NEWSLETTER

THE FAA SEZ . THE 787 CANNOT MEET CURRENT TRANSPORT AIRCRAFT CERTIFICATION STANDARDS BUT THEY CAN LIVE WITH THAT! (?)

Before we begin, allow me to remind you . . . . *§ 11.19 What is a special condition? A special condition is a regulation that applies to a particular aircraft design. The FAA issues special conditions when we find that the airworthiness regulations for an aircraft, aircraft engine, or propeller design do not contain adequate or appropriate safety standards, because of a novel or unusual design feature.*

The FAA has issued another Special Condition for the Boeing 787 - Lightning Protection of the Fuel Tanks . . . . . You can read the 4+ page document at this site.

The purpose of this Special Condition is to inform the public that section 25.981 as amended by 25-125 has not produced the desired effect. It also introduces the NITROGEN GAS INERTING SYSTEM that will prevent explosions in the fuel tanks . . . . unless it happens to be inoperative in accordance with the FAA Minimum Equipment List (for up to 10 days at a time) for the flight you are on! **Will they tell me when I check in?** Note: Any text in *italics* is from an FAA document (Regulation, Advisory Circular, Order, Memo or any other form selected by the FEDs. The selection of UPPER or lower case and underlining is mine in order to add emphasis to certain FAA selected words.

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I have spent a couple of days researching aircraft accidents caused by lightning strikes —there have been two Boeing jet transports lost after being struck by lightning—the first a PAN AM 707 flying over Maryland in 1963, the second, a former TWA 747-131 being operated by the Iranian Air Force, hit while approaching for landing at Madrid in 1976. United States National Transportation Safety Board reports are available for both accidents.

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FUEL TANK INERTING was proposed after both accidents and suggested again when a new section, *§ 25.581 - Lightning Protection, was adopted in 1970*. Congress finally mandated Fuel Tank Inerting in 2005–42 years after the Pan Am 707 accident.

The NPRM for this Special Condition was prepared by the same folks that have been "tilting at the TWA 800 windmill" for the past 10 years (they still haven't determined the cause but they have created many questionable Airworthiness Directives—one of which may have caused other fuel tank explosions).

THE NPRM begins with . . . . *The Boeing Model 787-8 airplane will incorporate a fuel tank nitrogen generation system (NGS) that actively reduces flammability exposure within the main fuel tanks significantly below that required by the fuel tank flammability regulations. Among other benefits, this significantly reduces the potential for fuel vapor ignition caused by lightning strikes.*

The problem that needs the Special Condition to correct is sub-paragraph 25.951(b), which was revised by amendment 25-102 - 4/19/2001. The FAA explains it as follows . . . .

*Application of Existing Regulations Inappropriate Due to **IMPRACTICAL**ity*
*Since the promulgation of § 25.981(a)(3), as amended by Amendment 25–102, the FAA has conducted certification projects in which applicants found it **IMPRACTICAL** to meet the requirements of that regulation for some areas of lightning protection for fuel tank structure. Partial exemptions were issued for these projects. These same difficulties exist for the 787 project.*

*The difficulty of designing multiple-fault-tolerant structure, and the difficulty of detecting failures of hidden **STRUCTURAL** design features in general, makes compliance with § 25.981 (a)(3) uniquely challenging and **IMPRACTICAL** for certain aspects of the electrical bonding of **STRUCTURAL** elements. Such bonding is needed to prevent occurrence of fuel tank ignition sources from lightning strikes. The effectiveness and fault tolerance of electrical bonding features for **STRUCTURAL** joints and fasteners is partially dependent on design features that cannot be effectively inspected or tested after assembly without damaging the structure, joint, or fastener. Examples of such features include a required interference fit between the shank of a fastener and the hole in which the fastener is installed, metal foil or mesh imbedded in composite material, a required clamping force provided by a fastener to pull two **STRUCTURAL** parts together, and a required faying surface bond between the flush surfaces of adjacent pieces of **STRUCTURAL** material such as in a wing skin joint or a mounting bracket installation. In addition, other features that can be physically inspected or tested may be located within the fuel tanks, therefore, it is **not PRACTICAL** to inspect for failures of those features at short intervals. Examples of such failures include separation or loosening of cap seals over fastener ends and actual **STRUCTURAL** failures of internal* *fasteners. This* ***inability to PRACTICAL****ly detect failures of* ***STRUCTURAL*** *design features critical to lightning protection results in any such failures that occur remaining in place for a very long time, and possibly for the remaining life of the airplane, prior to detection.*

Accounting for such long failure latency periods in the system safety analysis required by § 25.981(a)(3) would require multiple fault tolerance in the ***STRUCTURAL*** *lightning protection design. As part of the design development activity for the 787, Boeing has examined possible design provisions to provide multiple fault tolerance in the* ***STRUCTURAL*** *design to prevent ignition sources from occurring in the event of lightning attachment to the airplane in critical locations. Boeing has concluded from this examination that providing multiple fault tolerance for some* ***STRUCTURAL*** *elements is* ***not PRACTICAL****. Boeing has also identified some areas of the proposed 787 design where it is I****MPRACTICAL*** *to provide <u>even single fault tolerance</u> in the* ***STRUCTURAL*** *design to prevent ignition sources from occurring in the event of lightning attachment after a single failure. The FAA has reviewed this examination with Boeing in detail and has agreed that providing fault tolerance beyond that in the proposed 787 design for these areas would be IM****PRACTICAL****.*

As a result of the 787 and other certifications projects, the FAA has now determined that compliance with § 25.981(a)(3) is ***IMPRACTICAL*** *for some areas of lightning protection for fuel tank structure, and that application of § 25.981(a)(3) to those design areas is therefore inappropriate. The FAA plans further rulemaking to revise § 25.981(a)(3). The FAA plans to issue special conditions or exemptions, when appropriate, for certification projects in the interim. This is discussed in FAA Memorandum ANM–112–08–002, Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure, dated May 26, 2009.* I encourage you to read the legal opinion BEFORE the FAA MEMO.

The words STRUCTURAL is the first noteworthy (for me) item in the NPRM because the NPRM fails to reference *§ 25.571 Damage tolerance and fatigue evaluation of STRUCTURE* which includes paragraph *(c) Fatigue (safe life) evaluation. Compliance with the damage tolerance requirements of paragraph (b) of this section is not required if the applicant establishes that their application for particular structure is IMPRACTIBLE. This structure must be shown by analysis, supported by test evidence, to be able to withstand the repeated loads of variable magnitude expected during its service life without detectable cracks.*

. To be AIRWORTHY an aircraft must conform to the TYPE DESIGN—which must comply with the AIRWORTHINESS STANDARDS—PART 25 and be in condition for SAFE OPERATION—the workmanship items noted, re fasteners and not pulling the parts together, do not lead to SAFE OPERATION. In my opinion the failure to meet these standards is sufficient to deny the Applicant (Boeing) a Type Design Approval for the 787 Dreamliner.

YOU CAN READ ALL OF FAR 25.571 ADMT 25-45 AT THIS SITE or use the referenced text that follows. . . . .

§ 25.571 Damage tolerance and fatigue evaluation of structure.

(a) General. An evaluation of the strength, detail design, and fabrication must show that catastrophic failure due to fatigue, corrosion, manufacturing defects, or accidental damage, will be avoided throughout the operational life of the airplane. This evaluation must be conducted in accordance with the provisions of paragraphs (b) and (e) of this section, except as specified in paragraph (c) of this section, for each part of the structure that could contribute to a catastrophic failure (such as wing, empennage, control surfaces and their systems, the fuselage, engine mounting, landing gear, and their related primary attachments). For turbojet powered airplanes, those parts that could contribute to a catastrophic failure must also be evaluated under paragraph (d) of this section. In addition, the following apply:

. . . .

(3) Based on the evaluations required by this section, inspections or other procedures must be established, as necessary, to prevent catastrophic failure, and must be included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness required by § 25.1529. **Inspection thresholds for the following types of structure must be established based on crack growth analyses and/or tests, assuming the structure contains an initial flaw of the maximum probable size that could exist as a result of <u>manufacturing</u> or service-induced damage:**

ALLOW ME TO CLOSE THIS ISSUE OF THE NEWSLETTER WITH THE FOLLOWING . . . .

An Impossible Dream

Draft sample page from the chapter "When lightning strikes"

BY HANS VAN der ZANDEN

Lightning strike protection

Related lightning strike protection for both on the ground and isolated structures follows still a largely empirical approach and has developed over very long period of time, and focuses on structural protection of objects and shielding of sensitive electric and electronic equipment from electromagnetic radiation. Galvanic rods are widely used for the diversion of lightning current away from the structures. With aluminium aircraft lightning strike protection is based on the Faraday cage principle that provides electromagnetic shielding. Wire mesh is used to transform all composite aircraft into an artificial open Faraday cage, and wire mesh is also applied as lighting strike protection cover for on the ground structures instead of next to Galvanic rods. Electromagnetic compatibility is the concept that deals with shielding of electric and electronic equipment that are susceptible of damage form electric and magnetic fields.

> Next to improvement of conventional lightning strike protection systems, many attempts have been made to improve on lightning strike protection by applying non-conventional methods, so far with limited success. So have radioactive materials been used in lightning rods which are supposed to help ionize the air around the rod sufficiently to increase the likelihood of the rod being struck, rather than the building itself. Researchers focus also on systems where a sufficiently powerful and properly tuned laser ionize air from the clouds to the ground level, such that an artificial lower resistance path is created for the lightning to travel on. Charge transfer systems are claimed to eliminate the charge buildup on a structure by transferring it to the surrounding area, thereby eliminating the potential for a lightning strike.

Interaction between lighting and a structure is a very complicated issue and still poorly understood. Testing is very difficult and the process can only be modelled to limited extend, certainly at the scale of aircraft. Characteristic in this respect is a title of a recent book on this topic, *"The art and science of lightning protection"*. Published by one of the leading scientist in this field in 2009, the following question is put forward by the author when he discusses the state of the art of lighting protection - *"Is it perhaps telling that standards for lightning protection of small structures have changed relatively little from the time that the existence of the stepped leader and attachment process were unknown to the time following the various versions of the electrogeometric model"*. Such modelling may look impressive indeed, but is based on some relative very simple formula's that rest on *"very shaky theoretical foundation"*, according to the author. Better understanding of lighting and the attachment process is critical for advancing the theory of lightning protection for grounded structures, and even more so for the development of reliable lightning protection systems for modern more electric aircraft, in particular with all composite aircraft that still needs much long-term research.

The BOTTOM LINE in the book is The Plastic Airplane is truly an impossible dream . . . . **carbon fibre reinforced plastic is not the right material to build an entire large airplane. Any attempt to do so may be "unmake-able deal"**

-- The Impossible Dream. A Draft Copy is available "on the web" at"the lonely scientist". In his 7 July blog he wrote . . . *.truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident.*
Arthur Schopenhauer (1788 – 1860)

"An Impossible Dream' goes through stage one at the moment but will reach stage three sooner than later. For many it is still difficult to believe that civil aircraft can't be built all-composite; that is, some 80% out of composites by volume including the complete skin. For those familiar with materials science this all-composite approach has been incomprehensible from the start. This could only end in failure. One can only wonder why so many scientists involved themselves with these projects and even came to the defense. Most worrisome is that the scientific community kept silent – if not totally silent – when developments unfolded, not to mention the press. But soon enough we will read different stories and experts will arise from nowhere. It happened before, far too often actually, just read the appendices in my book about the *Comet*, *Concorde* and the *Columbia* in particular (can de downloaded on the right). May be this time disaster can be avoided. It appears to be extremely difficult to warn people beforehand, that is, to have the courage to come forward and present a different view. In this case to focus on the development of composed aircraft for which the A380 is paving the way, where aluminium reinforced composites will play key role together with monolithic

aluminium and titanium with plain composites for the large indoor primary structures like wing box and so on."

NEXT ISSUE . . . .   .,

PERHAPS BY 10 December

WHY DID MITSUBISHI HEAVY INDUSTRIES CANCEL THE COMPOSITE WING FOR THEIR NEW REGIONAL JET?

WILL THE MHI COMPOSITE WING CANCELLATION HAVE AN IMPACT ON THE 787's WING? DON'T BE SURPRISED!

THE LATEST FROM THE BIG AIRPLANE COMPANY . . . . FIRST 787 FLIGHT DATE IS 14 December!