5 percent of total costs, a seemingly manageable and reasonable amount. But that 5 percent of total is as much as 25 percent of variable costs, a significant amount and one that should and will get the attention of smart managers. You, as the Safety engineer, can help management control or reduce some of their costs with effective accident prevention, lessons learned, and other similar aviation safety programs, helping save a substantial portion of the variables over which managers have actual control. As a result, if for no other reason than economics, you can be effective. In short, make it about money and they will listen.

### ***Team Player – Good or Bad?***

At the risk of being a scold, I offer you some thoughts on a current buzz word: team. It has been fashionable of late to embrace the concept of “the team” as the ultimate in organizational construct to promote inclusiveness and attempt to enhance every member’s contribution. This can have value for the newer members of a group, particularly if they feel from the outset that they are free to speak out and offer opinions, “empowered” if you will to participate equally. Being a member of a team satisfies one of the basic needs of humans, that of belonging to a group and gaining social acceptance. This social need described by Abraham Maslow was subordinate to only physiological and safety needs in his famous hierarchy. In theory, and usually in practice, the group whole is greater and more effective than the sum of the individual parts. In these and probably other ways, the team is effective. There is, however, a potential pitfall that too often overcomes a team and that is the “groupthink” syndrome. Having a common goal is decidedly different from forced uniformity of thought and action. One of the principal reasons for assembling a team is to bring together people with disparate viewpoints to ensure you consider all aspects of a task before coming to a decision. Why bother putting together a group of people who all think alike? You might consider Xerox’s Barry Rand’s warning: “If you have a yes-man working for you, one of you is redundant.”

All too often these days, contributing to team success does not include raising objections to team activities and decisions or recommending different courses of action from what the majority thinks. Team leaders will at times accuse a dissident member of “not being a team player” if they disagree. Since when did dissent become synonymous with disloyalty? What if it is precisely a person’s job to enforce rules, standards, regulatory requirements, and processes? What often happens to these people? Human nature being what it is, those whose role it is to oversee, critique, judge, and evaluate the work of others often are not very popular. You who are flight examiners or quality inspectors know what I’m talking about. Standardization, evaluation, quality assurance, safety, audit, inspection, enforcement are all disciplines whose practitioners may not be the most welcome members of a group. But as General Colin Powell said: “Being responsible sometimes means pissing people off. It’s inevitable if you’re honorable.” Many people resent being told what they can and cannot do, or that what they are

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doing isn't right or doesn't meet requirements, or worse that they've failed at something. This goes for managers as well as workers. I've heard both accuse a Safety engineer of not being a team player when the safety guy pointed out an error, discrepancy, or failure to satisfy a requirement, and then recommended a fix; but I would counter that the accused was functioning as a true team member by raising the objection, for that is his role. Managers sometimes have asked that these type people be removed from their programs or have threatened to delete their budgets if they did not follow orders. People like this who fall in love with their projects and programs become defensive when their success is at risk and often blame whoever points out a problem instead of finding out who caused it. It's one thing to question a recommendation and ask for substantiation; that's a supervisor's responsibility. It's an entirely different matter to shoot the messenger just because he won't change the message.

### **Cost vs. Value**

Safety never costs nothing. It's one of those variable costs we talked about earlier, and the successful manager is the one most adept at managing these variables. So how do we keep the safety portion of these costs to a minimum? By doing it the right way, not by eliminating or refusing to pay for it. Here's how to go about it.

Safety used to consist largely of the "fly-fix-fly" method of hazard and risk control, the "Oops, back to the drawing board" approach. Designers gave little thought to trying to postulate beforehand what might go wrong—design, build, test, and fix was the accepted process. If you were smart and lucky enough to get it right the first time, all was well from both a safety and management point of view. But how many times are we that lucky? Few things, particularly we humans, ever approach perfection, and nothing is risk-free; why then do we persist in trying to prove otherwise? "Endlessly repeating the same process, hoping for a different result" is a definition of insanity sometimes attributed to Albert Einstein; whether he actually said it or not, it's true. It wasn't until the 1950s when we first began to embrace a systems approach to safety on the ballistic missile program, wherein requirements were established beforehand to preclude, prevent, or mitigate hazards and their consequences. Since the outcome of an unanticipated serious failure of a missile was usually catastrophic, it made sense to prevent it from happening from both an economic and human standpoint. The top-down, "fly-fix-fly" design approach was simply too costly. As we'll see, though, the systems approach wasn't universally adopted back then, despite the efforts of aviation safety pioneers like C. O. Miller and Roger Lockwood who founded the System Safety Society in 1962. In fact, it still encounters resistance in some respects even today. Here's an example you may recognize.

The late Dr. Richard Feynman, one of the world's leading physicists, in his role as a member of the President's Commission that investigated the Challenger accident, found fault with NASA's top-down design and testing methods. Speaking of the shuttle's main engine, he said it "was designed and put together all at once with relatively little detailed preliminary study of the material and components. Then when troubles are found..., it is more expensive and difficult to discover the causes and make changes...[A] simple fix...may be impossible to implement without a redesign of the entire engine." It would have been much wiser and certainly significantly less expensive to have used a bottom-up approach, or what he called the "component system" for main engine design, wherein the properties of the materials, components, subsystems, and systems are investigated and understood and then subjected to

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rigorous tests to validate preliminary design decisions. He wrote “as deficiencies and design errors are noted they are corrected and verified with further testing. Since one tests only parts at a time, these tests and modifications are not overly expensive....Failures are easily isolated... and there is a very good chance that the modifications to the engine to get around the final difficulties are not very hard to make, for most of the serious problems have already been discovered and dealt with in the earlier, less expensive, stages of the process.” In a nutshell, and in far more eloquent words than I could ever muster, he was describing system safety.

One of the many other findings in the Commission’s report was that “Organizational structures... placed safety, reliability, and quality assurance offices under the supervision of the very organizations and activities whose efforts they are to check.” This wasn’t meant as a compliment. There was no safety representative on the management team that made key decisions concerning the launch. The “extensive and redundant safety program” that existed on the earlier Apollo program was rendered ineffective in the face of unrelenting schedule pressures. Sounds familiar, even today. Those who advised no launch or recommended caution and further analysis were told to show reason why they considered the launch potentially dangerous. Thus, NASA management violated the cardinal rule of system safety: it is emphatically not the safety engineer’s job to prove something is unsafe; it is the designer’s, or management’s, or the operator’s job to prove that it is safe.

The US military long ago recognized the need for autonomy for these types of oversight functions and positioned them to reduce or eliminate control by the organizations and people under scrutiny. Safety in particular almost always reports directly to the commander as a staff function outside the control of any line unit or supervisor. Otherwise, the chilling effect of burying the Safety people deep within a group they are charged to oversee and evaluate ultimately would render them ineffectual, but even more worrisome, would send a powerful message to others that Safety isn’t important. That’s not the message any organization wants to send.

### ***Culture of Safety***

Among the several definitions of culture, the one that applies for our purposes is this: “the set of shared attitudes, values, goals, and practices that characterizes a company or corporation.” There can indeed be a culture of safety, one that operates to everyone’s benefit. It consists of four principal elements—leadership, trust, attitude, and integrity—each very important, and all of which, properly employed, will enhance your chances of success. The successful leaders are those who inspire rather than intimidate, leading by example instead of by demand. Just as important is an atmosphere of assured reliance, or trust, between and among superiors, peers, and subordinates, one that demonstrates confidence, dependability, and faith in their abilities. Your attitude itself can promote both safety and success, especially if you are always attuned to the needs and desires of your own people and those of your customers. Let me suggest, however, that the remaining element—integrity—may be the most important of the lot, both because it incorporates the attributes of the others and is the one without which the others would have little if any meaning.

Though related in some ways, integrity is different from honesty. Very simply, honesty is adherence to the facts, a refusal to lie, steal, or deceive in any way. Integrity is somewhat more

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complex, a firm adherence to a code of values, being trustworthy to a degree that you are incapable of being false to a trust, responsibility, or a pledge. The former is more rule oriented; the latter value based. Doing right because it's the rule is honesty; doing right because it's the right thing to do is integrity. This is similar to the distinction the columnist Leonard Pitts recently made between reputation and character. He wrote, "Reputation, it has been said, is about who you are when people are watching. Character is about who you are when there's nobody in the room but you. Both matter, but of the two, character is far and away the most important. The former can induce others to think well of you. But only the latter allows you to think well of yourself." Or as my mama told me when I was young, integrity is stopping at a stop sign in the middle of the desert when there's no one else around. It's what you do and how you behave when nobody's watching that really matters.

Business ethics has been the topic du jour of late with all the revelations of financial improprieties at many corporations. The people whose faces and behaviors have been in the news might have benefited from paying close attention to what Norm Augustine, former Lockheed Martin president and CEO, once presented as his personal checklist for helping decide what is the ethically correct thing to do:

- Is it legal?
- If someone else did this to you, would you think it was fair?
- Would you be content if this were to appear on the front page of your hometown newspaper?
- Would you like your mother to see you do this?

If you could answer "yes" to all four questions, then whatever you're about to do is probably ethical.

Another version of this is "Does it pass the smell test?" Occasionally, some course of action appears to or actually does follow all the technical rules but still leaves you with a feeling of discomfort; it just doesn't "smell" right. If so, ask yourself these four questions and see how it smells then. Chances are it may be a little rank!

What does all this have to do with safety? If your first response to a safety requirement is "How can I get around that?" instead of "How can I satisfy that?," you may be headed for trouble. If your attitude is that your situation, your project or task, you and your people are somehow "special" and thus have a different set of rules from everyone else, you're likely to have problems soon. If you more often than not sacrifice the "value" choice on the altar of expediency or schedule, you will eventually regret that decision. When you've cut the last corner and still must compromise to meet your deadline and you don't call a time out, you're only one decision from potential disaster. The "How did we end up in this mess?" post-mortem after many an accident contains some or all of these as significant steps in the sequence of events that culminated in a mishap. If this is your culture, the values you embrace and promote, failure is almost inevitable. It's a matter only of when, not if.

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### **So What Do We Do?**

In a September 2002 message to Company supervision, Dain Hancock, LM Aero President, reiterated the management behaviors he and his leadership team said were necessary to achieve the Company's goals for the year. Among several were three that sound pretty familiar. One was that **"Schedule will NOT take priority over Quality and Safety."** Another was that **"Healthy debate, discussion, and trust will form the basis of our interactions."** Finally, he challenged supervisors to be **"accountable for performance—getting the job done, safely, and with the highest quality – the first time."** These are meant as every day behaviors, not crisis actions, and they are key to meeting our goals.

In closing, let me suggest to you, especially those who manage and lead, something that has fallen from favor in recent years, an approach the truly successful leaders all use. I call it Managing Intangibles for lack of a better term. Everybody, especially those "bottom line" manager types about whom I spoke earlier, wants to be able to measure success in some quantifiable way, to be able to substantiate a dollar value to prove their worth. Many things, however, don't lend themselves to these type metrics; safety success is one of them. How does one count the number of accidents prevented or serious incidents avoided? Who can say whether this or any other safety briefing kept someone out of harm's way? No one can, of course.

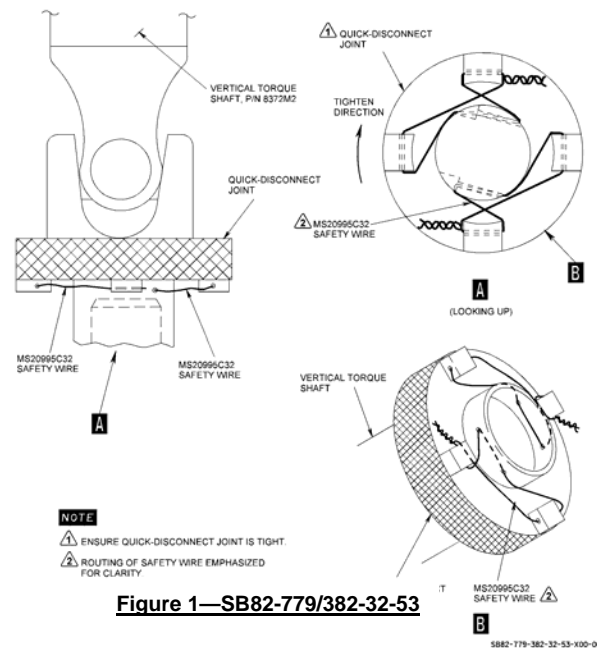
But somewhere inside I know I've been successful in some way. Can't prove it, but I know it when I see the light come on in a young crewmember's eyes or notice a change in behavior on the part of a maintenance troop after we've had a safety briefing. I see it in a design engineer's learning about safety design requirements and remembering them on the next program and a flight test engineer who initiates contact with his flight safety counterpart before a test program starts instead of after a problem occurs. And I see it when an operating unit asks for Safety to visit because they think they need some help getting the accident prevention message across. I'll admit to a chronic case of aging idealism as I arise each morning and don my rose-colored glasses, and I refuse to believe caring and commitment to one's profession are quaint, eccentric, or out of style. Someone once proposed that, in trying to decide on a course of action, once you reach 40 percent certainty that you're right on an unknown, go with your gut rather than waiting for 70 or 80 or 100 percent. Well, I've been beyond that 40 percent mark for a long time, I accept that I'll never get near 100, and I know in my gut that we're succeeding, however slowly, so I'll continue to forge ahead.

Maybe all of us could benefit from being a bit more daring in our decision making, from placing value ahead of cost as a decider, from doing something simply because it's the right thing to do. Get away from the bottom line as your only concern and dare to be innovative. Accept that success can be measured in many ways other than with a dollar sign. ***That one life is worth all the effort!***

# SERVICE BULLETIN **UPDATES**

## **SB82-779/382-32-53 – MAIN LANDING GEARS – MLG VERTICAL TORQUE SHAFT QUICK DISCONNECT**

This Service Bulletin calls for the inspection of the main landing gear vertical torque shaft quick disconnect joint for proper installation of safety wire. This inspection is to confirm that the safety wire is the correct size and type, the safety wire conforms to installation as shown in Figure 1.



## **82-772/382-28-20 Rev 2 – FUEL – SFAR 88 – INSTALLATION OF GROUND FAULT INTERRUPTERS (GFI), TRANSIENT SUPPRESSION DEVICES (TSD), AND FLAME ARRESTORS FOR PROTECTION OF FUEL SYSTEM**

Revision 2 is the first published issue of this Service Bulletin to the operator. The basic issue and Revision 1 were for FAA review only and were never published to the operator. This Service Bulletin outlines enhancements to the flame arresting system.

## **82-776/382-32-52, Dated November 9, 2004, LANDING GEAR – RELOCATION OF NOSE AND MAIN LANDING GEAR DOWN LOCK INDICATION**

Basic Issue - The purpose of this modification is to relocate the nose and main landing gear down lock indication grounds inside the nose and main landing gear wheel wells to locations where they are less likely to fail. Failure of the landing gear ground circuit results in loss of landing gear down lock indication.

## **82-781/382-34-04, Dated November 2, 2004 – NAVIGATION – INSPECTION AND REWORK OF THE DF301E DIRECTION FINDER ANTENNA**

Basic Issue - During troubleshooting of the DF301E UHF/VHF Direction Finder System, it was discovered that the 317970-1/-5 DF Antenna Systems have not been electrically bonded properly. Inspect aircraft for proper operation of the DF Antenna.

## **82-782, Dated October 20, 2004, ELECTRICAL POWER – INSTALLATION OF BATTERY CHARGER**

Basic Issue - This modification is an optional product improvement. The battery charger modification provides a controlled battery charging current, thereby preventing any overheating while safely maintaining the charge on the batteries. This prevents excessive battery replacement on the modified aircraft.



## CONTINUATION OF SERVICE BULLETIN UPDATES

### 82-771/382-57-82, Dated December 7, 2004, WINGS – INSPECTION OF CENTER WING UPPER AND LOWER RAINBOW FITTING FOR CRACKS

Basic Issue - Inspect center wing upper and lower rainbow fitting for cracks in accordance with Hercules Airfreighter C-130/L-382 Series Progressive Inspection Procedures work cards SP-176 (upper fitting) and SP-257 (lower fitting).

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### 82-784/382-71-23, Dated January 6, 2005, POWER PLANT - INSPECTION OF ENGINE TRUSS MOUNT FOR CRACKING OF THE DIAGONAL BRACE LUGS WITH THE PRESS FIT STEEL BUSHING INSTALLED

Basic Issue - Engine truss mount cracking of the diagonal brace lugs, with the press fit steel bushing installed, has been experienced by some C-130 operators. Aircraft serial number 4801 and up and aircraft prior to 4801 with diagonal lugs modified by Service Bulletin 82-410/382-71-13 and/or repaired by SMP 583 to install press fit bushing or replaced with current production configuration truss mounts.

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### 82-780/382-25-09, Dated January 6, 2005, EQUIPMENT/FURNISHINGS – REWORK OF LIFE RAFT RELEASE CABLE PULLEY BRACKET LOCATED AT FS 612.75 LH

Basic Issue - Field reports indicate that the life raft release cable has been rubbing against the top of the pulley bracket located at FS 612.75 LH. Locate the pulley bracket located at FS 612.75 LH and reverse the rub block in bracket assembly, such that the slot in the block is oriented downward.

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### 82-778/382-71-22, Dated January 23, 2005, POWER PLANT — TEFLON HOSES AS AN ALTERNATE FOR ELASTOMERIC (RUBBER) HOSES ON POWER PLANT, NACELLE, AND QEC

Basic Issue - This Service Bulletin is issued to make Teflon hoses available to operators using the engines and associated QEC, should operators choose to use Teflon hoses in lieu of the current standard elastomeric hoses. Teflon hoses offer many advantages over the older elastomeric types. Hose assemblies made of Teflon have practically unlimited shelf life and greatly enhanced service life. They also expand much less under pressure. This is a product improvement, and the Teflon hoses are provided as an alternate for the elastomeric hoses.

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Image Courtesy Don Rodgers

# AMS CALENDAR

2006

Although we are barely into 2005, it's time to begin the development of Air Mobility Support's 2006 Calendar.

The Lockheed Martin AMS Calendar is the only Lockheed Martin Calendar dedicated solely to the C-130 Hercules B-H models. This calendar features a selection of beautiful photographs of Hercules aircraft submitted by commercial and military operators around the world.

It takes almost the entire year to collect these images, determine the layout, and have the Calendar printed. So we need to start now. If you have digital (.gif or .jpg) photographs that you would like to be considered for the AMS 2006 Calendar, please send them to them to:



**It's Time to Send in Your Hercules Photographs!!**

Lockheed Martin AMS, Attn: 2006 Calendar, 86 South Cobb Drive, Marietta Georgia 30063-0589

# IMPROVING INFORMATION

Lockheed Martin Air Mobility Support has been working hard to improve its ability to quickly disseminate information and deliver data to the global population of Hercules operators and Service Centers.

DELIVERY

Actions taken include the use of the Lockheed Martin Enterprise Data/Collaboration System (EDCS).

Air Mobility Support makes EDCS available to Hercules operators, Service Centers and selected partners, vendors, and suppliers. The system allows for the secure, real time distribution of Service Bulletins and other important documents. All the documents are fully searchable, making it fast and easy to find the information you need.

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Themes:	88%	sb382-32-47.pdf	Location: 382- Commercial Bulletins
Common Authors:	Date: 02/12/2003	Size: 148 KB	
Author: antocg	Rating: ★★★★★	Include: <input type="checkbox"/>	<b>Summary:</b> A382-32-47, FAA certificated Aircraft. This Alert Service Bulletin is applicable to all model 382. (1) The purpose of this Alert Service Bulletin is to provide operators with new brake wear limitations imposed by FAA worn brake rejected takeoff (RTO) requirements. (2) LASC recommends that the inspection specified herein be accomplished within 30 days after receipt of this Alert Service Bulletin to assure availability of design stopping power at maximum. (1) The aircraft owner/operator will make an appropriate entry in the aircraft log records upon compliance with this Alert Service Bulletin. Inspect both main landing gear brake assemblies measured from end tip of wear pin to brake Brake wear pin protrusion (as.
Common Dates:	Date: 02/12/2003	Size: 132 KB	
Date: Past Year	Rating: ★★★★★	Include: <input type="checkbox"/>	<b>Summary:</b> LOCKHEED-GEORGIA COMPANY a Division of Lockheed Aircraft Corporation. lubrication of the main landing gear jackscrews until revision to SIP 515 and SRP 581. Giletin has been approved by the FAA Designated Engineering Rscortis upon compliance with this Service Bulletin. Service Bulletin, the aircraft owner complete the attached postcards a n d r, =turn them to the Lockheed-Georgia C o q a n y . I , T T : Tt assistance is needed, contact the Lockheed Field Service Representative or the Lockheed Field Service Office in Marietta,
Common Locations:	Date: 02/12/2003	Size: 222 KB	
Location: C130B-H Service Bulletins: 382- Commercial Bulletins	Rating: ★★★★★	Include: <input type="checkbox"/>	<b>Summary:</b> LOCKHEED-GEORGIA COMPANY a Division of Lockheed Aircraft Corporation. lubrication of the main landing gear jackscrews until revision to SIP 515 and SRP 581. Giletin has been approved by the FAA Designated Engineering Rscortis upon compliance with this Service Bulletin. Service Bulletin, the aircraft owner complete the attached postcards a n d r, =turn them to the Lockheed-Georgia C o q a n y . I , T T : Tt assistance is needed, contact the Lockheed Field Service Representative or the Lockheed Field Service Office in Marietta,
Common Topics:	Date: 02/12/2003	Size: 222 KB	
Topic: aircraft owner, lockheed-georgia co...	Rating: ★★★★★	Include: <input type="checkbox"/>	<b>Summary:</b> LOCKHEED-GEORGIA COMPANY a Division of Lockheed Aircraft Corporation. lubrication of the main landing gear jackscrews until revision to SIP 515 and SRP 581. Giletin has been approved by the FAA Designated Engineering Rscortis upon compliance with this Service Bulletin. Service Bulletin, the aircraft owner complete the attached postcards a n d r, =turn them to the Lockheed-Georgia C o q a n y . I , T T : Tt assistance is needed, contact the Lockheed Field Service Representative or the Lockheed Field Service Office in Marietta,

Sample EDCS Search Results

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