

Section 10

Guidelines for Damage Tolerance Design and Fracture Control Planning

The attainment of trouble-free and damage tolerant design for safety-of-flight structure on aircraft is a continuing multiple element process which begins in the preliminary design phase and extends through manufacturing into the operational planning and use of the aircraft. The purpose of this process is to develop a planned approach to the control of fracture damage in the aircraft. [Figure 10.0.1](#) illustrates the main elements of the process.

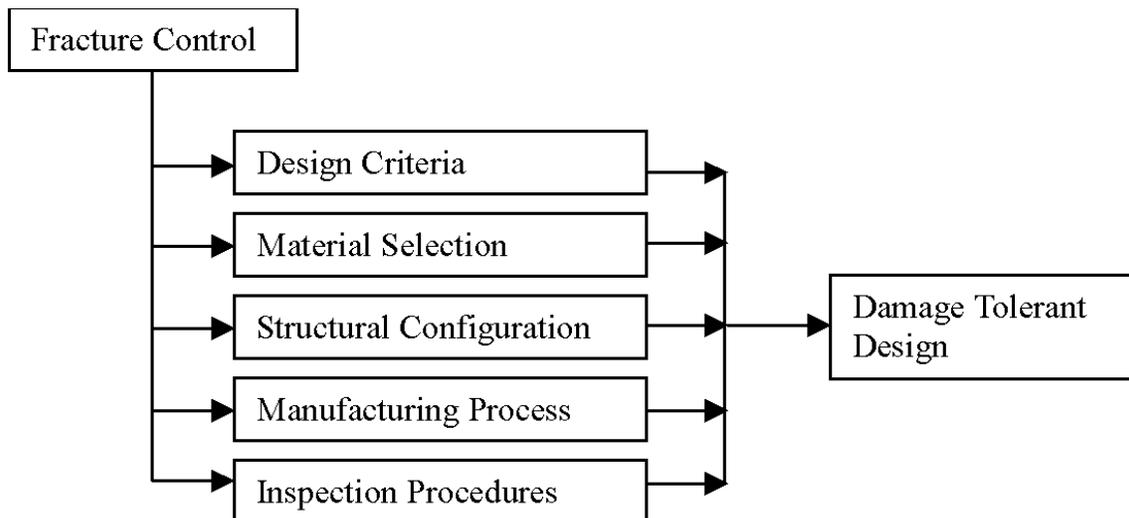


Figure 10.0.1. Elements of Damage Tolerant Design

The design criteria include the service loads history, the functional requirements, and the desired life of the structure. The initial damage assumptions to be used with each type of design concept and degree of inspectability are also specified in the criteria. These are discussed in detail in Section 1.3.

Material selection is a critical element of the process. Trade-off studies are conducted between competing materials and use a comparative property data is necessary in the selection process. Ultimate strength, yield strength, fracture toughness and stress corrosion resistance must be considered together with the expected aircraft environment. The crack growth rate as a function of stress-intensity factor is required.

The structural configuration development must consider the effects of design details on fracture control. The inspection level is defined and a list of critical parts is begun. Consideration of the inspection procedures to be used at each critical location is important. The analysis methods used and the stress-intensity factor computations are a function of the structural configuration and design details, and are set at this time. Testing methods for each critical part and assembly are also developed and incorporated into the damage tolerant design process.

Manufacturing processes must be selected for the critical parts such that they do not reduce the damage tolerance level required by the design. Control of processes and selection of inspection procedures to maintain process quality are the prime consideration of this element.

Procedures for inspecting the aircraft during operational maintenance and the development of the force structural management plan constitute the last element of the total damage tolerant design process.

This introduction of the elements illustrates the strong connections between design, testing, manufacturing, inspection and use in order to obtain and maintain the desired damage tolerant structure and to reduce the incidence of fracture related failures and loss.

The documents that outline the requirements for this activity and describe the various functions are military standards and specifications. MIL-HDBK-1530 establishes the requirements for aircraft structural integration program (ASIP) and JSSG-2006 describes the airplane damage tolerance design requirements.

Wood [1979] provides discussion of the ASIP technology. Tiffany [1978] presents extensive discussions of the durability and damage tolerance problem of USAF aircraft structures. In particular, the review by Mr. C.F. Tiffany, "Durability and Damage Tolerance Assessments of United States Air Force Aircraft," provides a thorough review of the background of this topic.

This section of the handbook describes these tolerant design elements in some detail, and when the described functions are followed, the resultant aircraft structure should have the required level of damage tolerance.