



U.S. Department
of Transportation
**Federal Aviation
Administration**

Policy Statement

Subject: High-Energy Wide-Area Blunt
Impact for Composite Structures

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Summary

To show compliance with Title 14, Code of Federal Regulations (14 CFR) 25.571(a), the applicant must show, among other things, that catastrophic failure due to accidental damage will be avoided throughout the operational life of the airplane. The applicant is required to consider possible damage scenarios when evaluating accidental damage that could result in catastrophic failure. One of these damage scenarios the applicant should assess is accidental damage caused by high-energy wide-area blunt impact (HEWABI) events. HEWABI events (e.g., impacts by service vehicles) are impacts that are spread over a large area and convey sufficient energy to cause potentially catastrophic structural damage. While the damage caused by a HEWABI event is typically readily visible in metallic structure, such damage may leave little or no external indications in composite structure. To ensure that any potentially catastrophic damage resulting from a HEWABI event is detected and repaired, applicants must provide appropriate conditional inspection instructions, or other procedures, to be implemented at the occurrence of such impact events as required per § 25.571(a)(3).

Definition of Key Terms

In the text below, the terms “must,” “should,” and “recommend” have specific meanings, which we explain in appendix A.

In addition, the following terms are defined as follows:

- 1 High-energy wide-area blunt impact (HEWABI) - A high-energy impact, spread over a large area, generated by a large mass when the type, force, or cause is significant with or without visible surface damage. In composite structure, HEWABI events may cause catastrophic structural damage with little or no external indication, and can cause Category 5 damage, as specified in Advisory Circular (AC) 20-107B. An example of a HEWABI event is a collision between a service vehicle and an airplane fuselage during ground servicing.

- 2 Principal structural element (PSE) - An element of structure that contributes significantly to the carrying of flight, ground, or pressurization loads, and whose integrity is essential in maintaining the overall structural integrity of the airplane. Principal structural elements include all structure susceptible to fatigue cracking which could contribute to a catastrophic failure. Refer to appendix 5 of AC 25.571-1D for clarification on how this term relates to fatigue critical structure and widespread fatigue damage susceptible structure.
- 3 Damage categories - AC 20-107B defines five categories of damage to composite materials. Summarized, these are:
 - 3.1 Damage Category 1 through 4 - A range of damages resulting from sources anticipated by the manufacturer and accounted for in the design through the fatigue and damage tolerance evaluation. Damage Category 1 is damage that the aircraft structure can withstand while retaining ultimate loads over the service life of the airplane. Damage Category 2 is damage for which scheduled inspection procedures are implemented. Damage Category 3 is damage that can be reliably detected by operations or ramp maintenance personnel within a few flights of occurrence. Damage Category 4 is damage that is immediately evident to the pilot, ground crew, or both leading to unscheduled maintenance prior to further flight. Refer to AC 20-107B for a full definition of each category.
 - 3.2 Damage Category 5 - Severe damage, created by anomalous ground or flight events, that is not covered in the damage tolerance evaluation or structural substantiation procedures required by § 25.571(b) and that requires immediate repair. However, design approval holders (DAHs) must consider Category 5 damage as part of their required evaluation under § 25.571(a) of any accidental damage that may result in catastrophic failure. A HEWABI event may result in Category 5 damage.

Current Regulatory and Advisory Material

The following 14 CFR regulations apply:

- § 25.571, *Damage-tolerance and fatigue evaluation of structure*
- § 25.1529, *Instructions for Continued Airworthiness*
- Appendix H to part 25, *Instructions for Continued Airworthiness*

AC 20-107B Change 1, *Composite Aircraft Structure*, dated August 24, 2010, provides guidance on a means acceptable to the FAA for showing compliance with certification requirements of composite structures.

AC 25.571-1D, *Damage Tolerance and Fatigue Evaluation of Structure*, dated January 13, 2011, provides guidance for compliance with the requirements for damage-tolerance and fatigue evaluation of transport category aircraft structure.

Relevant Past Practice

There is a long and continuing history of ground service-vehicle collisions with transport category airplanes. Some of the more common areas for such events are on the fuselage in and around the cargo and passenger doors. Generally, the DAH reinforces these areas due to the necessity to reinforce the structure for cutout loads, making the door surround structure more resistant to the impact forces that occur in a HEWABI event. Many of these events can be classified as normal accidental damage events, whose hazards must already be analyzed by the damage tolerance threat assessments required in showing compliance with § 25.571 and the related safe design and maintenance practices. Per § 25.1529 and appendix H to part 25, appropriate inspection thresholds, conditional inspections, and inspection methods must be included in the instructions for continued airworthiness (ICA). In general, for metallic construction, high-energy impact events will result in readily detectable damage (e.g., denting, plastic deformation), so no special directed inspections have been needed for these events. However, most DAHs include conditional inspections in the ICA for other events, such as hard landings, where damage might not be immediately evident.

Background

Although the potential threats to the structure of transport airplanes have not changed, the increased use of composite materials in transport airplane structures requires that greater attention be given to the incidents involving high-energy impacts. Tests on representative composite structural components have demonstrated that for some impacts, such as those associated with HEWABI events, there may be substantial damage to the underlying structure while the surface shows little or no visible damage. This damage may not be localized to the immediate impact area, but more widespread, making it necessary to inspect the structure over a larger area. These test results highlight that the practice of relying on visible inspection of an airplane exterior after a high-energy impact event is not sufficient in ensuring the continued safe operation of the airplane.

AC 20-107B categorizes the types of damages to consider when designing composite structure into five categories. These damage categories are based on the damage's detectability and its effect on structure. Damage Categories 1 through 4 are associated with damage threat scenarios that the applicant accounts for when conducting a damage tolerance evaluation (DTE) to show compliance with § 25.571(b). Damage Category 5 covers severe damage created by anomalous events beyond the scenarios used for Category 1 through Category 4 in the DTE. The intent of Category 5 is to take into consideration those anomalous events that cannot be easily predicted in advance by the applicant. An example of such an event is a ground service vehicle impacting an airplane, creating large damage which is beyond the other four categories. This type of impact tends to be of high energy due to the vehicle mass and contact speed. The area of the vehicle impact also tends to be broad (e.g., from a bumper designed to make light contact with the airplane). The resulting impact is termed a HEWABI event.

HEWABI events can occur during routine airplane operations. In composite airframes, damage from a HEWABI event may not be readily visible. As a result, there may be minimal exterior indications of damage (e.g., dents, scratches, tears), while catastrophic damage may be present in the internal structures (e.g., frames, ribs, stiffeners, spars, and shear ties), which reacted the high energy and corresponding forces. The damages that result from a HEWABI event may exceed those resulting from the scenarios associated with Category 1 through Category 4 damage, yet may be less visible; so to comply with § 25.571(a), other precautionary steps must be taken by the applicant to avoid catastrophic failures. HEWABI events are typically obvious to personnel involved in the event, either through the sound of creating structural damage or through personally experiencing the impact forces involved.

Because the HEWABI events addressed by this policy occur on the ground, the FAA does not require that the airplane be capable of continued safe flight and landing after the event. However, that fact makes an inspection imperative after such an event and prior to the airplane's next flight to insure that undetected severe damage has not occurred. While these events do not fit into the "scheduled inspections" determined by the damage growth analysis required by § 25.571(b), unscheduled inspections are necessary following these events to meet the primary objective of § 25.571 – that catastrophic failure due to fatigue, corrosion, manufacturing defects or accidental damage be avoided throughout the operational life of the airplane.

HEWABI events are similar to other unplanned events such as hard landings and lightning strikes, in that several steps must be taken, including recognizing that an event has occurred; having trained personnel available to assess the structure affected by the event; and having clear instructions and procedures to follow.

For more detailed background information on HEWABI events, see appendix B. For more discussion on how DAHs and operators can effectively work together to jointly share the responsibility for ensuring that potentially catastrophic damage caused by HEWABI events are detected through the ICA process, see appendix C.

Policy

Section 25.571(a) requires that applicants conduct an evaluation of the strength, detail design, and fabrication of the structure to show that catastrophic failure due to fatigue, corrosion, manufacturing defects, or accidental damage will be avoided throughout the operational life of the airplane. Section 25.571(a)(3) requires applicants to establish inspections or other procedures to prevent such catastrophic failure from those events, and include them in the Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness required by § 25.1529 and appendix H to part 25. While the ALS has historically focused on scheduled damage tolerance inspections to address fatigue, § 25.571(a)(3) also requires inspections or other procedures to address accidental damage from HEWABI events. Authorities and industry cannot easily predict HEWABI events that may cause Category 5 damage in PSEs, and therefore cannot readily establish scheduled inspections for such damage. Applicants should address these events by other safety risk

mitigation procedures such as reporting means and required conditional inspections and immediate repair. Because the damage caused during a HEWABI event could exceed the capability of the airplane to sustain the loads required by § 25.571(b), inspections of the damage prior to continued flight are necessary to prevent catastrophic failure and meet the requirements of § 25.571(a). The applicant does not need to consider Category 5 damage as part of the damage-tolerance evaluation used to establish scheduled inspections; however, the applicant should consider the potential effect of Category 5 accidental damage, develop conditional inspections, and include them in the ALS of the ICA per § 25.571(a)(3).

For composite structure, the applicant should evaluate HEWABI-related events by:

- 1 Drawing from past experience with airplanes in similar operational environments, provide guidelines, inspection instructions, or other safety management procedures as necessary to prevent catastrophic failure that will enable operators to distinguish between the level of damage that is covered under the substantiating data for § 25.571(b) (damage Categories 1 through 4) and the level of damage not covered under that substantiating data (damage Category 5).
- 2 Establishing a limitation in the ALS of the ICA which requires conditional inspections after a HEWABI event, and indicates how the operator can identify HEWABI events so that the airplane is removed from service until the appropriate necessary maintenance is completed.
- 3 Providing the appropriate detailed maintenance instructions in the ICA, such as inspections or other actions, to ensure HEWABI events are properly evaluated and dispositioned prior to the next in-service flight. Refer to Order 8110.54A for guidance on ICA content.

Effect of Policy

The general policy stated in this document does not constitute a new regulation. Agency employees and their designees and delegations must not depart from this policy statement without appropriate justification and concurrence from the FAA management that issued this policy statement. The authority to deviate from this policy statement is delegated to the manager of the Transport Standards Staff.

Whenever a proposed method of compliance is outside this established policy, the project aircraft certification office (ACO) must coordinate it with the policy issuing office using an issue paper. Similarly, if the project ACO becomes aware of reasons that an applicant's proposal that meets this policy should not be approved, the office must coordinate its response with the policy issuing office. Applicants should expect that certificating officials would consider this information when making findings of compliance relevant to new certificate actions. In addition, as with all guidance material, this policy statement identifies one means, but not the only means, of compliance.

Implementation

This policy discusses compliance methods that should be applied to type certificate, amended type certificate, supplemental type certificate, and amended supplemental type certificate programs. The compliance methods apply to those programs with an application date that is on or after the effective date of the final policy. If the date of application precedes the effective date of the final policy, and the methods of compliance have already been coordinated with and approved by the FAA or its designee, the applicant may choose to either follow the previously acceptable methods of compliance or follow the guidance contained in this policy.

Conclusion

To ensure the structural integrity of transport category airplanes with composite structure, applicants should consider HEWABI events and develop appropriate conditional inspections. Section 25.571(a) requires applicants to conduct an evaluation of potential accidental damage to PSEs that may result in catastrophic failure that may occur over the operational life of the airplane. For airplanes with composite structure, the accidental damage caused by a HEWABI event may not be readily apparent by visual inspections only. To comply with §§ 25.571, 25.1529 and appendix H to part 25, applicants should provide operators with the appropriate conditional inspections, or other procedures and instructions.

Original signed by

/s/

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Terms

Table A-1 defines the use of key terms in this policy statement. The table describes the intended functional impact.

Table A-1. Definition of Key Terms

	Regulatory Requirements	Acceptable Methods of Compliance (MOC)	Recommendations
Language	Must	Should	Recommend
Meaning	Refers to a regulatory requirement that is mandatory for design approval.	Refers to instructions for a particular MOC.	Refers to a recommended practice that is optional.
Functional Impact	No design approval if not met.	An MOC other than that provided by this policy has to be approved by issue paper (ref. FAA Order 8110.112A).	None, because it is optional.

Appendix B

Background Information: Differences and Similarities for Blunt Impact Versus More Common Impacts

A HEWABI event typically includes an impact object or vehicle whose geometry spreads the resulting forces over a large area of the airplane structure. The high energies involved in HEWABI events can cause damage within the structure, both at the impact location and in reacting structures that are some distance from the contact area. Not all vehicle collisions have enough force or energy to cause potentially catastrophic internal damage and hence may not be considered a HEWABI event. More common impact events may occur due to dropped tools, runway debris, less severe vehicle collisions, and other foreign object impact threats. These types of impacts leave surface markings (e.g., dents, scratches, or local fiber failure) or other damage characteristics which allow the use of industry-wide composite fatigue and damage-tolerance evaluation procedures, which include specific inspection, damage disposition, and repair procedures to return the structure back into service safely. For this policy, HEWABI events are those that have sufficient energy to cause Category 5 damage, but which damage may not be readily apparent from a visual inspection. The applicant should provide general procedures for operators to follow when a possible Category 5 damage event occurs to ensure that the structure is properly inspected and, if needed, repaired prior to further service. The applicant should take care to distinguish Category 5 events from the more typical events identified in damage Categories 1, 2, 3, and 4.

References to Publications Created from FAA/EASA Research

The FAA, EASA, and industry have invested significant research funding to study HEWABI events. Results to date indicate that significant forces are needed to create severe damage (e.g., broken frames, stiffening elements, and widespread disbonding) in HEWABI events. The purpose of this research is to evaluate structural analysis and test protocol for addressing HEWABI and to define the technology needed to support the safety management procedures that assure continued airworthiness. Important aspects of this research are being added to Volume 3, Chapters 12 and 14, of Composite Materials Handbook 17 (CMH-17).

Summary of AC 20-107B Guidance in Regard to Category 5 Damage

AC 20-107B defines Category 5 damage. As defined, there are no particular requirements for structural substantiation of Category 5 damage. However, the applicant needs appropriate thresholds of such damage in relationship to those Category 1 through 4 damage threats which are assessed during the damage tolerance evaluation required in § 25.571. As such, the applicant is responsible for defining the boundary between Category 5 damage and other damages that were considered when conducting their damage tolerance evaluation and establishing inspection and maintenance requirements. Because of the unpredictable nature of events that cause Category 5 events, applicants need not include Category 5 damage in their damage tolerance evaluation per § 25.571(b). However, they should include Category 5 damage when considering accidental damage in compliance with § 25.571(a). The applicant should develop the knowledge

and data to support continued airworthiness, including engineering, maintenance, and operation training and the inspection, disposition, and repair of possible Category 5 events.

By definition, events that cause Category 5 damage are of a magnitude that the applicant should establish operator-to-manufacturer reporting means and define necessary corrective actions, even if there is minimal or no visual evidence. As described in AC 20-107B, applicants should establish conditional inspections to ensure that maintenance personnel take proper action after the reporting of such events. The applicant should define the structural impact events that cause Category 1 through 4 damages such that there is no question of an event which may have caused Category 5 damage. Finally, paragraph 10d(2) of AC 20-107B covers the operations and line maintenance interface to ensure operators report and properly inspect the airplane following a HEWABI event.

Composite Structure Response to HEWABI Events

Product-specific design details have a strong effect on damage created in a HEWABI event. The structural configuration and materials used result in differences in structural element failure modes and progressive damage accumulation. These differences may also determine the exterior visibility of damage that occurs during an impact event. For example, the failure of frames and shear ties may allow very large skin deflections to occur without obvious exterior visual indications of failures in the skin panels during a HEWABI event. In fact, the skin may permanently deform over a very large dent radius but post-event springback leads to a condition where special measurements are needed over a large area to realize that significant interior damage was created. This is also true for sandwich construction, where the core can crush or tear over a wide area but springback occurring in the outer skin may hide the critical damage state. Accurate measurements of springback may indicate the extent of interior damage. As a result, applicants should document work performed by the manufacturer to develop relationships between damage caused by a HEWABI event, dent measurements following springback, and any visual clues of major damage (e.g., distress in bolt holes) to support conditional inspections. As the structural configuration and design details change over the exterior surface, differences are likely for HEWABI events. For example, exterior indications of a HEWABI event near a fuselage cargo door will differ from that occurring in other locations.

In HEWABI studies, DAHs have observed some typical visual clues on the exterior airplane structure that include distress around multiple fastener holes, missing fastener heads, scratches, and a gradual but significant dent depth that has to be quantified over a large distance around the impact site. If immediate access to the interior structure is possible, HEWABI events have become visually obvious (e.g., delaminated stiffeners, broken shear ties, cracked frames) in past DAH studies. This information has been useful in generating conditional inspections.

Appendix C

Recommendations on How a DAH Can Interface with Operators to Jointly Address HEWABI Events

As defined by the classification system offered by AC 20-107B, Category 5 damage is beyond the range of damage covered in damage Categories 1 through 4. Therefore, when an event occurs that could potentially cause Category 5 damage, appropriate safety management practices should be in place to ensure that the event is reported and that inspections and repairs are conducted prior to further flight. The DAH should work with operators and maintenance providers to establish the necessary training. The training should be based on data collected by the DAH in establishing conditional inspections for a HEWABI event. The appropriate training will differ significantly as a function of the corresponding roles in supporting safety. For example, operations, line maintenance, and engineering personnel all have different knowledge needs.

Due to the large number of potential HEWABI threats, it is typically not possible to develop complete inspections and approved repair design or process procedures with the necessary structural substantiation prior to the specific knowledge derived from the incident. To support an operator's ability to develop applicable safety management practices, the DAH should provide, in the maintenance manual (with appropriate references in the ALS), the appropriate conditional inspections or other actions an operator may use to address the occurrence of a HEWABI event. The DAH should also provide a reporting means so that the operator can provide a full description of the potential Category 5 damage to the appropriate engineering personnel to determine damage disposition and repair prior to the next flight. Once maintenance personnel have finished repairs, they may need instructions from the DAH for performing supplemental inspections depending on structural details.

The objective of this policy is to clearly state that the type certificate applicant or DAH should provide limitations in the ALS which reference detailed instructions in the ICA, such as in the aircraft maintenance manual (AMM) or an equivalent document, for the conditional inspections or other procedures an operator should conduct after a HEWABI event. The DAH may provide the operator with data collected during HEWABI tests or analyses to derive "go" versus "no-go" considerations for subsequent flight. The conditional inspections should not rely on information documented in the SRM unless the AMM deems it is appropriate to use for a HEWABI event. The conditional inspections should include either a method of exterior nondestructive inspection that has been proven to detect critical HEWABI damage or interior detailed visual access to all affected structures. The DAH should work with the operator so that when conditional inspections and definitive criteria for damage acceptance and repair do not exist for HEWABI events occurring on specific locations of the structure, the operator understands that they should perform proper inspection and engineering disposition before returning the aircraft to service.

The knowledge gained through HEWABI information from the DAH can help support training development for safety awareness. The FAA encourages DAHs to provide information generated from HEWABI engineering studies that could help form the basis for operator-developed or maintenance provider-developed training used with operations, line maintenance, engineering, and anybody else involved in the reporting, inspection, and engineering disposition

process. The DAH information shared to develop the training should consider personnel job functions and decision levels in the line environment. For example, the DAH should work with the operator to make sure that operations personnel are aware of any incident that could potentially be a HEWABI event and understand that they should properly report the event. The DAH should also work with the operator to ensure line maintenance personnel and inspectors can determine if Category 5 damage is present using procedures to detect such damage with a very high degree of reliability. Finally, the DAH should work with the operator to ensure engineering personnel reviews known details of the event to determine load paths and structure that may have been damaged by the HEWABI event. This information sharing and collaboration between the DAH and the operator should also help to minimize the time from when a HEWABI event is reported to when the airplane may be returned to service.

The DAH should document and share data collected in HEWABI engineering studies with maintenance support organizations internal and external to the DAH. Discussions of HEWABI phenomena and the supporting engineering efforts performed to establish safety management procedures appear in CMH-17, Volume 3, Chapters 12 and 14, Revision G.

The AMM, or an equivalent document, outlines conditional inspections for a HEWABI event. The allowable damage limits (ADL) in the SRM, derived from static strength, fatigue, and damage tolerance data, may not be accurate for HEWABI events because the events causing Category 5 damages are beyond those that are addressed by structural design and substantiation. The FAA recommends adding notes to the SRM to ensure ADL are not applied to a HEWABI event.

In summary, the type certificate applicant (or DAH) should perform the engineering studies to characterize the sources of potential HEWABI events. The DAH should utilize the information obtained from those studies in providing instructions to operators for their reporting of HEWABI events. This information may include any exterior visual clues of serious internal Category 5 damage. The information may also provide conservative estimates of the vehicle collisions needed to cause Category 5 damage in specific locations on the airplane using reasonable scenarios when a HEWABI event may occur (e.g., approximate vehicle size, weight, and speed as a function of structural location.) Additionally, the information may also identify the full range of structural areas that could be affected by a HEWABI event, including the contact zone and adjacent structural reinforcements that react the loads. Operators and maintenance providers should benefit from DAH-defined conditional inspections documented in the AMM that should enhance safety awareness within the industry.