AIR FORCE

STRUCTURES

Structures Bulletin

AFLCMC/EZ
2145 Monahan Way
Bldg. 28
WPAFB, OH 45433-7101
Phone 937-255-5312

Number: EZ-SB-15-001

Date: 30 January 2015

Subject: Aircraft Structure Teardown Inspection and Evaluation Program Protocols

References:

1. Department of Defense Standard Practice, MIL-STD-1530C, “Aircraft Structural Integrity Program”, 1 November 2005.
2. USAFA-TR-2015-01, “CAStLE Teardown Analysis Program Protocol 1: Teardown Data Management System”, October 2014
3. USAFA-TR-2015-02, “CAStLE Teardown Analysis Program Protocol 2: Identification and Tracking”, October 2014
4. USAFA-TR-2015-03, “CAStLE Teardown Analysis Program Protocol 3: Teardown Section Extraction”, October 2014
5. USAFA-TR-2015-04, “CAStLE Teardown Analysis Program Protocol 4: Teardown Section Disassembly”, October 2014
6. USAFA-TR-2015-05, “CAStLE Teardown Analysis Program Protocol 5: Part Coating Removal”, October 2014
7. USAFA-TR-2015-06, “CAStLE Teardown Analysis Program Protocol 6: Lap Joint and CPC Evaluation”, October 2014
8. USAFA-TR-2015-07, “CAStLE Teardown Analysis Program Protocol 7: Nondestructive Inspection”, October 2014
9. USAFA-TR-2015-08, “CAStLE Teardown Analysis Program Protocol 8: Root Cause Analysis of NDI Indications”, October 2014

Introduction:
Aircraft structure teardown inspection and evaluation programs are conducted on durability test specimens and retired aircraft to discover, characterize and thoroughly document structural damage that was not detected via other methods. In this context, they are destructive inspections as opposed to disassembly to enable inspections. The data obtained from these efforts are used in the durability, damage tolerance, and risk

analyses to determine the aircraft structure service life capability and to establish the appropriate maintenance program.

Paragraph 5.3.4.4 in Reference 1 states: “at the end of the full-scale durability test, including any scheduled damage tolerance tests, a destructive teardown inspection program shall be conducted. This inspection shall include disassembly and laboratory-type inspection of those critical areas identified in design as well as additional critical structure identified during testing and during close visual examination while disassembly is performed. Fractographic examinations shall be conducted to obtain crack growth data and to assist in the assessment of the initial quality of the aircraft structure. The EIFS (equivalent initial flaw size) distribution shall be derived from the damage discovered during testing and the teardown inspection. The methods, procedures, and data used to determine the EIFS shall be documented and delivered to the USAF as part of the acquisition contract to serve as a basis to validate any future changes in analytical methods. Prior to teardown, consideration should be given to evaluation of the effectiveness of the anticipated NDI (non-destructive inspection) methods that may be applied to fielded aircraft.”

In addition, paragraph 5.4.3.3.2 in Reference 1 states: “a Structural Teardown Program may be required if an aircraft is expected to operate beyond its design service life or if there is evidence of extensive damage that may jeopardize the aircraft’s structural integrity. The need for and timing of a Structural Teardown Program shall be based on force management updates described in 5.5.6.”

Purpose:
The purpose of this bulletin is to recommend protocols to be used in aircraft structure teardown inspection and evaluation programs.

Discussion:
One of the primary objectives of an aircraft structure teardown inspection and evaluation program is to discover, characterize and thoroughly document structural damage that exists in the as-received condition. An aircraft structure teardown inspection and evaluation program consists of five primary execution elements: extraction, disassembly, coating removal, nondestructive inspection (NDI), and root cause analysis (often referred to as failure analysis). Procedures and processes used to extract sections (areas of interest) and disassemble them to the part level for detailed inspections (e.g. cutting, fastener removal, coating removal, cleaning) should be carefully planned and controlled to prevent accidental or incidental damage. In addition, the detailed methods for coating removal, NDI and root cause analysis to maximize damage detection and to adequately characterize the damage (e.g. location, orientation, type, and dimensions) must be established to support the teardown inspection and evaluation program fidelity requirements.

However, there are other critical aspects of a properly executed aircraft structure teardown inspection and evaluation program that must be developed and implemented that are not as obvious. For example, the number of parts and amount of data generated demands a carefully planned and flawlessly executed data management system throughout the entire chain of custody to ensure traceability at each step in the process. This is not a trivial task considering that parts may be further sectioned to enable root cause analysis.

Procedures and processes to accomplish the above have evolved based on lessons learned and have culminated in a set of protocols that have been used successfully in several recent aircraft structure teardown inspection and evaluation programs. These protocols are documented in References 2 through 9 and are summarized as follows:

1. Establish a teardown data management system (TDMS) that serves as the permanent electronic record of the entire teardown inspection and evaluation program and that provides the ability to create and maintain continuity of data visibility and control through every stage of the program (Reference 2).
2. Identify and track teardown sections (structural areas of interest) for extraction that ensures accurate teardown component identification and continuous tracking throughout the teardown inspection and evaluation program (Reference 3).
3. Perform teardown section extraction that removes structural parts and/or assemblies while preventing incidental damage (Reference 4).
4. Conduct precision component disassembly in a deliberate and organized manner that minimizes damage induced by disassembly (Reference 5).
5. Perform part coating removal while preventing substrate material damage in order to optimize nondestructive inspection results (Reference 6).
6. Where applicable and as needed, perform lap joint and corrosion preventive compound (CPC) evaluation that determines the presence of corrosion in the occluded region of the lap joint and that ascertains whether CPC applied on the lap joint helped to mitigate the corrosion. Also where applicable and as needed, determine the residual strength and residual life in these structural elements (Reference 7).
7. Perform nondestructive inspection (NDI) that interrogates structures and materials for discontinuities, defects, and damage without causing damage to a component or resulting in a loss of vital metallographic evidence (Reference 8).
8. Conduct root cause analysis of NDI indications that determines the root cause and that documents the relevant characteristics of each finding (Reference 9).

Recommendation:
Use References 2 through 9 to establish program-specific protocols for aircraft structure teardown inspection and evaluation programs. When doing so, the program office should determine the primary objective(s) of the teardown inspection and evaluation program such as: (1) identifying new critical locations for follow-on durability and damage tolerance analysis and corresponding updates to the maintenance program, (2) providing data for follow-on quantitative structural risk analysis, (3) providing data for follow-on corrosion assessments and corresponding updates to the maintenance program, (4) determining if the onset of widespread fatigue damage has occurred. The primary objective(s) can lead to different fidelity requirements to include selecting how many and which NDI indications are subjected to root cause analysis. Therefore, the primary objective(s) should be determined early so that the teardown inspection and evaluation program has the proper scope and the program-specific protocols ensure success.

Prepared and Approved by:

Charles A. Babish IV
Technical Advisor, ASIP
AFLCMC/EZ
WPAFB, Ohio

Coordination

Name	*Office Symbol*	*Signature*
Gregory A. Shoales	HQ USAFA/DFEM	
John C. Brausch	AFRL/RXSA	
Gregory A. Schoeppner	AFLCMC/EZFS	
Juan C. Lado	AFLCMC/EZFS	