

# Structural Damage Capability (SDC)

- **Questions asked**

- Do you agree on the recommendation to add a requirement to show a certain level SDC to ensure that the airplane maintenance program will not be defeated by unforeseen damage sources?
- Do you agree that the proposed standard increases the level of safety relative to industry practice in regard to compliance with Amendment 25-96 or 25-132?
- Does the proposed standard generally capture what has been industry practice?

# SDC

- **Some commenters supported the concept, however—**
  - Compliance demonstration is unclear and it may be difficult to show compliance because the proposed guidance material is not adequate
  - Compliance demonstration may be difficult to show for repairs and supplemental type certificates
- **Some commenters did not support the proposed standard**



# SDC (cont.)

- **Commenters suggested industry and regulators meet to review and discuss the draft guidance material, including:**
  - SDC list
  - Residual strength requirements (e.g., cabin differential pressure conditions)
  - Compliance demonstration for single load path structure (e.g., methods for demonstrating quality control for those parts throughout the lifecycle of the airplane—manufacturing practices correlate with technical assumptions)

# Any costs or benefits to address?

- **Costs will depend on the acceptable means of compliance, specifically for SDC:**
  - More focus on demonstration by testing could increase costs
  - Insufficient guidance may result in additional compliance costs
  - Costs may increase as a result of having additional parts
  - Additional costs for addressing repairs and modifications
- **Benefits may be hard to quantify**

# Any comments on differences between CFR and CS?

- **All commenters expressed concern that the FAA's and EASA's rules may not be harmonized**
- **All commenters supported industry and authorities working together to achieve harmonization of rules**



## **General Structures Harmonization Working Group 2003 Recommendations on § 25.571**

### **Response Summary**

Commenters expressed concern about compliance demonstration and transferring airplanes if the FAA and EASA rules are not harmonized. USA questioned whether the FAA will have enough resources to address any differences that may occur between the two rules.

### **III. Questions on Structural Damage Capability [[Appendix C Link](#)]**

5. Do you agree on the recommendation to add a requirement to show a certain level structural damage capability to ensure that the airplane maintenance program will not be defeated by unforeseen damage sources?
6. Do you agree that the proposed standard increases the level of safety relative to industry practice in regard to compliance with Amendment 25-96 or 25-132?
7. Does the proposed standard generally capture what has been industry practice?

### **Response Summary**

Learjet and KLM did not support the proposed standard. KLM stated that unforeseen damage is just that, unforeseen. There will always be unforeseen damage sources that can defeat the airplane's maintenance program. The amount of structure that can fail without resulting in a catastrophic failure would be an arbitrary requirement. Learjet believes the current residual strength requirements under § 25.571 are adequate. The further added that the proposed standard is a recommendation to a question no one is asking.

Although JAL supported the concept of having a certain level of structural damage capability, they did not support the proposed standard. They stated that maintenance programs are already required to account for inspection detectability and probability of detection. The proposed standard would result in over specification in certain areas.

Gulfstream partially supported the proposed standard.

Airbus, ANA, Boeing, Bombardier, Cessna, and Lockheed Martin supported the concept of showing a certain level of structural damage capability (SDC). In addition, most commenters indicated that the proposed standard generally captures industry practice. Cessna added that the proposed standard would result in critical crack sizes being on the order of inches and not millimeters – with Amendment 25-96 or 25-132 there is no such assurance.

Boeing stated that compliance would be a significant effort and challenge. Gulfstream stated that they did not necessarily support the proposal (partially agrees) to add a “fail-safe” requirement to § 25.571 to address unforeseen damage sources. They further stated that an unqualified requirement can add complexity to the design without a demonstrated improvement in reliability if the initial failure is latent and there is no associated effective maintenance task. Adding design features to protect against nonexistent threats is also a distraction.

Gulfstream also commented on the GSHWG recommendation on slow crack growth for single load-path structures. In short, they believed that the approach may not protect against all unforeseen threats. It would be better to focus on certain parameters of the analysis for establishing inspection

## **General Structures Harmonization Working Group 2003 Recommendations on § 25.571**

thresholds. Also, establishing a prescribed minimum threshold (i.e., 50% LOV) in the regulation is problematic in that it allows no variation for unexpected circumstances.

Lockheed Martin stated that the industry trend is to design more monolithic structure and that may present concerns for aging aircraft. BA asked whether the concern was more for composite structure rather than metallic structure.

Many commenters expressed concern about the adequacy of the proposed guidance material. BA added that it's unclear how you would demonstrate compliance, especially for repairs and supplemental type certificates.

Several commenters stated there should be a review and discussion on the SDC list defined in the proposed draft guidance material. Topics of discussion should include:

- Residual strength requirements (e.g., cabin differential pressure conditions).
- Compliance demonstration for single load path structure (e.g., methods for demonstrating quality control for those parts throughout the lifecycle of the airplane—manufacturing practices correlate with technical assumptions).
- Guidance on performing a threat assessment and adding design features to address and mitigate the threat through the normal maintenance inspections of the Maintenance Review Board Report (MRBR). Detail design points that do not possess this capability are to be evaluated for special, damage-tolerance-based inspections/replacements.

Cessna, ANA, and JAL agreed that the proposed standard increases the level of safety.

Learjet and Lockheed Martin didn't agree that the proposed standard increases the level of safety. Lockheed Martin stated that industry is moving to materials and monolithic structure, which may increase the likelihood of unforeseen damage sources for aging aircraft. Airbus stated that the safety benefit brought by this new proposed standard is not as high as the one brought by Amendment 25-96 compared with the previous amendments. Gulfstream partially agreed. The way the proposed standard is defined would increase the complexity of showing compliance without a definable benefit to safety.

### **IV. General Questions (Costs, Benefits, and Harmonization)**

[\[Appendix D Link\]](#)

8. Are there any costs or benefits that should be included or addressed?

#### **Response Summary**

Cessna believes that the proposed actions would not impose any additional costs.

Airbus stated that additional costs for the SDC demonstration depend on the acceptable means of compliance. If Authorities would put a lot of focus on demonstration by testing, this could increase costs by having to perform more test runs to cover failed structure. Airbus would propose to rely significantly on analysis validated by existing testing. Boeing added that cost to industry for SDC compliance may be more than anticipated due to the recommendation not having sufficient guidance. Bombardier also added that costs may increase due to having additional parts because of

## **General Structures Harmonization Working Group 2003 Recommendations on § 25.571**

the SDC proposed standard. Bombardier and Gulfstream stated that more parts may result in more weight, which affects the cost of producing and operating airplanes. Bombardier identified possible benefits as follows:

- Safer structure overall (which may be hard to quantify).
- Lower manufacturing costs [minimizing part criticality classification number (PCCN) parts].
- Alternate load path design could extend PSE inspection intervals.

KLM is concerned that any new requirement to address the effects of structural damage capability will also require addressing existing and new repairs and modifications. They were specifically concerned about having to perform surveys of existing repairs and modifications. This will increase costs for design approval holders and operators. Most commenters expressed concern about additional costs that may occur if the FAA's and EASA's rules are not harmonized.

9. Because EASA's final rule is pending approval (comment period and disposition of comments), it is difficult to identify differences at this time. Despite this fact, do you have any comments related to the differences between the CFR and CS?

### **Response Summary**

Airbus, All Nippon Airways (ANA), Boeing, Bombardier, British Airways (BA), Japan Airlines (JAL), and Lockheed Martin expressed concern that the FAA's and EASA's rules will not be harmonized. Presently, there are multiple differences between them. For example, EASA is proposing to add a requirement to include a statement that the ALS that corrosion be controlled to Level 1 or better. Cessna would like to see the FAA adopt such a requirement. Commenters supported industry and authorities working together to achieve the harmonization of rules.

## **General Structures Harmonization Working Group 2003 Recommendations on § 25.571**

### **Appendix C: Responses to Questions on Structural Damage Capability**

**Question 5:** Do you agree on the recommendation to add a requirement to show a certain level structural damage capability to ensure that the airplane maintenance program will not be defeated by unforeseen damage sources?

#### **Responses**

**AIRBUS:** AIRBUS agrees on the recommendation to add a requirement to show a certain level of SDC. However, AIRBUS suggests reviewing the levels of SDC defined in the current draft material in an appropriate forum. Airbus also suggests to define an appropriate residual strength level that might deviate from the ones specified in 25.571b. Especially the cabin differential pressure value needs to be reconsidered.

Maintenance program itself already considering detectability, probability, therefore adding requirement to show a certain level structural damage capability leads to over specification, therefore JAL does not agree the recommendation.

Adding fail-safe concept in FAR and CS is to ensure airplane have more durability than an existing airplane.

**ANA:** Yes, but coordination with the EASA will be necessary to harmonize the corresponding requirements.

**Boeing:** Boeing believes that designs with inherent damage capability are optimum but consistent interpretation & compliance policy will be difficult to implement. We would like to see further industry input/discussion before the working group proposal is considered.

**Bombardier:** Yes in principle.

Proposed 25.571 f(2) provides for SLP structure although the expectation is that there will be a more robust quality control for these parts relative to the sub-paragraph f(1) structure (multiple load path/fail-safe).

For the sub-paragraph f(2) structure some issues are :-

1. How to ensure (throughout production) the necessary Quality Control for those parts, e.g. inspect 100% of the parts?
2. How to demonstrate compliance

**British Airways:** It is unclear how this would be demonstrated. How can structure be designed for unforeseen damage sources – if the damage is unforeseen? How would this work for repairs/STC's/changes? Would the requirement be for the repair/STC itself or the affect of the repair/STC on the baseline structure?

**Cessna:** Cessna agrees with the recommendation to add a requirement to show a certain level of structural damage capability (SDC). As proposed, minimum structural damage requirements are specified for non-single load path structure. This would insure that critical crack sizes are on the order of inches and not millimeters – with Amendment 25-96 or 25-132 there is no such assurance. Additionally, there is a requirement to demonstrate slow crack growth for single load path structure and guidance material suggesting that one DSG of crack growth life be demonstrated from detectable to critical crack size to show compliance.

**Gulfstream:** Gulfstream partially agrees.

## **General Structures Harmonization Working Group 2003 Recommendations on § 25.571**

The concept of 'fail-safe' does not necessarily provide increased safety if there is no evaluation showing an acceptable period of unrepaired use to allow detection. There are several significant accidents where 'fail-safe' features did not provide adequate protection. In general, the structure should be able to withstand some initially detectable damage for a number of normal (as defined in the MRBR) inspection intervals.

It is not fully understood that a prescribed 'slow crack growth' for single load-path structures will protect against all unforeseen threats, although it does establish some robustness of the structure. Since most of these cracking scenarios require disassembly and NDT to detect, it is not clear that any additional benefit can be expected from normal maintenance activities. Gulfstream believes it is far more worthwhile to focus on the parameters of the analysis used to derive the thresholds (spectra, retardation, material properties). A robust analysis is probably more critical than a prescribed threshold.

In addition, establishing a prescribed minimum threshold (i.e. 50% LOV) in the regulation is problematic in that it allows no variation for unexpected circumstances. Will a TCH be required to retro-fit an existing fleet if subsequent test data indicated the threshold should be 40% of LOV? Minimum thresholds should really be established in the guidance and coordinated between the ACO and the applicant after a consideration of all of the applicant's criteria and methods.

Gulfstream does not necessarily agree with the concept of designing against unforeseen damage sources. 'Fail-safe' features should be added to address those rare threats not typically encompassed in the full-scale fatigue tests. These threats are known in general terms and include corrosion (environmentally accelerated cracking), mis-rigging of hydraulic actuators, mis-rigging of fuselage doors, improperly applied repairs or alterations, etc. An unqualified requirement can add complexity to the design without a demonstrated improvement in reliability if the initial failure is latent and there is no associated effective maintenance task. Adding design features to protect against nonexistent threats is also a distraction.

Gulfstream believes that the major portions of the airframe should be able to withstand initially detectable damage for a period of use equivalent to the normal maintenance interval as defined in the MRBR for that structure. It is also possible to safely design detail design points that do not possess such large damage capability and protect them through inspections/replacements.

It is difficult to see how this delineation can be codified into a regulation applicable across the industry. Gulfstream would prefer to see guidance that a threat assessment be performed and design features be added to enable that threat to be mitigated through the normal maintenance inspections of the MRBR. Detail design points that do not possess this capability are to be evaluated for special damage tolerance based inspections/replacements.

**JAL:** Agree

**KLM:** KLM does not agree. By definition unforeseen damage sources will result in unforeseen damage. There will always remain unforeseen damage sources that can defeat the airplane maintenance program; no matter to what extent the structural damage capability is improved. Introduction of such a requirement will introduce a gliding scale in the rulemaking. The amount of structure that may fail as result of this new requirement without resulting in a catastrophic failure is arbitrary: is 10% of the structure acceptable or should it be 20%, or more?

**Learjet:** Learjet does not agree that demonstrating a certain level of large damage capability will enhance aircraft safety. What kind of unforeseen damage is contemplated? If it is so large as to be

## General Structures Harmonization Working Group 2003 Recommendations on § 25.571

unforeseen, why should the OEM be responsible for it? Further, if this damage is large, wouldn't it be obvious in a walk around inspection? The current residual strength requirements associated with 25.571 regulations have been working satisfactorily since implementation. This is an answer to a question that no one is asking.

**Lockheed Martin:** Yes.

**US Airways:** Can you please provide more clarification of what this requirement is specifically? It would seem that the residual strength requirement which already exists in the rule accomplishes the perceived intent of this terminology. What is the difference between structural damage capabilities vs. residual strength analysis? If this is a new requirement ... what is it and what is the assumed benefit of the addition of this requirement? When is enough ... enough? I really don't understand this term ... what it is ... what it does ... how it's done ... or what is the benefit to make an informative comment.

[\[Return\]](#)

**Question 6:** Do you agree that the proposed standard increases the level of safety relative to industry practice in regard to compliance with Amendment 25-96 or 25-132?

### Responses

**AIRBUS:** The safety benefit brought by this new proposed standard is not as high as the one brought by Amendment 25-96 compared with the previous amendments.

**ANA:** Yes.

**Boeing:** This does not increase safety over that of current Boeing design criteria and products certified using that criteria, however a showing of compliance would be a significant effort/challenge.

**Bombardier:** Current practice is to take credit for multiple load-path fail safe structure when establishing PSE inspection intervals. Thus Bombardier philosophy is to design with fail-safe capability wherever possible. The proposed standard will support this philosophy.

**British Airways:** No Comment.

**Cessna:** Cessna Aircraft agrees that the proposed standard increases the level of safety relative to industry practice in regard to the requirements of Amendment 25-96 or 25-132. Adding the requirement for single load path structure to be inspected at a maximum of half of the DSG will increase the probability of damage detection before catastrophic failure, should undetected larger than anticipated damage occur.

**Gulfstream:** Gulfstream partially agrees.

Without a defined threat and an associated inspection program, mandating universal 'failsafe' concepts can increase complexity without a definable benefit to safety. Gulfstream standard practice includes an assessment of the ability to withstand initially detectable damage for a period of inspection intervals. An example of this criteria applied to fuselage structure is given in AC25-20, para. 8.b (Gulfstream aircraft are typically certified to operate at 51,000 ft.). This criteria does add weight to the airframe, with the fuselage skins being ~0.005" thicker than would be otherwise.

For the design of single load-path structures, Gulfstream typically prescribes a minimum required threshold of 50% of DSG/LOV. Additional criteria are added to address the planned NDT methods

## **General Structures Harmonization Working Group 2003 Recommendations on § 25.571**

such as designing for through-thickness cracks. These structures are also designed to fatigue requirements. The prescribed minimum threshold matches Gulfstream design intent, but there are cases in practice where a threshold is less than 50%.

It should be noted that Gulfstream operators are generally opposed to special NDT inspections due to the added costs, so there is an economic incentive to design them out of the airframe. It is not clear that this proposed standard is required, but an update of the guidance material is likely appropriate.

**JAL:** Agree

**KLM:** No comment.

**Learjet:** Learjet does not agree that the proposed standard increases safety. For small business jets, it has not really been industry practice to demonstrate an arbitrary level of damage. It has been industry practice to design for fail safety whenever possible and demonstrate this fail safety by test. But that approach is consistent with current 25.571 philosophy, and is not tied to a predefined level of damage. Additionally, current regulations do allow single load path – slow crack growth structure. This allowance should be retained.

**Lockheed Martin:** No, Industry is moving to materials and monolithic structure that may increase the likelihood of unforeseen damage sources for aging aircraft.

**US Airways:** No Comment.

[\[Return\]](#)

**Question 7:** Does the proposed standard generally capture what has been industry practice?

### **Responses**

**AIRBUS:** The proposed standard mostly captures the current AIRBUS practice.

**ANA:** Yes.

**Boeing:** [Same response as provided in question six above.] This does not increase safety over that of current Boeing design criteria and products certified using that criteria, however a showing of compliance would be a significant effort/challenge.

**Bombardier:** Yes.

**British Airways:** It is difficult to answer without a better understanding. Have there been industry events that demonstrate this? Is it more of a concern for composite structure where damage can be less evident?

**Cessna:** The proposed standard captures Cessna's design philosophy.

**Gulfstream:** Note, response is combined with the response for question six.

**JAL:** We operator believes that this requirement is standard in the aircraft industry.

**KLM:** No comment.

**Learjet:** No comment.

**Lockheed Martin:** Yes, it is probably industry standard to design to meet this criteria. However, see comment to question 5.

**General Structures Harmonization Working Group  
2003 Recommendations on § 25.571**

**US Airways:** No comment.

[\[Return\]](#)